

The Influence of Human Support on Adherence to, and Outcomes of, an Online, Interdisciplinary Mental Health Promotion Intervention for a Healthy Adult Cohort

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Dip Teach, BEd (Primary), Grad Dip (Lifestyle Medicine)

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Doctor of Philosophy

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November 2021

Certification

Statement of Original Authorship

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I hereby certify that this dissertation is in the form of a series of four papers. This dissertation is by publication, supplemented by narrative, as per Avondale University guidelines. Included in this dissertation is a written endorsement by my principal supervisor, Associate Professor Darren Morton, attesting to my contribution to any jointly authored papers.

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List of Publications Included as Part of this Dissertation

This dissertation is presented as a series of four papers. The papers have been published in peer-reviewed journals. The first three papers were published in the *Journal of Medical Internet Research*, a Q1 ranked journal with an Impact Factor of 5.43 (as at September 2021). The fourth article was published in *Frontiers in Health Psychology*, a Q2 ranked journal with an Impact Factor of 2.99 (as at September 2021).

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Other Scholarly Activities Related to the Dissertation

Following is a list of conference presentations, awards and other publications undertaken during the PhD candidature.

Scientific Abstract & Poster Presentations

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Renfrew, M., Morton, D., Kent, L., Morton, J., Hinze, J., Beamish, P., Przybylko, G., & Craig, B. (2018). Study protocol: The human touch - the influence of adherence to and outcomes of an online, lifestyle-based mental health intervention [Oral and poster presentation], Australasian Society of Lifestyle Medicine Conference, 17-19 August 2018, Brisbane, Australia.

Renfrew, M., Morton, D., Morton, J., Hinze, J., Beamish, P., & Przybylko, G. (2019). The influence of human support on the effectiveness of a web- and mobile app-based multimodal lifestyle intervention targeting mental health: A randomised comparative study [Oral presentation], Australasian Society of Lifestyle Medicine Conference, 8-10 June, Auckland, New Zealand.

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Other Publications

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<https://doi.org/10.1186/s40359-021-00577-8>

Przybylko, G., Morton, D. P., Morton, J. K., Renfrew, M. E., & Hinze, J. (2021). An interdisciplinary mental well-being intervention for increasing flourishing: Two experimental studies. *The Journal of Positive Psychology*, 1-16.
<https://doi.org/10.1080/17439760.2021.1897868>

Przybylko, G., Morton, D. P., & Renfrew, M. E. (2021). Addressing the COVID-19 mental health crisis: A perspective on using interdisciplinary universal interventions [Perspective]. *Frontiers in Psychology*, 12(1102).
<https://doi.org/10.3389/fpsyg.2021.644337>

Morton, D. P., Hinze, J., Craig, B., Herman, W., Kent, L., Beamish, P., Renfrew, M., & Przybylko, G. (2020). A multimodal intervention for improving the mental health and emotional well-being of college students. *American Journal of Lifestyle Medicine*, 14(2), 216-224. <https://doi.org/10.1177%2F1559827617733941>

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Abstract

Escalating mental health distress has prompted the call for mental health promotion initiatives to improve the mental resilience of the general population and provide a buffer against common mental health disorders. Digital delivery modes offer accessible and scalable opportunities to implement lifestyle-based interventions to enhance mental well-being. However, digital interventions are hampered by sub-optimal adherence, which negatively impacts outcomes. Little is known about the effectiveness of human support to improve adherence to and outcomes of digital interventions amongst general population cohorts.

This dissertation documents the rationale for and findings of a randomised comparative study that assessed the influence of adding different types of human support to an online, interdisciplinary mental health promotion intervention. Participants were randomised into three intervention groups: standard intervention with automated emails only (S); standard intervention plus personalised text messages (S+pSMS); and standard intervention plus videoconferencing support (S+VCS). A questionnaire was administered pre- and post-intervention to assess changes in depression, anxiety, stress, mental health, vitality, life satisfaction, and flourishing. Adherence was measured by the number of video lessons viewed, points scored for experiential activities, and the number of weeks that participants logged activity. Inductive, thematic analysis of free-text responses in the post-intervention questionnaire elicited participant perceptions about facilitators and barriers impacting adherence. The study results led to a series of three publications, which addressed the three research questions presented in the dissertation and a fourth publication that consolidated the findings and reviewed them in the context of the current literature.

The first publication addressed Research Question 1—What is the influence of different modes of human support on the outcomes of a web and mobile app, lifestyle-based mental health intervention for a healthy adult cohort? This publication found that human support had little influence on the outcomes of the intervention. Significant improvements were recorded from baseline to post-intervention in every outcome measure, irrespective of the types of human support offered ($P \leq 0.001$). Between-group differences were not observed for any of the outcome measures:

depression ($P=0.93$), anxiety ($P=0.25$), stress ($P=0.57$), mental health ($P=0.77$), vitality ($P=0.65$), life satisfaction ($P=0.65$), and flourishing ($P=0.99$).

The second publication addressed Research Question 2—What is the influence of different modes of human support on attrition and adherence to a web and mobile app, lifestyle-based mental health intervention for a healthy adult cohort, including the influence of participant preference? Early dropout attrition differed between the groups ($P=.009$), being disproportionally higher in the videoconferencing support group. However, there was no difference in adherence behaviour between the groups (i.e., number of videos viewed, $P=0.42$; mean challenge points scored, $P=0.71$; and the number of weeks challenge points were logged, $P=0.66$), indicating that human support had little effect.

The third publication addressed the final research question—What do healthy adult participants perceive as the facilitators of, and barriers to, adherence to a web and mobile app, lifestyle-based mental health intervention? Qualitative thematic analysis revealed that human support did not feature strongly as a facilitator or barrier to intervention adherence. Perceived adherence facilitators included engaging content, time availability, accessibility, enjoyable challenges, valuing the program, and personal motivation. Time scarcity was overwhelmingly perceived as the most dominant adherence barrier. Other barriers included completing and logging experiential activity, content length, technical difficulties, and interindividual personal factors.

The study's findings provided novel insights into an exposed research gap, as little was known about the influence of human support on adherence to and outcomes of a digital mental health promotion intervention when delivered to a general population group. The fourth publication, a review, synthesised the overall findings of this dissertation in conjunction with other recent literature and provided recommendations for future studies.

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Glossary of Common Abbreviations

7DWI	Seven Dimensions of Wellness Index (Questionnaire)
BITs	Behavioural intervention technologies
CBT (ICBT)	Cognitive Behavioural Therapy (Internet CBT)
DASS- 21	Depression Anxiety & Stress Scales – 21 Question version
DMHPI	Digital mental health promotion intervention
eLMS	Web-based learning management system
LM	Lifestyle medicine
LMP	Live More Project
MHPI	Mental health promotion intervention
PERMA	Positive emotions, engagement, relationships, meaning, accomplishment
PP	Positive psychology
PPT	Positive psychotherapy
PSD	Persuasive Systems Design
RCT	Randomised control trial
S	Standard (automated emails only)
SAM	Supportive Accountability Model
SF-36	Short-form 36 Health Survey
S + VCS	Standard plus videoconference support
S + pSMS	Standard plus personalised short message service

SMS	Short message service
SDT	Self-determination Theory
TPB	Theory of Planned Behaviour
WHO	World Health Organization

Definition of Terms

Adherence	The extent to which individuals experience the content of an intervention in the way it was intended by designers (Kelders et al., 2012).
Affective disorders	Psychiatric mood disorders (e.g., depression, bi-polar).
Behavioural Intervention Technologies	“The application of behavioural and psychological intervention strategies through the use of technology features to address behavioural, cognitive and affective targets that support physical, behavioural and mental health” (Mohr, Burns, et al., 2013, p 332).
Chronic disease	A non-communicable disease, often lifestyle-related, that is ongoing in nature.
Clinician	A qualified person in direct contact with a patient (e.g., general practitioner, psychiatrist or psychologist).
Co-morbidity	The presence of two or more diseases in an individual at the same time.
Dropout attrition	The number of participants who do not achieve the research protocols at various time points (e.g., early dropout—did not complete the pre-questionnaire).

E-Intervention	Interventions delivered via online or digital methods (web, app, tablet or other electronic technologies).
Healthy adult cohort	A non-clinical population group who have not been grouped according to diagnosis or disease.
Lifestyle Medicine	“The application of environmental, behavioural, medical and motivational principles to the management (including self-care and self-management) of lifestyle-related health problems in a clinical setting” (Sagner et al., 2017, p.3).
Live More Project	A 10-week, interdisciplinary lifestyle-based intervention that uses a range of strategies from the fields of positive psychology and lifestyle medicine to enhance mental well-being.
Mental distress	Symptoms relating to public health that may include high perceived stress, depressive mood, anxiety and other somatic symptoms such as low energy, disturbed sleep and fatigue.
Mental health promotion	A resource, practice, event, or intervention that focuses on enhancing mental well-being.
Mental illness	A broad range of conditions that affect thinking, mood, and behaviour.
Non-usage attrition	An alternative term for non-adherence.
Persuasive Systems Design	“Computerized software or information systems designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception” (Oinas-Kukkonen & Harjumaa, 2009, p. 486).

Positive psychology The study of the strengths and virtues that enable individuals, communities, and organisations to thrive (Seligman & Csikszentmihalyi, 2000a).

Chapter One - Overview

1.1 Background

Mental well-being is languishing globally. Affective (i.e., mood) disorders are amongst a range of chronic diseases that continue to escalate, and depression is a leading cause of disability worldwide, with greater than 264 million people of all ages suffering from depression (World Health Organization [WHO], 2021a).

Globally, between 50-85% of people with a mental illness go without treatment (WHO, 2017a). Escalating antidepressant use and the high incidence of suicide, both globally and nationally in Australia, indicate severe mental distress among the world population—suicide is the second leading cause of death in the 15-29 age group worldwide (WHO, 2021a). In Australia, general practitioners report that psychological problems are the most common ailment they manage (The Royal Australian College of General Practitioners, 2020), and mental health disorders are the most common chronic condition in people under 45 years old (Australian Institute of Health & Welfare, 2020b).

The factors that contribute to poor mental health stem from a complex interplay of political, social, environmental, and biological influences. The World Health Organisation (WHO) reports that unemployment or poor employment conditions, socio-economic pressures, violence (particularly sexual violence), psychological trauma, gender discrimination, rapid social change, physical ill-health, unhealthy lifestyle practices, deprivation of human rights, personality influences, and genetic factors all contribute to poor mental well-being (WHO, 2021a). In addition, the recent Coronavirus Disease 2019 (COVID-19) pandemic has severely augmented mental health distress (Holmes et al., 2020; Kola, 2020). While the aetiology of mental distress is diverse and varies widely between individuals and even nations, there are overarching distal influences (e.g., industrialisation, modernisation) that have radically reshaped how humans live. The inadvertent side-effects of such radical changes (e.g., sedentary living, processed foods) have likely contributed to the widespread increases in chronic disease (Egger, 2011), including mental health disorders.

In 2013, in response to the burgeoning rise in mental health disorders, the WHO (2013) called for a comprehensive country-level response and developed a Mental Health Action Plan (2013–2020), which has since been extended to 2030. The key objectives of the plan include strengthening leadership and governance, provision of comprehensive mental health care services in communities, implementation of mental health prevention and promotion strategies, and strengthening of information systems (i.e., data gathering and reporting) (WHO, 2021b).

While medication, psychotherapy, and commonly used traditional treatments will always play a vital role in treating mental health disorders, the 21st-century mental health crisis, sometimes referred to as a pandemic due to its worldwide pervasiveness (Junne et al., 2018), requires every effective option to be employed to halt its escalating prevalence. A vital component of a mental health plan of action for the 21st-century should incorporate evidence-based mental health promotion and primary prevention initiatives as a core public health objective, along with established secondary and tertiary prevention to curtail the escalation in the prevalence of mental health disorders (Cuijpers et al., 2015). Psychotropic medications are limited in efficacy, and there have been repeated calls and mounting evidence to broaden the repertoire of treatment for mental health disorders (Gander et al., 2016; Gander et al., 2013; Jacka, 2017; Rucklidge et al., 2015; Walsh, 2011). Interventions should include not only assistance for those already affected by a mental health disorder (i.e., secondary and tertiary prevention) but a more focused approach to prevent the onset of mental health disorders (i.e., primary prevention) and strategies to enhance the mental resilience of healthy population groups (i.e., mental health promotion). Notably, there is an array of lifestyle-based approaches that may be used to boost the mental resilience of the general population, potentially safeguarding them against mental distress.

For a prolonged period, various researchers have advocated for the adoption of effective non-pharmacological strategies (e.g., physical activity, nutrition, stress management, mindfulness, gratitude writing) to address the burgeoning mental health crisis (Davey & Chanen, 2016; Rucklidge et al., 2015; Sarris et al., 2014; Stephenson et al., 2013; Walsh, 2011). In particular, some strategies have been identified as mental well-being enhancers from two distinct yet complementary

fields: positive psychology (PP; Bolier et al., 2013; Hendriks et al., 2020; Lyubomirsky et al., 2011; Sin & Lyubomirsky, 2009) and lifestyle medicine (LM; Bodai et al., 2018; Dale et al., 2014; Rohrer et al., 2005; Walsh, 2011). Therefore, multidisciplinary, lifestyle-based mental health promotion interventions (MHPIs) may offer an evidence-based and palatable range of strategies to enhance the mental well-being of the general (i.e., healthy) population, potentially buffering against the development of mental distress. Of vital importance is how best to disseminate MHPIs to optimise efficacy.

Innovation in digital technology provides an opportunity for disseminating MHPIs for the general population, particularly in middle and high income countries, in a way that maximises accessibility, scalability, and cost-effectiveness (Apolinário-Hagen et al., 2018; Ebert, Buntrock, et al., 2017; Romero-Sanchiz et al., 2017; Woodworth et al., 2017). A German general population cohort indicated a preference for interventions delivered using the internet) as they provide several advantages to participants, including greater autonomy, convenience and flexibility in intervention engagement (Apolinário-Hagen et al., 2018). Furthermore, the ongoing development and refinement of digital behaviour change technology (Michie et al., 2013; Michie et al., 2015; Michie et al., 2017) and persuasive system design (PSD) (Matthews et al., 2016; Oinas-Kukkonen & Harjumaa, 2009) has led to sophisticated intervention development designed to induce behaviour change in participants undertaking digital interventions. However, despite increasingly innovative intervention design and delivery, a common problem limits the effectiveness of digital mental health promotion interventions (DMHPIs)—namely, high attrition and low adherence.

Digital interventions that focus on mental health often have unacceptably high attrition (i.e., participants drop out of a study early or are lost to follow-up) and low adherence (i.e., participants not adhering to the intervention in the way recommended by program designers), sometimes called non-usage attrition (Kelders et al., 2012). Low adherence has thwarted the success of many digitally-delivered interventions, with wide variations in adherence levels between studies (Kelders et al., 2012; Linardon & Fuller-Tyszkiewicz, 2020; Mohr et al., 2011; Rickard et al., 2016; Schueller et al., 2016; Yardley et al., 2015). Eysenbach (2005), in a formative article titled “The Law of Attrition”, highlighted a critical factor with digitally delivered, health-related interventions—the ease in which participants can stop using

an intervention or drop out. This problem is possibly due to the anonymity afforded by digital approaches (Carolan & de Visser, 2018). Notably, while a range of factors influencing adherence to digital interventions has been identified (Beatty & Binnion, 2016), human support has been commonly asserted as a central moderating factor (Baumeister et al., 2014; Mohr et al., 2011).

Previous research that evaluated digital psychological interventions for patients in clinical settings has generally demonstrated that the addition of human support has improved adherence and outcomes (Baumeister et al., 2014; Kelders et al., 2012; Richards & Richardson, 2012). However, more recent studies have revealed mixed results (Shim et al., 2017). Furthermore, some recent studies have demonstrated that even in clinical settings, carefully designed, self-guided interventions achieve comparable outcomes as identical interventions that have added human support (Dear et al., 2015; Dear, Fogliati, et al., 2018; Titov et al., 2015; Titov et al., 2016). Plausibly, healthy participants from the general population (i.e., non-clinical clients) may differ in their need for added human support compared to those impacted by symptoms of a disorder (e.g., low mood, general malaise) (Mohr, Duffecy, et al., 2013).

It is vital to evaluate the influence of adding different modes and levels of human support to DMHPIs. While adding human support may improve adherence and outcomes, it may also have cost implications, often uses scarce human resources, and reduces the scalability of interventions that may be widely disseminated to enhance the mental resilience of the general population.

This dissertation evaluates the influence of human support on attrition, adherence, and outcomes of a web- and app-based DMHPI. The dissertation will also evaluate users' perceptions concerning the key facilitators and barriers that influence adherence to a DMHPI.

1.2 Research Aims and Objectives

1.2.1 Aims

This study aimed to evaluate the influence of different modes of human support on the outcomes of, and adherence to, a web- and mobile app-based MHPI

for a general population cohort. The study also aimed to evaluate user perceptions about the factors (i.e., facilitators and barriers) influencing adherence to the intervention.

1.2.2 Objectives

The objectives of the study focused on answering three research questions:

1. What is the influence of different modes of human support on the outcomes of a web and mobile app, lifestyle-based mental health intervention for a healthy adult cohort?
2. What is the influence of different modes of human support on attrition and adherence to a web and mobile app, lifestyle-based mental health intervention for a healthy adult cohort, including the influence of participant preference?
3. What do healthy adult participants perceive as the facilitators of, and barriers to, adherence to a web and mobile app, lifestyle-based mental health intervention?

1.2.3 Contribution of the study

This dissertation contributes to the scant knowledge regarding how to optimise the effectiveness of online interventions for general population cohorts. It informs about the level of human support required to maximise outcomes and adherence and examines key participant perceptions influencing adherence. The dissertation provides recommendations for the future implementation of DMHPIs, that may satisfy human support preferences while also optimising efficacy, scalability, and cost-effectiveness.

1.3 Dissertation Structure and Overview

The data for this dissertation is derived from a three-armed, randomised, comparative DMHPI that was designed to compare the influence of three different modes of human support on attrition, adherence, and outcomes and examine user perceptions about influences on adherence. The intervention was administered as a web- and mobile app-based initiative for a healthy, adult, community-based population group. A series of three publications explain the study results. The

dissertation is structured to sequentially address the research questions, culminating with the findings, discussion and a fourth publication in the form of a review.

1.3.1 Dissertation outline

Chapters One to Three explain the setting for the intervention. Chapter One (this chapter) provides an overview of the background to the study, states the aims and objectives of the intervention, and outlines the structure of this dissertation. Chapter Two presents an extensive literature review concerning many facets of mental health, the importance of mental health promotion, the numerous facets of human support, and the evidence relating to the influence of human support on adherence and outcomes of DMHPs. Chapter Three describes the methodology in planning, implementing, measuring, and analysing the intervention study results.

Chapters Four to Six share the study results through a sequence of three publications published in the *Journal of Medical Internet Research* (JMIR)—the leading peer-reviewed journal for digital health and medicine. Chapter Four presents the first publication and addresses the first research question, “*What is the influence of different modes of human support on the outcomes of a web and mobile app lifestyle-based mental health intervention for a healthy adult cohort?*” Chapter Five presents the second publication and shares the results of the second research question, “*What is the influence of different modes of human support on attrition and adherence to a web- and mobile app-based lifestyle-based mental health intervention for a healthy adult cohort, including the influence of participant preference?*” Chapter Six presents the third publication and addresses the third research question, “*What do healthy adult participants perceive as the facilitators of, and barriers to, adherence in a web- and mobile app-based lifestyle-based mental health intervention?*”

Chapter Seven provides a summary and discussion of the findings, suggests future directions, and presents conclusions of the study. The chapter culminates with a review paper titled “*The Influence of Human Support on the Effectiveness of Digital Mental Health Promotion Interventions for the General Population*”, published in the peer-reviewed journal, *Frontiers in Health Psychology* in July 2021.

Chapter Two – Literature Review

2.1 Chapter Overview

This chapter provides an overview of the many facets of mental health and its promotion to enable communities and individuals to thrive. The first section explores the numerous aspects of mental health, including a definition, and reviews vital global and national indicators of mental health distress. The chapter also evaluates the multifactorial aetiology of mental distress within the context of distal, medial, and proximal influences. Mental health promotion and the various forms of prevention are defined and summarised, including the typical treatments for common mental health disorders. Strategies from the fields of lifestyle medicine and positive psychology introduce an interdisciplinary intervention approach, which may enhance the mental resilience of the general population. Such an approach requires effective implementation; hence, the effectiveness of face-to-face and digital (i.e., online) delivery modes are evaluated, recognising the practicality of the widespread transition to digital methods. The chapter reviews the benefits of and barriers to digital delivery, identifying a foremost problematic factor—sub-optimal adherence—which negatively influences outcomes.

The second section of this literature review exposes factors influencing adherence to digital interventions and specifically appraises human support which is commonly perceived as a substantial influence on adherence and outcomes. The chapter reviews the underpinning theoretical framework and models of human support, along with several other widely used modes of support. Numerous studies that test the influence of human support on adherence and outcomes are appraised, revealing mixed results. Notably, the review reveals substantially more studies evaluating the effectiveness of human support amongst clinical cohorts than non-clinical, general population groups. The scarcity of research amongst the healthy general community population groups has led to the formulation of this intervention study to determine the effectiveness of human support to improve adherence and outcomes for a general population cohort.

2.2 Mental health – Definitions and Challenges

The global and national decline of mental health is alarming, and the call to address it as a priority resulted in the World Health Organization (WHO) preparing a Global Mental Health Action Plan (2013-2020) which has since extended to 2030 (WHO, 2021b). The WHO recognised that “there is no health without mental health” (2013, p. 6); yet, precisely defining mental health is challenging given diverse ideas regarding this critical well-being construct.

The WHO Mental Health Action Plan (2013-2020) conceptualises mental health/well-being for an adult as a “... state of well-being in which the individual realises his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community” (WHO, 2013, p. 6). Similarly, in a review of wellness theories within the counselling field, Roscoe (2009, p. 219) synthesises various interpretations of mental wellness from key researchers (Adams et al., 1997; Hettler, 1980; Renger et al., 2000) to be conceptualised as “... awareness and control of feelings as well as a realistic, positive and developmental view of self, conflict and life circumstances”. Elucidating further, Roscoe (2009, p. 219) proposes optimal mental wellness may include:

- i. Positive attitudes and beliefs for self and others (e.g., positive and realistic self-concept, identity, and self-esteem).
- ii. Awareness and constructive handling of feelings.
- iii. Realistic appraisal of own limitations.
- iv. Ability to act autonomously and cope with stress.
- v. Capacity to foster fulfilling relationships with others.

The relatively new field of positive psychology (PP) expands on the definition further. Traditionally, good mental health may have been perceived as the absence of a mental illness; yet, Seligman (2013) observed that alleviating mental illness does not result in a thriving, happy person. Therefore, the absence of mental illness is not synonymous with optimal mental health. Consequentially, Seligman developed his Well-being Theory, where the gold standard for optimal well-being is flourishing. Five pillars underpin flourishing: positive emotions, engagement,

relationships, meaning, and accomplishment (PERMA) (Seligman, 2013). While some of these factors may influence other dimensions of wellness, Seligman's theory predominantly refers to the realm of mental well-being.

PP has helped expand the view of mental health from a focus on surviving, attenuating, or avoiding illnesses such as depression or anxiety to the purposeful development of positive attributes that enable optimal functioning and ultimately a flourishing life (Mitchell et al., 2009). Notably, Seligman's Well-being Theory has gained traction globally, with various sectors (e.g., defence forces, education) now using PERMA as a psychological well-being framework (Australian Psychological Society, 2016; Lovett & Lovett, 2016).

Given the above discussion, the definition of mental health should incorporate critical aspects such as positive attitude, healthy self-esteem, awareness of and ability to manage feelings, the ability to think and act autonomously, and the ability to modulate stress and cultivate fulfilling relationships with others. At the same time, with some crossover, purposeful pursuit of optimal mental wellness may include Seligman's five pillars: fostering positive emotions, seeking engagement, nurturing positive relationships, seeking meaning and purpose, and succeeding through accomplishment appropriate to an individual's strengths. Intentional cultivation of the above attributes facilitates emotional resilience and undoubtedly provides a vital buffer against mental distress. Notably, in concert with a broader well-being perspective, an individual's mental health will also be influenced by extrinsic factors such as living standards, political policy, economic conditions, environmental factors (artificial and natural), work circumstances, and social support (Kazdin & Rabbitt, 2013; WHO, 2017b).

2.2.1 Global and national indicators of mental health distress

Typically, within the allopathic paradigm (i.e., a system of medicine focused on treating disease with drugs, surgery, and other conventional methods), physical health has commanded greater attention than mental health, despite mental wellness drastically deteriorating worldwide (O'Neil et al., 2015; Whiteford et al., 2013). Four chronic diseases—cardiovascular disease, type 2 diabetes, cancer, and chronic respiratory disease—that result in the most deaths globally have received the highest

attention (O'Neil et al., 2015; Whiteford et al., 2013). Moreover, the WHO (2017a) states that health systems have not satisfactorily responded to mental health needs and acknowledge the extensive gap between provision and requirement of treatment. As many as 76-85% of those diagnosed with mental health disorders in low- and middle-income nations receive no treatment, and 35-50% in high-income countries go without medical intervention (WHO, 2017a). The costs are high to individuals, healthcare systems, and the economy. A recent analysis reports that mental illness represents one-third of global disability, with depression and anxiety being major contributors (Vigo et al., 2016).

Depression, as a chronic disorder, is a significant contributor to the global burden of disease, affecting over 264 million people and resulting in dysfunction in the family, work, and school environments (WHO, 2021a). According to the WHO (2013), individuals with major depression have a 40-60% risk of dying prematurely. Additionally, suicide is the second leading cause of death globally in those aged 15-29 years (WHO, 2021a), and many people, although not diagnosed with a disorder, appear to be stressed or anxious and are certainly not flourishing (Australian Psychological Society, 2015; Sin & Lyubomirsky, 2009; Slade, 2010).

Australian indicators reflect the global situation. While many people are not necessarily diagnosed with a mental health disorder, they are not flourishing either. Escalating stress and pervasive anxiety across nearly all age groups demonstrate the declining emotional well-being in the seemingly healthy population. As an example, in the 2015 Stress and well-being in Australia survey, 35% of Australian adults reported significant levels of distress, 26% stated they suffered from above-normal anxiety, and 26% described themselves as having moderate to extreme depression levels (Australian Psychological Society, 2015). The Health of the Nation 2020 report from the Royal Australian College of General Practitioners (RACGP) demonstrates that mental health issues continue to be the most common reason for visits to a general practitioner. This trend has remained unchanged since 2017 (RACGP, 2020). Alarming, one study reported that the prevalence of mental health distress in Australia doubled in the early stages of the COVID-19 pandemic (Fisher et al., 2020). Additionally, suicide is in the top five leading causes of premature death across every Australian region and is the foremost cause of death in the 15-44 age group (Australian Institute of Health & Welfare, 2020a).

Trends in the use of psychotropic drugs also indicate escalating mental distress. Antidepressant use has more than doubled in Australia (Organisation for Economic Co-operation and Development, 2015). With escalation of depression prevalence, antidepressants are the most commonly prescribed psychotropic medications used by one in ten Australian adults (Jorm et al., 2017; Stephenson et al., 2013). Similar scenarios exist globally, where one in eight North Americans (Jorm et al., 2017; Kantor et al., 2015) and 15% of the United Kingdom population (Coupland et al., 2011) routinely use antidepressant medication.

2.2.2 Aetiology of mental health distress

The causes of mental health distress are multifactorial and complex, requiring much broader consideration than only factors within individuals' direct control. The WHO describes factors affecting mental health as those that come from distal influences (i.e., factors beyond individuals' control) or proximal impacts (i.e., factors within an individual's direct control). Factors include social, cultural, political, environmental, and economic determinants such as war, living standards, working conditions, violence, human rights violations, gender discrimination, poor lifestyle habits, genetic factors, physical ill-health, age-related factors, and other inter-individual variables (WHO, 2018b; 2021a; 2021b).

Egger and Dixon (2014) assert that causes of a host of chronic conditions, including mental health disorders, may have a deep-rooted aetiology in significant societal change. Egger et al. (2009) describe a hierarchy of causes for chronic diseases, labelling distal causes as industrialisation, modern lifestyle, and economic growth. They propose that chronic physical and mental health diseases emerged in tandem with a colossal lifestyle shift, heralded by industrialisation and pushed along by an insatiable desire for economic growth. As Pusey pertinently states, "economic reform is all about feeding the furnace, not the souls of the people" (2003, p. 176). Similarly, in evaluating the increase in psychopathy in young Americans from 1938 to 2007, Twenge et al. (2010) concluded that the escalation in mental distress fits a model of cultural change where the focus on extrinsic goals such as money, appearance, and status has overtaken intrinsic factors such as community and relationships. Arguably, manufacturing, automation of industry and transport, technological advancement, food processing, the fast-food industry, advertising,

changing gender roles, job changes, rapid urbanisation, and an array of other factors have revolutionised life as it was known. The distal, yet broad-based transformation to a modern lifestyle, influences a variety of medial causes such as occupation, stress, anxiety, depression, social and peer pressure (Egger et al., 2009). Furthermore, medial causes become direct links to proximal causes of chronic disease, such as smoking, poor diet, inactivity, alcohol, drugs and obesity (2009), all of which impact mental and physical health. Additionally, the recent, almost ubiquitous, adoption of digital technology may have augmented the decline in mental well-being.

2.2.2.1 Social media & social isolation

Technological innovation enables constant and instant communication globally; however, evidence is emerging that increased social media activity may be associated with increased social isolation rather than social connectedness, further augmenting mental health crisis. Numerous studies have demonstrated that social connectedness is crucial to vibrant health and lower mortality risk (Holt-Lunstad et al., 2015; Holt-Lunstad et al., 2010). However, research conducted in the United States of America (USA) concluded that young adults who engaged in high social media use experienced more perceived social isolation than counterparts with low social media use (Primack et al., 2017; Shensa et al., 2015). Problematic smartphone use, described as a form of unhealthy dependency, has been linked to anxiety, depression, the need for touch, and the fear of missing out (FOMO) phenomenon, which is the need to be constantly connected to social media so as not to miss out on important events (Elhai et al., 2016). Conversely, a systematic review found inconsistent evidence regarding the negative effect of social media concerning mental well-being for adolescents (Best et al., 2014). Pittman and Reich (2016) found that image-based social media (e.g., Instagram, Snapchat) ameliorated loneliness compared to text-based styles, suggesting image-rich media enhanced intimacy. In situations where social media has been an adjunct to health care in patient and caregiver situations, the effectiveness has generally been positive, although not significant (Hamm et al., 2013). Despite the conflicting evidence regarding social media, there appears to be a growing realisation in the community that real-time human interaction is becoming a threatened norm. The preoccupation with technology may indeed have a negative effect that impairs mental well-being.

Two poignant pictorial portrayals of the snares of modern social media culture have received substantial attention on YouTube, indicating a growing awareness of social media's effects. *I Forgot My Phone* (2013), has been viewed by more than 52 million people and *Look Up* (2014) tallied more than 62 million views.

2.2.3 Mental health disorders and comorbidities

Many disease determinants are interrelated and share common pathways to mental health disorders and various other chronic diseases. Therefore, comorbidities are prevalent (Kazdin & Rabbitt, 2013; Mrazek et al., 2014; O'Neil et al., 2015). Twenty-five per cent of the Australian population in 2014/15 had two or more common chronic conditions (Australian Institute of Health & Welfare, 2016). For instance, having depression predisposes sufferers to cardiovascular disease and vice versa (O'Neil et al., 2015). Anxiety disorders predispose sufferers to cardiovascular disease and death (Roest et al., 2010), and the use of antidepressant medication independently predicts the onset of type 2 diabetes (de Groot et al., 2018). Determinants such as low socioeconomic status, alcohol use, and stress are risk factors common to many chronic conditions (WHO, 2013). Additionally, comorbidities within various mental health disorders are common (McGrath et al., 2020).

2.3 Mental health - Promotion, Prevention and Treatment

It is essential to understand the terms used for prevention and the population groups that the various types of prevention target when discussing mental health. Table 1 provides a summary of definitions. Mental health promotion activities focus on enhancing mental health through a range of measures to boost emotional resilience and are usually disseminated to population groups without screening for symptoms of a disorder. Primary prevention includes three sub-groups—universal, selective, and indicated—and all primary prevention sub-groups seek to prevent the onset of mental health disorders. Notably, universal primary prevention interventions may frequently include those considered to fit the criteria for selective or indicated prevention (Tan et al., 2014). Secondary prevention targets treatment for groups displaying signs and symptoms of a disorder, and tertiary prevention focuses on

rehabilitation through alleviating and managing symptoms for those diagnosed with a mental health disorder.

Table 1. *Promotion and prevention definitions (Patterson, 2009; WHO, 2002)*

Term	Definition
Mental Health Promotion	Focuses on enhancing mental health and well-being for all.
Primary Prevention	Seeks to prevent the onset of a mental health disorder.
(a) Universal/general	Targets prevention of onset for general population groups, regardless of risk status (e.g., mental health literacy program).
(b) Selective	Targets prevention of onset for individuals or specific groups deemed at higher risk for developing a mental health disorder (e.g., refugees, new mothers).
(c) Indicated	Targets prevention of onset for individuals or groups at imminent risk of developing a mental health disorder (e.g., children of substance abusers).
Secondary Prevention (Treatment)	Focuses on lowering the prevalence through early detection and treatment for those at risk or who show early signs or symptoms (e.g., screening tests, counselling).
Tertiary Prevention (Rehabilitation)	Seeks to alleviate the impact of an existing mental health condition by reducing disability, providing rehabilitation, and preventing relapses in those who already have a mental health disorder (e.g., support groups, management programs).

A broad array of resources focuses on enhancing mental health or averting, treating, and managing mental health disorders. The following section outlines some of the resources, methods, and programs available for mental health promotion and

the various forms of prevention. Notably, there is substantial cross-over between the multiple designations, as what may be helpful for a patient who is managing a mental health disorder may also be used for another person to promote positive mental well-being (e.g., healthy diet). Resources have been grouped generally into two sub-sections: mental health promotion and primary prevention, secondary and tertiary prevention.

2.3.1 Mental health promotion & primary prevention

Numerous agencies provide an extensive array of information and links that are helpful for mental health promotion and primary prevention. Commonly used websites in Australia include Head to Health (<https://headtohealth.gov.au/>), Beyond Blue (www.beyondblue.org.au), and the Black Dog Institute (www.blackdoginstitute.org.au)—all are freely accessible resource hubs. These may assist users in engaging in activities to enhance their mental health, avert common mood disorders, and provide valuable support to those already affected by mental health disorders.

The Act-Belong-Commit (ABC) campaign developed in Western Australia is a lifestyle framework website designed to promote mental health at the population, community, or clinical level (Donovan & Anwar-McHenry, 2016). It provides a framework that encourages positive physical, spiritual, social, and mentally active behaviours that increase a sense of belonging and promote commitment to worthwhile causes that give meaning and purpose (Donovan & Anwar-McHenry, 2016). The ABC initiative includes an online self-assessment tool, an extensive self-help guide, and links to a broad selection of geographically-specific resources for the Western Australian population.

From the field of PP, the Penn Resilience Program, also called PERMA Workshops (Reivich et al., 2011), is a strength-based program designed to build resilience, optimism, and well-being, and may be customised to suit different audiences such as schools, military, corporate groups, government agencies, and community groups (Macfarlane et al., 2017). Additionally, many other specific strategies from PP and LM are also broadly applicable and prove efficacious as

preventive measures (Gander et al., 2016; Walsh, 2011). PP and LM will be discussed extensively in a subsequent section.

Some primary prevention initiatives target population sub-groups such as children, young adults, cultural groups, and those falling into specific at-risk categories (e.g., refugees, new mothers, and defence personnel). Prevention settings include schools, universities, workplaces, cultural groups, community clusters, and within support networks for specific groups identified as high-risk. For instance, the Stress Resilience Training System (Cohn et al., 2013) is an interactive iPad gaming tool for improving stress resilience and is embraced by military and other high-stress occupations to buffer against work-related trauma. *Mind Matters* for secondary schools and *Kids Matter* for primary schools are comprehensive support frameworks for school administration teams to develop and administer mental health promotion and primary prevention in the classroom. The Australian-based *Mates in Construction* suicide-prevention program is a program that addresses unacceptably high suicide statistics in the construction industry (Gullestrup et al., 2011).

Moreover, sometimes effective prevention messages occur organically within the community. A viral selfie campaign in 2016 quickly spread its influence worldwide when United Kingdom rugby player, Luke Ambler, posted an image of himself doing the “okay” sign with the hashtag #ITSOKTOTALK on social media after the sudden death of his brother-in-law (Laschon, 2016). The viral campaign led to an increase in men talking about their mental well-being problems with a direct focus on reducing lives lost to suicide.

2.3.2 Secondary & tertiary prevention

Many resources address secondary (i.e., treatment-focused) and tertiary (i.e., rehabilitation and management-focused) prevention. The following sub-sections provide an overview of commonly used secondary and tertiary methods in mental health: guided self-help, the stepped-care treatment model, psychotherapy, and psychotropics.

2.3.2.1 Guided self-help

There are various forms of guided self-help. Firstly, cognitive behavioural therapy (CBT) approaches on the internet (ICBT) are used as a form of self-help with

support and guidance from a therapist. Intervention effects of ICBT vary substantially due to an interplay of factors, including content, personal support provided, and therapist role (Johansson & Andersson, 2012). Secondly, bibliotherapy is a treatment where a patient works through an agreed-upon self-help book under a doctor or therapist (Usher, 2013). Notably, many forms of ICBT are online bibliotherapy (Andersson et al., 2014). As a possible option for initial treatment, bibliotherapy presents numerous advantages: it is easily accessible, relatively inexpensive, avoids adverse side effects, empowers the client, avoids stigmatisation, and may shorten treatment time (Gregory et al., 2004). As bibliotherapy is a non-pharmacological treatment, it requires a series of structured consultations where the professional supports, motivates and guides the client to work through the agreed text (Gregory et al., 2004; Usher, 2013). Patients require a positive attitude and a high level of motivation to use bibliotherapy; however, those traits are typically scarce in patients with moderate to severe depression. Therefore, bibliotherapy may only be suitable for patients with mild symptoms (Gregory et al., 2004; Usher, 2013). A meta-analysis of bibliotherapy treatments found that a combined effect size (Cohen $d=0.77$) was comparable to psychotherapy. Teens and younger adults tended to respond well to the treatment method, and group bibliotherapy was also a possible option (Gregory et al., 2004). Careful consideration of influencing factors is vital to bibliotherapy, including age, media suitability to the individual, and cultural appropriateness (Gregory et al., 2004).

2.3.2.2 The stepped-care treatment model

In the stepped-care model, treatment progresses through stages and is generally acceptable to patients (Haugh et al., 2019). Clients start on a brief, usually non-invasive treatment and then progress to other treatments such as psychotherapy and medication, if needed (van Straten et al., 2015). For instance, bibliotherapy, computerised care or group therapy may be considered a low-intensity starting place, and patients may be upgraded to a greater intensity of care if necessary—namely psychotherapy or psychotropics (Bower & Gilbody, 2005).

2.3.2.3 Psychotherapy

Psychotherapy, which may be in the form of numerous approaches such as CBT and interpersonal psychotherapy (Johansson & Andersson, 2012), is a form of

psychological treatment usually administered one-to-one in a series of 45–50-minute sessions. Notably, CBT is often used as an umbrella term to cover various cognitive and behavioural techniques (Johansson & Andersson, 2012). Based on the physician’s practice model, the individual therapy approach still tends to be the enduring model of care (Kazdin & Rabbitt, 2013). It is deemed efficacious, albeit costly in time and resources. While psychotherapy may yield good results, Davey & Chanen (2016) suggest inflation of positive outcomes due to low-quality studies. Furthermore, those who suffer from treatment-resistant depression experienced only a 20% probability of achieving remission in psychotherapy treatment (Mrazek et al., 2014).

Some researchers assert that psychotherapy, unlike drug treatment, tends to be offered less, which may be because psychotherapy is mainly the domain of psychologists. Doctors, often the first point of call, tend to prescribe medication rather than refer patients to other professionals (Davey & Chanen, 2016). This situation results in monotherapy, even though multiple therapy approaches demonstrate better efficacy (Davey & Chanen, 2016). Notably, the Australian Medicare-funded Mental Health Care Scheme, which commenced in 2006, allows doctors to refer patients to other therapists for ten visits, reversing the monotherapy trend somewhat (Davey & Chanen, 2016). Nevertheless, Walsh (2011) purports that economic, institutional, and professional pressures (e.g., time, cost) compel health professionals to prescribe less psychotherapy and more drugs.

2.3.2.4 Psychotropics

Psychotropics—drugs that affect behaviour and mood—play an essential role in treating depression; yet, there seems to be a tendency towards overuse, disconcerting when other therapies are available, and critical analyses query their level of efficacy (Hengartner, 2017). Antidepressant use varies considerably from country to country. Of countries that belong to the Organisation for Economic Co-operation and Development (OECD), Iceland ranks as the highest user, followed by Canada and Australia (Gurkan et al., 2019). However, depression prevalence continues to escalate, and there are concerns about the safety and efficacy of antidepressants with their numerous debilitating side effects (Hengartner, 2017; Mrazek et al., 2014), questionable advantage over placebo, and lack of effectiveness

(Davey & Chanen, 2016; Hengartner, 2017). Selective Serotonin Reuptake Inhibitors (SSRIs) are commonly used drugs that are helpful for some but link to an increased tendency to suicide, particularly in younger patients (Davey & Chanen, 2016). Patients have increasingly been prescribed antidepressants; however, they tend to prefer a consultation with a therapist (Wilhelmsen et al., 2013).

The relatively recent focus on precision medicine may help to improve the psychotropic approach to treatment. Pharmacogenomics aims to do this by matching psychotropic medications to the individual genetic profile of a patient. Test results can detect variability in psychiatric drug response and medications tailored accordingly to improve outcomes in clinical settings (Hall-Flavin et al., 2012; Hall-Flavin et al., 2013; Winner et al., 2013). Recent research proposes that genetic factors may even determine responders to the placebo effect, termed *placebome*, and provide a safer therapeutic alternative to try before drugs (Hall et al., 2015). Therefore, Winner et al. (2013) propose that the precision medicine approach may reduce prospective costs through more effective methods by matching patients with appropriate medication to reduce the incidence of adverse reactions and improve pharmacoeconomic benefits.

2.4 Time for a New Paradigm

While medication, psychotherapy, and other treatments mentioned above will continue to play a role in alleviating mental health distress, the 21st-century mental distress pandemic requires every effective option available to be employed to halt the escalating prevalence. Additionally, the lack of development of new psychotropics, their limited effectiveness and the growing evidence that other options can be effective necessitate broadening the repertoire of treatment to include other possibilities with greater emphasis on mental health promotion and primary prevention (Davey & Chanen, 2016; Hengartner, 2017; Rucklidge et al., 2015).

Various researchers have, for a prolonged period, advocated for the adoption of numerous effective non-pharmacological, lifestyle-based strategies (e.g., exercise, nutrition, and mindfulness) to address the burgeoning mental health crisis (Davey & Chanen, 2016; Sarris et al., 2014; Stephenson et al., 2013; Walsh, 2011). In the mainstream, these calls have been overlooked, with status quo treatments remaining

prevalent. Notably, many of the strategies advocated are also foundational to the relatively new LM and PP disciplines, gaining global traction. For instance, Walsh (2011) advocates eight LM-related factors for improving mental health: exercise, nutrition/diet, nature time, relationships, recreation, relaxation/stress management, religion/spirituality, and serving others. Also, a meta-analysis by Sin and Lyubomirsky (2009) found that PP strategies (e.g., gratitude visits, signature strengths, positive writing exercises) designed to cultivate positive thinking and emotion significantly improved well-being for both healthy clients and those with a diagnosed mental disorder. These, and a growing repertoire of other research studies (Bolier et al., 2013; Gander et al., 2016; Hendriks et al., 2020; Morton, 2018a; Morton et al., 2020; Przybylko et al., 2021a), uphold the efficacy of LM and PP strategies as enhancers of mental health and successful preventative and remedial measures for mental distress.

2.4.1 The efficacy of lifestyle medicine for improving health

LM boasts an ancient and rich heritage through biblical characters such as Daniel, ancient philosophers such as Hippocrates, and 19th-century health reformers such as Sylvester Graham and Ellen White. They, with numerous others, pioneered lifestyle reform. However, it is in the 21st-century that LM is emerging as an evidence-based discipline. Defined as “the application of environmental, behavioural, medical, and motivational principles to the management (including self-care and self-management) of lifestyle-related health problems in a clinical setting” (Sagner et al., 2017, p. 3), the core principles of LM (Table 2) differentiate it from standard medical care.

Table 2. *Core principles of lifestyle medicine (Egger, 2009, p 144)*

a) Treatment of lifestyle causes.
b) Patient is an active partner in care.
c) Patient is required to make big changes.
d) Treatment is almost always long-term.
e) Responsibility is on the patient.
f) Medication may be needed—but as an adjunct to lifestyle change.
g) Emphasis on motivation and compliance.
h) Goal is primary/secondary/tertiary disease prevention.
i) Consideration of environment.
j) Referral to allied health professionals.
k) Doctor works in conjunction with other health professionals.

Two pillars of LM are exercise and nutrition. Meta-analyses, reviews, and individual studies have provided ample evidence that lack of activity is a causation factor in mental health distress and that physical exercise prevents and alleviates depression and anxiety (Al-Qahtani et al., 2018; Bartholomew et al., 2005; Blumenthal et al., 2007; Blumenthal et al., 1999; Booth et al., 2012; Ernst et al., 2006; Josefsson et al., 2014; Mammen & Faulkner, 2013; Penedo & Dahn, 2005; Stanton et al., 2013; Stathopoulou et al., 2006; Ströhle, 2009; Stubbs et al., 2016). Likewise, nutrition research generally demonstrates that a Mediterranean dietary pattern that promotes vegetables, grains, and some fish is protective for mood disorders (Blanchflower et al., 2013; Crichton et al., 2013; Ford et al., 2013; Jacka et al., 2017a; Lai et al., 2014; Lee et al., 2015; McMillan et al., 2011; Sarris et al., 2014; White et al., 2013). The increase in vegetable intake and mood improvement may be a dose-response relationship (Blanchflower et al., 2013) with almost immediate benefits (White et al., 2013).

While early LM interventions targeted diet and exercise as the antidote for chronic disease, foremost LM advocates now champion an increasingly broader and more eclectic assortment of lifestyle-derived factors, including mental resilience, to improve well-being (Sarris et al., 2014; Walsh, 2011). Ornish et al. (2008) built LM

interventions around four key pillars: nutrition, physical activity, stress management, and social support. Katz (2011) espouses a *Super 6* list which includes feet (exercise), fork (diet), fingers (smoking status), sleep, stress, and love. In establishing physician competencies for prescribing LM, Lianov & Johnson (2010) list smoking, alcohol, diet, physical activity, body mass index, stress level, sleep, and emotional well-being as the vital signs for doctors to address. Egger and Dixon (2014) previously designated a particularly comprehensive list of lifestyle-based determinants of chronic disease using the mnemonic NASTIE ODOURS, subsequently adjusted to NASTIE MALODOURS: nutrition, activity/inactivity, stress, techno-pathology, inadequate sleep, environment, meaninglessness, alienation, loss of culture/identity, occupation, drugs (including smoking & alcohol), over and under-exposure, relationships, and social inequality. Very recently, Egger et al. (2021) recognised the detrimental effects of adverse childhood experiences (ACEs) on chronic disease development and adjusted the mnemonic to NASTIE ODOURS with MALACE.

The rationale for LM as a discipline grew out of the emergence of lifestyle-related chronic diseases in the 20th century and the alarming escalation of chronic disease prevalence into the 21st-century, coupled with the numerous ground-breaking, seminal studies that validated the correlation between lifestyle practices and major chronic diseases (Belloc & Breslow, 1972; Campbell et al., 1998; Dawber et al., 1951; Esselstyn Jr et al., 1995; Fraser, 2009; Khaw et al., 2008; Ornish et al., 1998). The extensive research represents a plethora of evidence, dating back more than 60 years, which overwhelmingly demonstrates the value of lifestyle modification for chronic disease treatment and prevention.

Although the field of LM may have not yet gained widespread traction as it relates specifically to mental health, years of research have established a compelling association between lifestyle factors and mental well-being. For instance, anxiety and depression are associated with inactivity and poor diet for patients at risk of cardiovascular disease (Bonnet et al., 2005). Depression is directly associated with smoking and inactivity (Cassidy et al., 2004), and exercise is an effective antidote for depression (Al-Qahtani et al., 2018; Cooney et al., 2014; Dale et al., 2014; Egger et al., 2009; Rohrer et al., 2005; Stathopoulou et al., 2006).

Nutrition improvement is an effective strategy to prevent and alleviate many chronic diseases, including depressive disorders (Crichton et al., 2013; Dale et al., 2014; Egger et al., 2009; Huang et al., 2019; Jacka, 2017; Jacka et al., 2017a). Fruit and vegetable intake appear to demonstrate a dose-response relationship and predict improved mood the following day (Blanchflower et al., 2013; White et al., 2013). Furthermore, exposure to natural environments (Cohen-Cline et al., 2015; Mantler & Logan, 2015; Nutsford et al., 2013; Pouso et al., 2021) and numerous other lifestyle-related measures such as sleep (James et al., 2017), relaxation (Bhasin et al., 2018), meditation, socialisation, and pet therapy may be notable moderating factors in mental health (Sarris et al., 2014; Walsh, 2011).

2.4.2 The efficacy of positive psychology for improving health

Various fundamental tenets of PP are not new. Ancient biblical wisdom promotes positive emotions (Proverbs 17:22), encourages focusing on positive thoughts (Proverbs 23:7, Philippians 4:8), recognises the importance of social relationships (Proverbs 17:17), and promotes the importance of forgiveness and kindness (Ephesians 4:32). Notable characters in the 19th-century (e.g., Phineas Quimby) advocated the power of positive thinking as a significant factor in health (Miller, 2005). Numerous 20th-century happiness researchers have been forerunners in recognising essential information elements for building mental resilience and thriving. For instance, Fordyce (1977) created a program to increase personal happiness for college students. The program included fourteen strategies, some of which are spending more time socialising, increasing exercise, developing optimistic thinking, and strengthening closest relationships; nevertheless, events on the eve of the 21st-century thrust PP onto the world stage as a new field of study.

In 1998, when Martin Seligman became president of the American Psychological Association, he, in conjunction with Mihaly Csikszentmihalyi, urged the psychology profession to be part of what Seligman describes as a *tectonic upheaval* (Seligman & Csikszentmihalyi, 2000b; Seligman, 2013, p. 1). He called for the adoption of a new goal of the field of psychology that involved exploring “what makes life worth living and building the enabling conditions of a life worth living” (Seligman, 2013, pp. 1,2). Until that time, psychology typically centred around a model of deficiency that focused on treating problems (Lyubomirsky et al., 2011).

However, Seligman's visionary directive heralded the scientific study of the strengths and virtues that empower people to improve their quality of life to flourish (Seligman & Csikszentmihalyi, 2000b; Seligman, 2013). From that mandate, PP emerged as a new 21st-century discipline and launched a burgeoning area of research.

Seligman's Well-being Theory highlights five elements for flourishing psychologically: positive emotions, engagement, relationships, meaning, and achievement (PERMA). PP intervention strategies revolve around practical ways to develop and enhance PERMA. A significant body of evidence outlines the efficacy of many approaches to improve the PERMA elements and facilitate flourishing (Feicht et al., 2013; Hendriks et al., 2020; Przybylko et al., 2021b). Notably, high levels of psychological well-being relate to numerous positive outcomes, including improved productivity, healthier relationships, positive social behaviour, higher quality of life, improved life expectancy, positive effects on immune function (Chida & Steptoe, 2008; Diener & Chan, 2011; Diener & Seligman, 2004; Huppert & So, 2013) and prevention or treatment of mental ailments (Bolier et al., 2013; Gander et al., 2016; Gander et al., 2013; Proyer et al., 2014; Proyer, Gander, et al., 2015; Proyer, Wellenzohn, et al., 2015).

The application of PP includes an assortment of strategies (e.g., positive writing, acts of kindness, gratitude-based activities, savouring the moment, goal setting, and strengths-based activities) to boost psychological health, and a growing number of researchers are reporting on the efficacy of the various strategies (Bolier et al., 2013; Gander et al., 2016; Hendriks et al., 2020). Interestingly, varying the activities may reduce adaptation by helping to maintain a positive mindset (Lyubomirsky et al., 2011). The use of PP strategies is also known as Positive Psychotherapy (PPT), which is an umbrella term for using the various strategies, either singularly or grouped, to improve well-being (Seligman et al., 2006).

2.4.3 Using lifestyle medicine and positive psychology as an interdisciplinary approach

Considering the above evidence, a coalescence of LM and PP, as an interdisciplinary approach, may provide a robust pathway to enhance mental well-

being. Disparate, yet complimentary, with some crossover of the boundaries between them, LM's and PP's various intervention approaches reveal an evidence-based range of strategies that can integrate to promote optimal mental well-being and prevent and alleviate mental health disorders. Furthermore, there is evidence that a *shotgun* approach (i.e., using several strategies simultaneously) provides better outcomes than using one single activity at a time (Seligman et al., 2005; Sin & Lyubomirsky, 2009).

Recognising the influence of strategies from both fields to affect mental well-being transformation, a newly developed intervention called the *Live More Project* (LMP), also known as the *Lift Project*, draws LM and PP together by combining vital components from both disciplines. The program was initially piloted face-to-face in a tertiary university setting (Hinze & Morton, 2017; Morton et al., 2020) and implemented as an online randomised controlled trial (RCT) intervention for a faith-based community cohort (Przybylko et al., 2021a). Significant improvements in outcomes measured were observed in both settings. The intervention has recently been adopted by several local council authorities, encouraging community members from within the respective council jurisdictions to engage in the program in an online format. Notably, online intervention delivery offers an enticing opportunity for easily-accessible and scalable dissemination of such interventions; therefore, it is necessary to evaluate the critical factors in optimising intervention delivery.

2.5 Optimising the Effectiveness of Intervention Delivery

There is a broad range of variables that may influence the efficacy of an intervention. Some examples include the participant-recruit process, theoretical underpinning, use of behaviour change techniques, self-efficacy, the participants' education level/age/gender, interaction with a therapist or support person, locus of control, personality traits, and engagement behaviour (Fry & Neff, 2009; Johansson & Andersson, 2012; Klein & Cook, 2010; Kohl et al., 2013; Lyubomirsky et al., 2011; Mohr et al., 2010; Tsan & Day, 2007; Webb et al., 2010). Nevertheless, the delivery method is arguably one of the most critical decisions regarding implementing an intervention. The recent transition, away from the face-to-face model towards online and mobile delivery methods, highlights a core component that has undergone a monumental transformation in the 21st-century.

2.5.1 Face-to-face delivery

For this dissertation, *face-to-face* refers to a literal, offline, real-time appointment in a physical setting (e.g., a therapist office) between a client and a professional, or a presentation by a speaker, with participants present at a designated venue. In the face-to-face situation, communication is more straightforward, non-verbal cues are easy to monitor, and a presentation is uninterrupted by technical glitches.

2.5.1.1 Advantages & disadvantages of face-to-face delivery

The education sector has produced significant insight regarding the advantages of face-to-face learning, including social and spatial awareness, which allow many reciprocal observations. The physical room arrangement plays a role in interaction opportunities, or lack of, and an array of non-verbal cues and communication methods are faster and more efficient than online settings where interaction is limited. Other positives include instant questioning and feedback opportunities to facilitate understanding of content and ease of relationship building (Wuensch et al., 2008). Burch et al. (2016) describe unintended positive outcomes that face-to-face settings may provide, such as increased social competencies and cognitive, emotional, and overall engagement growth.

Notably, there is a strong, positive correlation between face-to-face delivery and outcome measures in some studies (Bock et al., 2014); hence, unsurprisingly, face-to-face may be the preferred delivery method for many potential intervention participants (Mohr et al., 2010). For instance, a review of physical activity interventions demonstrated that face-to-face group sessions and face-to-face counselling were most effective (Bock et al., 2014). In cases of severe depression, Chinese and White groups favour the face-to-face method (Choi et al., 2015). In an Australian study, 77% of participants preferred the traditional face-to-face style (Klein, 2010). Furthermore, for patients interested in receiving a behavioural psychology treatment, almost 92% desired the face-to-face method (Mohr et al., 2010). Importantly, face-to-face tends to foster greater engagement and adherence, as demonstrated across various studies related to weight loss, alcohol, and stop-smoking interventions (Kohl et al., 2013).

Face-to-face methods have numerous disadvantages. Accessibility limitations (e.g., geographic distance, transportation difficulties, disability) that restrict attendance, lack of anonymity, often desired to reduce stigma concerns, and wait/lag times for an intervention to commence are all commonly touted drawbacks (Choi et al., 2015; Steele et al., 2009; Wagner et al., 2014). Other frequently cited disadvantages include time constraints (Mohr et al., 2010; Wagner et al., 2014), costs, and human resource scarcity from the providers' viewpoint (Kohl et al., 2013).

2.5.2 Delivery mode transition

Before the 21st-century, program delivery modes traditionally included print, mass media, computer (e.g., CD-ROM) and face-to-face (Steele et al., 2009). However, unprecedented technological innovation has led to the creation and adoption of diverse digital delivery methods in the last 20 or more years. Along with well-known communication methods such as telephone, email, short message service (SMS), websites, videoconferencing, interactive apps, the innovation has introduced pioneering areas of integrative research such as persuasive system design (PSD)—the potential of technology to persuade behaviour change (Asbjørnsen et al., 2019; Kelders et al., 2012; Oinas-Kukkonen & Harjumaa, 2009; Wildeboer et al., 2016).

The broad-based adoption of digital methods has superseded the once common face-to-face approach. However, program designers may adopt a blended delivery approach that includes face-to-face appointments and online components. While the blended approach may provide the best of both worlds, it is not a viable method for a large-scale preventative intervention and will not be examined closely in this dissertation. The dissertation explores the online approach in further detail to expose the advantages and disadvantages of the relatively rapid transition away from face-to-face methods.

2.5.3 Online delivery mode

The online delivery mode of intervention delivery has numerous names—e-therapy, e-health, cyber-therapy, e-Interventions, digital (Barak et al., 2009)—and has a relatively short history, commencing in the 1990s (Andersson et al., 2014). Furthermore, the term *online* may include an ever-expanding assortment of delivery elements, and some are not necessarily on the internet (e.g., phone counselling,

computer program). For ease of definition in this dissertation, online or digital delivery may include any situation where program content delivery is through a medium that is not face-to-face and has digital or screen-based methods. Webb et al. (2010) developed a novel coding system for classifying different types of online delivery modes into three broad areas: automated functions, communicative functions, and the use of supplementary modes (Table 3). Numerous innovations, post the year 2010, could be added to Webb's coding, and some of the functions listed may function as primary means of delivery or simply a support method.

Table 3. *Coding for online delivery methods (Webb et., 2010, p 5)*

Code	Online delivery mode
Automated functions	Enriched information environment – supplement content, links, testimonials, games, videos. Automated tailored feedback based on individual progress. Automated follow-up messages (reminders, tips, newsletters, encouragement).
Communicative functions	Access to an advisor for advice. Expert-led discussion board or chat session. Scheduled contact with an advisor (e.g., email). Peer to peer access. Forums. Discussion board.
Use of supplementary modes	Email. Phone SMS/TXT. CD-ROM. Videoconferencing.

2.5.3.1 *Advantages and disadvantages of online delivery*

The online delivery method has many documented advantages from the user's point of view, although elucidating the most influential factors is sometimes challenging due to the wide variations in online delivery practices (Kohl et al., 2013). An online intervention creates enormous potential through increased portability and overcoming accessibility barriers such as geographic factors, transport, and fear (Andersson & Titov, 2014; Choi et al., 2015; Langrial et al., 2012; Mohr et al., 2018; Mohr et al., 2010; Wagner et al., 2014). Other online advantages include minimising

time restraints (Klein & Cook, 2010; Mohr et al., 2010; Wagner et al., 2014), reducing stigma fears (Choi et al., 2015; Klein, 2010; Wagner et al., 2014), reduction of long waiting periods, increased flexibility in accessing treatment, and more time for clinicians to see others (Choi et al., 2015; Kaltenthaler et al., 2008; Wagner et al., 2014). E-interventions may overcome lack of motivation for some (Choi et al., 2015), they may suit more introverted personality types (Klein & Cook, 2010), and may also improve potential reach due to easy internet access for most people (Carper et al., 2013). Online interventions provide a level of autonomy and privacy (Kooistra et al., 2016; Wagner et al., 2014), allowing participants to avoid perceived shame and fear of re-visiting old wounds (Andersson & Titov, 2014; Choi et al., 2015). However, anonymity can also lead to higher attrition rates (Carolan & de Visser, 2018; Kohl et al., 2013).

From a provider's standpoint, there are numerous further advantages to online delivery methods. For example, content can often be tailored to the needs of the user and is easily updated. Online questionnaires eliminate researcher error, and access to para-data (further explained in section 2.5.4.2) provides vital information, particularly concerning adherence (Kohl et al., 2013). Cost-effectiveness is often touted as an online intervention advantage, although Kohl et al. (2013) warns that determining the actual cost is often difficult. Most participants are also willing to try online interventions (Choi et al., 2015; Klein & Cook, 2010; Mohr et al., 2010), and online programs are a reasonable adjunct to face-to-face therapy (Carper et al., 2013). Research in systems design has also established frameworks of persuasive techniques available for planning efficacious online programs (Oinas-Kukkonen & Harjumaa, 2009; Wildeboer et al., 2016).

The widespread adoption of the web- and smartphone-based applications for behaviour change interventions has opened up new frontiers in research regarding key persuasive features those online applications may include to maximise behaviour change and, therefore, program efficacy. Several persuasive models have been proposed. For example, the Fogg Behaviour Model asserts that behaviour is the product of motivation, ability, and triggers. Fogg (2009) proposes that all three need to operate together for behaviour change to occur. The PSD model, developed by Oinas-Kukkonen and Harjumaa but primarily based on earlier work by Fogg (2003), defines *persuasive systems* as those digital software or information systems that

“reinforce, change or shape attitudes or behaviours” (Oinas-Kukkonen and Harjumaa, 2009, p. 486). The PSD model provides a helpful taxonomy of 28 principles classified under four key support areas—primary task support, dialogue support, system credibility support, and social support—for designing efficacious and completely digital behavioural change interventions.

While the advantages for online interventions are substantial, there are several disadvantages, and online interventions are sometimes less effective than traditional face-to-face methods. Perceptions of potential participants include concerns about confidentiality and cultural sensitivity (Choi et al., 2015). There is a greater reliance on participants to self-manage, which is an advantage to those with high self-efficacy but problematic for those with low self-efficacy or who typically place a high locus of control on a medical professional (Klein & Cook, 2010). Furthermore, some people prefer the face-to-face setting with the inherent human and social component (Batterham & Caele, 2017). Additionally, two factors that frequently arise in research regarding online delivery include lower adherence rates compared to face-to-face delivery (Kohl et al., 2013; Short et al., 2014) and human support provision (or lack of) (Kristén et al., 2015; Mohr et al., 2011; Shim et al., 2017). Adherence to an online intervention and the provision of human support may be inextricably linked. Numerous studies, particularly amongst clinical cohorts (Asbjørnsen et al., 2019; Baumeister et al., 2014; Yardley et al., 2016), suggest that human support (or lack of) may be a moderating factor on adherence, which subsequently impacts the outcomes of a study. The remainder of this chapter examines adherence and human support in more detail.

2.5.4 Adherence and human support

This sub-section reviews adherence behaviour and the influence of human support to improve adherence and outcomes in online interventions targeting mental well-being. Poor adherence is the nemesis of digital interventions, with the addition of human support typically being positively associated with improved adherence and outcomes amongst clinical cohorts (i.e., persons with a diagnosed disorder). This section defines adherence, explains how it is measured and documents the diversity of influences on adherence behaviour. It includes evaluating the theoretical framework for human support, overviewing several human support models,

appraising the influence of human support in clinical and non-clinical settings, examining automated support options, briefly reviewing evidence regarding human support personnel, and investigating several commonly used modes of human support. Finally, a substantial research gap is exposed—the paucity of studies that have examined the influence of human support on adherence and outcomes in non-clinical, healthy (i.e., general population) group settings.

2.5.4.1 Definition of adherence

Delineating between adherence and engagement behaviours is essential because several variant terms may be used to describe them. *Dropout attrition* refers to participants who registered to participate in a research study or program; however, for various reasons (e.g., illness, lack of interest) do not complete the expected steps (e.g., questionnaires) and are therefore released from the research program (Kelders et al., 2012). *Non-usage attrition* refers to participants who, while remaining in a study, do not interact with or use the intervention as prescribed—it is, therefore, a measure of adherence (Kelders et al., 2012). *Adherence*, sometimes labelled as dosage, exposure or engagement (although there are differences between adherence and engagement), is a crucial factor that may refer to both depth and breadth of interaction by a participant with intervention components (Couper et al., 2010). Kelders et al. (2012) define adherence in a way that includes usage as program designers intend it— “the extent to which individuals should experience the content (of the intervention) to derive maximum benefit from the intervention, as defined or implied by its creators” (p. 2). Notably, adherence may be quite different to *engagement*, as participants may engage with an intervention throughout the designated period but not necessarily in the way the designers intended. Hence, a participant may demonstrate a level of engagement without being adherent to the recommended depth and breadth of exposure. Definitions are somewhat heterogeneous between studies; however, this dissertation refers to attrition as the number of participants who withdraw from a study before commencing (early drop-out attrition) or who are lost to follow-up and do not complete post-intervention requirements (late-dropout attrition). As defined previously by Kelders et al. (2012), adherence refers to participants experiencing the content in the way it was described or recommended by program creators.

Maintaining adherence is crucial to researchers because adherent participants generally complete an intervention that enables outcomes to be measured. Understandably, high adherence levels are often statistically significant with improved outcome measures and low adherence usually results in relatively poor outcomes (Couper et al., 2010; Donkin et al., 2013). However, online interventions tend to have a lower adherence rate when compared to face-to-face delivery methods (Couper et al., 2010; Kelders et al., 2012; Mohr, Burns, et al., 2013; Mohr et al., 2011; Spijkerman et al., 2016). In a systematic review of 83 web-based interventions, Kelders et al. (2012) noted an average adherence of just 50% and, in some programs, the adherence rate was below 10%. In a meta-analysis of 40 computer-based RCT studies, Richards & Richardson (2012) reported an average adherence of just 43%. Similarly, a recent meta-analytic review of online interventions noted adherence rates varied greatly (ranging from 35 – 92%) between studies (Spijkerman et al., 2016), although, once again, measuring adherence was heterogeneous between studies.

2.5.4.2 Measuring adherence

There are numerous ways to measure adherence in online interventions. Para-data, defined as “auxiliary data that capture details about the process of interaction with the online intervention” (Couper et al., 2010, p. 2), can be a valuable source for measuring adherence behaviour. Each research intervention may use variant ways of measuring adherence, dependent upon the unique program components. For instance, time stamps for key actions (e.g., logons, loading a session, survey completions) measure the breadth of adherence (Couper et al., 2010). Total minutes spent, percentage of videos viewed, access to extra resources, and records of completed challenges may provide a measure of depth. Nevertheless, despite the usefulness and accuracy of para-data, it does not reveal the vital why or why not information regarding adherence (Couper et al., 2010).

2.5.4.3 Factors influencing adherence

Influences on adherence in online interventions are multifactorial. Table 4 outlines a range of factors influencing adherence in various settings, as identified in previous studies. In a recent review examining theoretical perspectives related to adherence, Ryan et al. (2018) suggested the need for greater interdisciplinary

collaboration to develop a complete understanding of the broad range of technological, environmental, and individual influences on adherence behaviour. Likewise, Zarski et al. (2016) stated that many inter-individual differences regarding adherence remain a mystery. Notwithstanding, despite the seemingly long and complex array of factors influencing adherence in online interventions, the remainder of this chapter reviews human support in more detail, as it is typically viewed as a crucial moderating factor (Andersson et al., 2016; Mohr et al., 2011).

Table 4. *Factors influencing adherence*

Factor	Reference/s
Recruitment method	Lyubomirsky et al., 2011
Participant motivation	Alfonsson, Olsson, & Hursti, 2016; Mohr et al., 2011
User expectations	Mohr et al., 2011
Literacy and education level	Johansson et al., 2015; Leung et al., 2017
Health status	Beatty et al., 2017; Johansson et al., 2015; Mohr, Duffecy, et al., 2013
Feedback provision	Schueller et al., 2016
Cultural considerations	Schueller et al., 2016
Emotional well-being status	Leung et al., 2017; Schueller et al., 2016
Website design	Asbjørnsen et al., 2019; Beatty et al., 2017; Schueller et al., 2016
Time availability or constraints	Beatty & Binnion, 2016; Carolan & de Visser, 2018; Christensen et al., 2009
Perceived treatment credibility	Alfonsson, Olsson, & Hursti, 2016; Beatty & Binnion, 2016
Age and gender	Beatty & Binnion, 2016; Short et al., 2014; Webb et al., 2010
Persuasive system design	Asbjørnsen et al., 2019
Behaviour change techniques used	Asbjørnsen et al., 2019; Short et al., 2014; Webb et al., 2010
Employment status	Leung et al., 2017
Dialogue support (i.e., rewards, reminders)	Akhu-Zaheya & Wa'ed, 2017; Beatty et al., 2017; Kelders et al., 2012
Regular intervention updates	Kelders et al., 2012
Human support factors	Andersson & Titov, 2014; Baumeister et al., 2014; Beatty & Binnion, 2016; Carolan et al., 2017; Johansson & Andersson, 2012; Kelders et al., 2012; Kleiboer et al., 2015; Mohr et al., 2011; Richards & Richardson, 2012; Shim et al., 2017
Provision of incentives	Mohr et al., 2011
Level of personalisation and tailoring	Beatty & Binnion, 2016

2.5.4.4 Human support

Human support is a multi-faceted construct, and its many facets expose the difficulties in establishing its efficacy to improve adherence and outcomes in online interventions. A recent scoping review of human support factors in online psychological interventions for depression and anxiety identified seven specific human support sub-categories in 19 studies that were reviewed (Shim et al., 2017). Human support factors identified included the comparison between supported and unsupported conditions, the expertise of the support personnel, human versus automated support, synchronous or asynchronous support, the mode of support communication, whether support was scheduled or unscheduled, and the intensity of the support provided. Recognising its complexities, the remainder of this review chapter appraises the numerous facets of human support that are most relevant to implementing a scalable digital mental health promotion intervention (DMHPI).

2.5.4.5 Human support - theoretical framework

Human relationships are central to mental well-being (Cacioppo & Cacioppo, 2014); however, the broad-sweeping transition from face-to-face delivery methods to online delivery methods has meant that the previously inherent human element is inevitably eliminated (Langrial et al., 2012; Mohr et al., 2011). Therefore, intervention designers must decide if and how human support will be added back and incorporated into intervention designs. The rationale for human support as a critical element in online interventions is anchored theoretically in Ajzen's (1985) Theory of Planned Behaviour (TPB) which highlights the human component (subjective norms) as one of three elements vital in behaviour change (see Figure 1). A meta-analysis and review of 85 studies found that interventions using the TPB demonstrate substantial effects on health behaviour change (Webb et al., 2010).

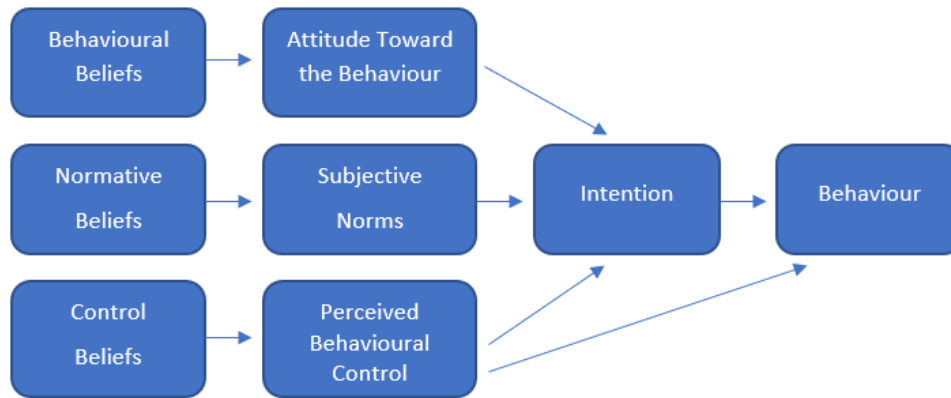


Figure 1. *The Theory of Planned Behaviour (Ajzen, 1985)*

According to the TPB, beliefs ultimately drive behaviour (Ajzen, 1985). Beliefs influence attitudes towards behaviour regarding the perceived consequences and outcomes (i.e., behavioural beliefs). Normative beliefs impact subjective norms, which involve an individual's perceptions about the expectations of others (e.g., family and friends) and the personal level of motivation to comply with those norms. Control beliefs refer to perceptions about the existence and potential impact of perceived facilitators and barriers to performing specific behaviours (i.e., perceived behavioural control). Essentially, the more favourable behavioural beliefs and normative beliefs, and the greater the perceived behavioural control, the more likely intentions will be influenced positively, resulting in the desired behaviour (Ajzen, 1985). Concerning human support, while participants in an intervention will derive subjective norms from family, friends, and individual social circumstances, intentional supportive human interaction may enhance the desired normative beliefs and ultimately improve the intention to perform an alternative behaviour. Knowing this, intervention designers must choose if and how to add human support components back into online intervention design. This choice requires multiple decisions about intensity, frequency, synchronicity, personnel, and mode of human support. To this end, several models of human support have been proposed.

2.5.4.6 Human support models

Digital mental well-being interventions seek to modify human behaviour and, in doing so, utilise Behavioural Intervention Technologies (BITs). This term

incorporates applying behavioural and psychological strategies through digital media to induce behaviour change that benefits mental and physical health (Schueller et al., 2013). Human support may be utilised as a supplementary component for BITs to ensure the most efficacious outcomes, and several models address human support (Mohr et al., 2014). A model commonly called the Swedish Experience (Andersson et al., 2008; Schueller et al., 2016) refers to an online type of guided self-help that involves weekly completion of a lesson, feedback, encouragement, and help from a support person (typically a clinician). The Macquarie University Model is a model for ICBT, similar to the Swedish Experience, which includes highly structured teaching methods, gradual release of content, homework tasks and individualised, systematic support by a clinician through phone, email, and short SMS messages to encourage practice and implementation of skills (Titov et al., 2015). The Efficiency Model (Schueller et al., 2016) focuses on five major failure points of BITs that should inform any human support efforts to assist the participant: usability, engagement, fit, knowledge, and implementation. Schueller et al. (2016) assert that support personnel generally only have limited information regarding whether a person is using a BIT and propose that supporter portals or interfaces should include information regarding the five areas mentioned above to enable optimal communication conditions between the support person and the user. Finally, the Supportive Accountability Model (SAM) (Mohr et al., 2011) is a framework of human support underpinned by Self-determination Theory (SDT).

The SAM highlights the features of bond (i.e., the relationship between support person and participant), accountability (i.e., specific expectations regarding actions between the participant and support person), and legitimacy (i.e., the support person has credibility and is trustworthy) as vital aspects of human support (see Figure 2). It also notes the importance of motivation (both intrinsic and extrinsic) and effective communication (e.g., timely, positive, constructive) as cues for determining adherence to an intervention. *Bandwidth* in the model refers to the nature of communication. For instance, a telephone conversation with a client is higher in bandwidth than an email yet lower than a face-to-face conversation. While generally believed that a higher bandwidth mode of support would be more effective than a lower bandwidth, research has found that lower bandwidth support may be just as, if not more, effectual than higher bandwidth support modes (Mohr, Burns, et al., 2013).

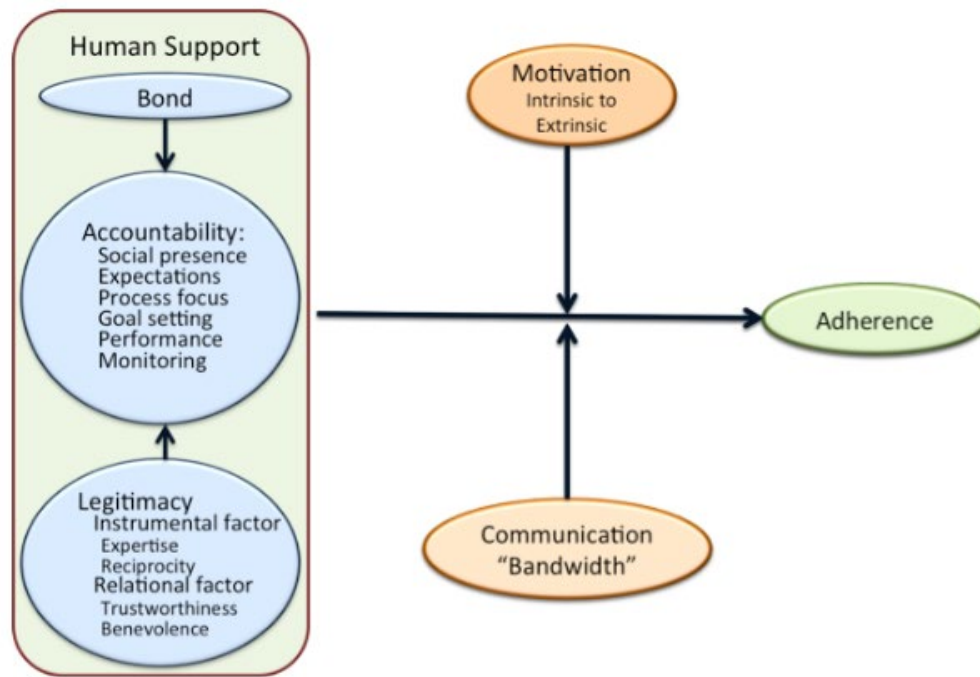


Figure 2. *The Supportive Accountability Model as proposed by Mohr et al. (2011)*

The theory of SDT underpins the motivation aspect of the SAM model (Figure 2) and is also commonly used independently as the theory of choice that informs health-related interventions. SDT assumes that humans desire to master new experiences and have the intrinsic motivation to make and sustain positive behaviour changes when three innate psychological needs are met: competence, autonomy and relatedness (Ryan & Deci, 2000). A recent meta-analysis of interventions underpinned by SDT found modest improvements in health behaviours that were partly due to enhancements in self-determined motivation (Ntoumanis et al., 2021). In behaviour change, participants require the skills and information to facilitate the competence to succeed and the autonomy to choose their behaviours and goals (Flannery, 2017). Furthermore, while a sense of relatedness may come from numerous sources such as family, friends and colleagues, human support may be provided as part of behaviour change interventions and foster relatedness. Human support will usually include establishing a strong bond built on trustworthiness, reciprocal accountability, timely and encouraging communication, and benevolence (Mohr et al., 2011). Ryan and Deci assert that natural curiosity, growth, positive wellbeing and self-motivation will be optimal when the three needs are met (Ryan & Deci, 2000). Hence, SDT, as an underpinning theory to the SAM model and a

distinct theory of behaviour change, poses important implications for the implementation of health-related interventions.

Notably, some of the previously mentioned models describe intense forms of human support, which may be appropriate for one-to-one clinical situations between a clinical therapist and their patient. However, the support provided may not need to be so intense for a general population cohort. Nevertheless, general principles of effective human support, particularly those listed above in the SAM (e.g., trustworthiness and credibility of the support person, timely communication), may be applied more broadly in settings where support needs to be scalable for large groups.

2.5.4.7 Human versus automated support

Human support may include an automated feature of an online intervention design. Typically, automated emails, pre-determined SMS messages, or app notifications are disseminated at pre-determined intervals or under particular conditions (e.g., a participant has not viewed content after a specific time has elapsed). Often messages act as prompts to remind participants to engage with the intervention content. Limited studies have compared automated support with in-person human support, and those previously conducted demonstrated mixed results. For example, in an RCT designed to assist participants in coping with difficulties and depressive symptoms, Mira et al. (2017) compared an automated human support condition with the same condition plus weekly phone calls. Both groups improved significantly compared to the control group, and no differences in attrition, adherence, or outcomes were observed. Furthermore, participant satisfaction was high in both intervention groups. Another RCT found that participants who received telephone support and automated support achieved higher adherence and superior outcomes than the group who only received automated support (Titov et al., 2009); nevertheless, effect sizes were large in both groups. Conversely, other studies have found no significant difference between outcomes or adherence in automated support compared to physical human support (Aardoom et al., 2016; Kelders et al., 2015).

It is essential to highlight the PSD model mentioned previously (Oinas-Kukkonen & Harjumaa, 2009), as some aspects of PSD may be considered automated human support. The PSD model proposes seven social support elements (Table 5) that may be incorporated into an online intervention to leverage behaviour

change (Oinas-Kukkonen & Harjuma, 2009). While not a direct, in-person human support mechanism from a coach, facilitator, or therapist, Oinas-Kukkonen & Harjuma (2009) note that the social support features may enable users to observe others, learn from peers, compare behaviours, see norms, co-operate, compete, and draw inspiration from the success stories of others, all within the application features (e.g., discussion feed, badges, leaderboard). Notably, research indicates that social support elements tend to be under-utilised (Langrial et al., 2012); nevertheless, an in-depth analysis of the most efficacious workplace interventions (in terms of adherence and outcomes) found that the best-performing interventions all included elements of PSD (Carolan et al., 2017). The use of social support elements in intervention design requires more research regarding its effectiveness as a form of automated support.

Table 5. *The social support elements used in Persuasive System Design (Oinas-Kukkonen & Harjuma, 2009)*

Principle	Definition
Social Learning	Users are more motivated to perform a specific behaviour if they can observe others performing the behaviour.
Social Comparison	Users demonstrate greater motivation to perform if they can compare their performance with others.
Normative Influence	Leverages normative influence to increase the likelihood of behaviour adoption.
Social Facilitation	Users perform target behaviour if they discern others are performing the behaviour too.
Co-operation	Motivate users to adopt the target behaviour by leveraging off the natural drive to co-operate.
Competition	Leverage off human beings' innate drive to compete.
Recognition	Offering public recognition for an individual or group increases the adoption of the target behaviour.

2.5.4.8 Human support personnel

Human support may be delivered by a range of individuals, including specialists, general medical practitioners, therapists, allied health professionals, trained facilitators, trainees, volunteers, students, and office administrative staff. The differential effects of expert (e.g., psychologist) versus lay (e.g., office staff) support

are mixed. A review and meta-analysis of 40 studies by Richards et al. (2012) regarding computer-based treatments for patients with depression demonstrated that support provided by therapists had the most substantial overall effects sizes (Cohen $d=0.78$), followed by administrative support by office staff ($d=0.58$). Where there was no support, the effect size was approximately half of those studies that included support ($d=0.36$). While the therapist support was greatest, administrative support was also a notable improvement on no support at all. In the review of human support factors in online interventions for depression and anxiety, Shim et al. (2017) identified five out of 19 studies that evaluated differences in outcomes or adherence based on the level of expertise of the support personnel. No differences in outcomes were observed between expert (i.e., clinician) and lay support personnel. However, two of the five studies reported improved adherence where an expert support person was present; although, one study demonstrated significantly higher dropout attrition in the clinician-led group compared to the group led by a layperson. Mixed results indicate that the expertise level of human support personnel may not be a significant moderating influence. However, a range of heterogeneous variables between studies hindered the ability to draw emphatic conclusions.

2.5.4.9 Modes of human support

Commonly used modes of human support for online interventions include telephone, email, SMS, and videoconferencing. Interventions comprise a combination of support mechanisms which makes determining the most useful support methods difficult. Nevertheless, while suitable in clinical scenarios between therapist and patient, phone calls will not be discussed in more detail as they are inappropriate for a large-scale DMHPI. Email support is common, both as an automated and more personalised communication medium. Both SMS and videoconferencing have proved efficacious in various settings (Banbury et al., 2018; Webb et al., 2010), so they are reviewed individually.

Electronic mail (Email)

Emails are commonly used forms of human support (Shim et al., 2017) that provide great flexibility. They are attractive to intervention designers as they can be easily integrated into interventions as cost-effective (Lancee et al., 2013), automated, and asynchronous forms of support. Furthermore, email frequency is readily

manipulated to alter the distribution intensity. Conversely, emails may be used for individualised, personally tailored forms of human support that would be considered intensive in terms of in-person human contact (Vernmark et al., 2010).

The variation in email use makes reviewing email support's effectiveness problematic, and studies reveal mixed findings. Several RCT studies have compared email support to no support at all and found no statistically significant differences in outcomes (Berger, Hämmerli, et al., 2011; Santucci et al., 2014; Sundström et al., 2020); furthermore, adherence was not enhanced by email reminders either (Santucci et al., 2014; Sundström et al., 2020). Researchers compared low-intensity email support (i.e., student psychologists provided passwords and positive encouragement through email) with a more intense email therapy condition (i.e., student psychologists individualised the content, checked on homework, and applied CBT techniques suitable to individual patients). There were no significant differences between treatment groups (Vernmark et al., 2010). An RCT for Generalised Anxiety Disorder compared the differences between weekly telephone reminders and email reminders; no differences were observed between the two conditions (Christensen et al., 2014). Conversely, motivational support provided by email significantly improved the effects of an online delivered self-help program for insomnia, compared to the condition where no extra support was provided (Lancee et al., 2013). Unsurprisingly, the heterogeneity in the way emails is utilised interferes with drawing robust conclusions about its effectiveness as a form of support. However, email support is worthy of further investigation due to the ease it can be incorporated as an automated intervention feature or utilised for a more personalised approach.

Short message service

SMS is a primary intervention delivery mode and an adjunct for support purposes, with largely positive results. SMS is a preferred medium for some as it is portable, easily accessible (Ho et al., 2016), and less intrusive than a phone call. Researchers have successfully used SMS to aid adherence to medication (Park et al., 2014; Quilici et al., 2013), support asthma treatment (Strandbygaard et al., 2010), promote adherence to healthy lifestyle practices (Akhu-Zaheya & Shiyab 2017; O'Brien & Palfai, 2016), and as encouragement for young people to adhere to a diabetes treatment regime (Franklin et al., 2006). A systematic review and meta-

analysis of web-based interventions by Webb et al. (2010) that used additional support modes demonstrated that SMS was highly effective (Cohen $d=0.81$) compared to phone calls ($d=0.35$) and emails ($d=0.18$). Conversely, SMS support to encourage diabetes self-management in three low-income countries did not yield improved results. However, the likely interplay of other factors (e.g., degree of phone coverage) was acknowledged (Van Olmen et al., 2017).

There may be numerous other factors influencing the efficacy of SMS messaging. Developers of the SAM reported that the number of messages was crucial. Too many messages may unintentionally indicate to users that they are not competent or cannot be trusted to engage autonomously (Mohr et al., 2011). Interestingly, the use of SMS messaging in a study to increase physical activity in obese adults found that the positive effect of the SMS messages only lasted during the first week. Participants reported the messages as “too many”, and some stopped reading them when they realised that they were impersonal and automated (Wang et al., 2015).

Furthermore, a group of researchers engaged in an intervention focused on SMS messaging to assist patients in blood pressure control. They identified the most effective SMS messages as those with credible information that was polite in tone, contextualised and authorised by a known person from the primary care setting (Bobrow et al., 2018). Further study into the efficacy of SMS messages and the many variables that may influence effectiveness (e.g., intensity/frequency, automation, personalisation, and content) is essential.

Videoconferencing

Videoconferencing has been used in several settings as a method of support. For instance, it has provided support for caregivers (Damianakis et al., 2016; Marziali & Donahue, 2006), support for elderly patients with chronic disease (Marziali, 2009), support for new parents (Nyström & Öhrling, 2006), and weight loss support for patients after bariatric surgery (Wild et al., 2015). In a recent review, videoconferencing proved to be an acceptable mode of human support for various age groups when reasonable technical assistance was provided (Banbury et al., 2018). Additionally, accessibility is enhanced, and group bonding is still able to occur in the online setting. Group-based videoconferencing enables participants to

observe others, compare stories, and share with like-minded people. Although not as rich in bandwidth as face-to-face, videoconferencing has a higher social presence than other computer-mediated communication (e.g., discussion boards) and potentially provides a more personable interaction (Banbury et al., 2018). Group-based videoconferencing, as opposed to individual videoconferencing, may also enable more effective use of human resources.

2.5.4.10 Comparing different modes of human support in clinical settings

The addition of human support has previously been a fundamental intervention inclusion (Andersson, 2016; Mohr et al., 2013; Mohr et al., 2011; Schueller et al., 2016). Generally, online initiatives for patients suffering from common mental health disorders (i.e., clinical groups) have demonstrated that the greater the level of support and the more personalised the human contact, the better the effectiveness (Fry & Neff, 2009; Kleiboer et al., 2015; Richards & Richardson, 2012; Spek et al., 2007; Wilhelmsen et al., 2013). Numerous studies have demonstrated that supported conditions positively influence adherence and outcomes across different treatment regimens (Andersson & Titov, 2014; Baumeister et al., 2014; Carolan et al., 2017; Johansson & Andersson, 2012; Kelders et al., 2012; Kleiboer et al., 2015; Mohr et al., 2011; Richards & Richardson, 2012). Specifically, some researchers found human support to be more effective than automated or non-personal prompts (Mohr et al., 2011; Schueller et al., 2016) with Wilhelmsen et al. (2013) asserting that while humans may naturally possess motivation for change, they usually require supportive conditions to enact it. Andersson and Cuijpers (2009) conducted a meta-analysis of twelve studies that targeted adults with depression noted that effect sizes for studies that included personal support were significantly larger ($d = 0.61$) compared to those that were unsupported ($d = 0.25$). Huang et al. (2018) conducted a systematic review and meta-analysis of studies for common mental health problems in university students. They found that easier-to-disseminate interventions (e.g., online, unsupported, a short length of time) had smaller effect sizes (Hedges' $g = 0.37$) compared to supported, longer interventions ($g = 0.70$).

Conversely, other studies have demonstrated mixed findings or no statistical differences between supported and unsupported conditions. An RCT testing different levels of adherence for the depression program *Mood Manager* found that those

receiving telecoaching demonstrated greater adherence but not statistically better outcomes than the self-directed group. Most recruits from both arms had dropped out by week 12, indicating that adherence may be an issue for those with depressive symptoms despite the provision of human support (Mohr et al., 2013). Several other RCTs have also found no significant difference in adherence or outcomes with or without human support. However, the type of support was heterogeneous between studies (Berger, Caspar, et al., 2011; Berger, Hämmerli, et al., 2011; Farrer et al., 2011). In a scoping review of studies targeting depression and anxiety disorders, Shim et al. (2017) found human support improved adherence in just four out of nine studies. Furthermore, a recent series of RCTs (Dear et al., 2016; Dear et al., 2018; Titov et al., 2015; Titov et al., 2016) for patients with common mental health disorders compared both supported and unsupported conditions. They found that well-designed, unsupported (i.e., self-guided) intervention arms were equally as effective concerning adherence level and measurement outcomes as the supported conditions.

Additionally, patients were reportedly just as satisfied with the treatment in both the supported and unsupported conditions. These findings appear to contradict some of the earlier analyses that reported the efficacy of human support (Baumeister et al., 2014; Richards & Richardson, 2012). They may indirectly indicate ongoing improvements in the development of well-designed interventions (i.e., judicious inclusion of specific design elements) that lessen the requirement for additional human support.

2.5.4.11 Comparing different modes of human support in non-clinical settings

For this review, non-clinical settings include online interventions conducted in either workplace or community settings as a form of health promotion or primary prevention for the general population.

There are only a few studies where RCTs have compared varying levels of human support in workplace settings for non-clinical groups, and the findings are mixed. For instance, Allexandre et al. (2016) compared three conditions in the workplace: no support, group support, and group support with a clinician. Group support improved adherence and outcomes compared to the no support condition but added clinician support provided no additional benefit. However, adherence was sub-

optimal despite the support offered, with 50% of participants never engaging with the intervention. Notably, the intervention was delivered digitally but provided face-to-face support, highlighting the heterogeneity when comparing studies. Zarski et al. (2016) conducted a stress-management intervention for employees comparing different modes of support. Support modes included content support (i.e., written feedback about tasks completed), adherence support (i.e., monitoring of module completion and sending reminders), and administrative support (i.e., provision of contact details for participants to request assistance). There was no difference in adherence behaviour between the content and adherence-focused support conditions; yet, they were superior to the administrative support. Notably, adherence-focused support required substantially less time investment from the support personnel, signalling that support intensity is an essential factor to consider as it has cost implications.

Two interventions compared human support conditions in a general community setting; added human support had little impact. Participants in an online mindfulness intervention participated in either a control group, the intervention with no support, or the intervention with an added online message board hosted by a facilitator. Both intervention groups improved compared to the control group; however, the message board made no significant difference, and 85% of participants reported that the message board added no value to the experience (Morledge et al., 2013). Alfonsson et al. (2016) conducted a digital relaxation training intervention for a general community group. Randomised participants experienced either *normal* treatment (i.e., black and white text files and weekly therapist support) or *enhanced* treatment (i.e., colour text and video, daily therapist support). There was no significant difference between the conditions, indicating that a higher level of human support intensity did not improve adherence or outcomes.

With very few RCT studies directly comparing supported with unsupported conditions in non-clinical groups, systematic reviews and meta-analyses were reviewed to appraise overall patterns between studies that included human support and those that did not. In 2011, a systematic qualitative review of 64 community health-promoting studies found that adherence was superior in interventions that included human support, such as counsellors, peers, phone, and email contact (Brouwer et al., 2011). In a more recent review, Stratton et al. (2017) conducted a

meta-analysis of 23 online interventions for employees. Both supported interventions (9 studies) and unsupported interventions (14 studies) demonstrated small effect sizes (Hedges $g=0.27$ and $g=0.22$, respectively). Conversely, Phillips et al. (2019) also conducted a meta-analysis of 22 studies in the workplace and supported interventions consistently demonstrated larger effect sizes (approximately double the effect size of unsupported interventions) across various outcomes measured (e.g., burnout, insomnia, mindfulness). Carolan et al. (2017) conducted a systematic review of 21 digital psychological studies for employees and demonstrated similar improvements in supported and unsupported interventions. Closer analysis of the most effective studies regarding higher adherence revealed numerous common variables, including PSD principles, shorter intervention length (6-7 weeks), and secondary communication modalities. Most studies also included human support.

Individual studies that directly evaluate the effectiveness of different human support conditions when administering DMHPIs in general community-based population groups are scarce. Furthermore, results in systematic reviews and meta-analyses are heterogeneous, making it clear that more research is needed to determine the efficacy of human support in such contexts.

2.6 Research Gaps

There is a noticeable research gap in understanding how healthy persons from the general community engage with a DMHPI. While research has evaluated the influence of human support on adherence and outcomes in some online mental health interventions, the vast majority of studies to date have centred on patients who belong to specific clinical population groups or employees in workplace situations. Notably, clinical groups typically comprise individuals experiencing mental health disorder symptoms such as lack of motivation and general malaise. Such participants may require substantially different levels of human support compared to generally healthy, non-clinical cohorts. Furthermore, unique variables impact employees in workplace settings, such as employer expectations, employee vulnerability and privacy concerns (Carolan & de Visser, 2018). Hence, human support needs in such environments may differ from healthy participants in a general, community-based setting. Therefore, it is crucial to establish the optimum human support conditions

required to maximise adherence and outcomes for DMHPIs amongst non-clinical, general community cohorts.

Importantly, human support provision has barriers and benefits. It has cost implications (Drozd et al., 2014; Michie et al., 2017), uses scarce human resources, and reduces the scalability of online initiatives (Mohr, Burns, et al., 2013). Conversely, human support may improve adherence by prompting participants to engage, fostering participant accountability, strengthening motivation, and optimising outcomes (Mohr et al., 2011; Schueller et al., 2016). Consequently, it is crucial to establish the most effective human support elements for non-clinical, general community population groups.

The purpose of this dissertation is to contribute novel insights into the research gap by evaluating the human support needs of a non-clinical, healthy, general population group when undertaking a DMHPI. A randomised comparative study will examine the impact of different modes of human support on a multi-disciplinary intervention. The study will: investigate group differences in outcomes, attrition, and adherence between the different human support conditions; appraise the impact of participants receiving their preferred mode of support; and examine participant perspectives regarding main factors influencing adherence behaviour for a non-clinical, general population group. The study's findings will assist in both designing and refining interventions to provide the best human support conditions to foster optimal levels of adherence and outcomes while minimising unnecessary cost and maximising scalability to reach substantial numbers of people within general community settings.

Chapter Three - Methods

3.1 Chapter Overview

This chapter provides a comprehensive overview of the methods used in the study. It details the randomised, comparative study design, includes specific information regarding the participants in the study, outlines the recruitment process, and describes the process of randomisation. The chapter delivers a comprehensive outline of the intervention, called the *Live More Project*, and details its administration in a digital format. It outlines quantitative and qualitative measurement methods and instruments, data analysis procedures, tests, and tools used. The chapter explains adherence measurement methods and the specific details of human support provision. Step-by-step details of the qualitative analyses are also delineated, along with information regarding ethics, consent, and study registration.

3.2 Study Design

This study applied a multi-group, randomised comparative trial design. Participants were randomised into three intervention groups that varied according to different modes of human support:

- i. Group 1: Standard (S) - included automated emails and a helpdesk function.
- ii. Group 2: Standard plus regular personalised SMS support (S+pSMS).
- iii. Group 3: Standard plus weekly videoconferencing support (S+VCS).

3.3 Subjects

3.3.1 Study sample

Sample size calculation was based on data from earlier studies (Morton et al., 2020; Przybylko et al., 2021a) as well as the following assumptions:

- i. Participants would be allocated equally between the three intervention arms.
- ii. The ability to detect improvements in the ‘mental health’ and ‘vitality’ scales of 15% is considered clinically significant (Morton et al., 2020).

- iii. An attrition rate of 30%, based on a comparable attrition rate in a previous similar study (Przybylko et al., 2021a).
- iv. A power level of greater, or equal to, 80%.
- v. A significance level of 0.05 (95% confidence interval).
- vi. A distribution standard deviation (SD) of 16.1, as demonstrated by a prior study (Morton et al., 2020).

The *a priori* power analysis indicated a required sample size of 148 participants for each intervention group.

3.3.2 Recruitment

Participants were recruited from among the Australian and New Zealand Seventh-day Adventist (SDA) Church membership. Advertisements from 1 June to 30 August 2018 included ads in the weekly SDA Church magazine called *Adventist Record* circulated across Australia and New Zealand, ads in SDA regional conference periodicals and weekly bulletin newsletters, and a paid marketing campaign on Facebook. A QR code featured on all advertising to direct participants to a landing page—a website designed to lead interested persons through information about the study and culminating in completing an online enrolment form. The landing page included general information about the study and intervention, an information statement about the role and expectations of participants, and a list of the required inclusion criteria for participants (Table 6). Visitors to the landing page who met the criteria and agreed to abide by the participant expectations completed an online enrolment form to register their initial interest as participants in the study.

Table 6. *Inclusion criteria*

✓ 18 years or over.
✓ Mobile phone with SMS capability.
✓ Internet access.
✓ Australian or New Zealand resident.
✓ Fluent in English.
✓ Acceptance to provide informed consent.
✓ Permission for anonymous data to be used for research

3.3.3 Randomisation

At the close of the advertising period, all potential participants who had enrolled on the landing page were screened to ensure they met the mandatory eligibility criteria. Using computer random number generation, those who met the conditions were randomised into three intervention groups by an independent person, not on the research team. Randomised groups were subsequently screened to ensure equitable dispersal of both age and gender between the groups. Participants who shared the same physical address were allocated to the identical intervention condition to minimise cross-contamination between the groups. Participants were informed of their group allocation and corresponding human support mode when completing the registration process to access the web-based portal during the orientation period, one week before the intervention commenced.

3.3.4 Participants

Out of a total of 605 potential participants who enrolled online and were randomised into an intervention group, 458 completed registration and the pre-intervention questionnaire (S, n=157; S+pSMS, n=163; S+VCS, n=138). Categorical analysis showed that the mean age of participants was 45 (± 13.7) years, 78% were female, 77% were white, and 78% were tertiary educated. There were no significant differences between the groups in any categorical variables, including baseline mental well-being measures (see Table 9 in Chapter Four for the detailed categorical analyses). A total of 320 participants (S, n=103; S+pSMS n=114; S+VCS n=103) completed the post-intervention questionnaire. For a detailed view of the flow of participants through the study, refer to Figure 3 in Chapter Four.

3.4 Intervention

The ten-week intervention designed to enhance mental well-being is the *Lift Project* or *Live More Project* (LMP). The LMP is a multimodal, multidisciplinary program that includes ten audio-visual lessons. The LMP content has a neuroscience foundation and teaches a range of evidence-based strategies from the two distinct yet complementary fields of lifestyle medicine (LM) and positive psychology (PP). Participants become acquainted with the limbic system's role as the *emotional* or

feeling brain and develop an awareness of the interplay of various lifestyle behaviours with limbic function. Table 7 briefly summarises the ten weekly topics and the daily and weekly experiential challenges. An apt mnemonic, SMILERRS, which is simplified to SMILERS, assists participants to recall the intervention topics within a positive framework.

Table 7. *Live More Project overview*

Wk	Topic	Overview	Daily Challenge	Weekly Challenge	Reference/s
1	S peak Positively ‘Your Limbo is Listening’	Limbic System introduction – the emotional brain Limbic System is wired to the language area of the brain.	Offer a genuine compliment.	Memorise an inspirational text or saying.	(Carrere et al., 2000; Losada, 1999)
2	M ove Dynamically ‘Motion Creates Emotion’	• Proprioceptors (i.e., nerve cells that detect movement) pass through the Limbic System. • Movement—even just 10 minutes— improves mood.	Complete 30 minutes of moderate-intensity activity.	Perform resistance exercises once during the week	(Josefsson et al., 2014; Lathia et al., 2017; Nair et al., 2015; Richards et al., 2015)
3	I mmerse in an Uplifting Natural Environment ‘Blue and Green Should Often be Seen’	• The Limbic System receives messages from all the senses. • The Limbic System likes blue and green spaces (i.e., natural settings). • The Limbic System needs approximately 30 minutes of 10,000 LUX of light each day.	Immerse in an uplifting natural environment for 30 minutes each day.	Watch sunrise from an appealing blue or green location.	(Barton & Pretty, 2010; Mantler & Logan, 2015; McMahan & Estes, 2015)
4	I mmerse in a Positive Social Environment ‘Together Feels Better’	• Limbic systems communicate. • Create positive social environments by making new friends or strengthening existing relationships. • Forgive others.	Do something intentional each day to show a friend or family member they are loved and use their love language.	Give up your right to hurt someone who has hurt you (i.e., forgiveness).	(Fowler & Christakis, 2008; Toussaint et al., 2016; Toussaint et al., 2015)
5	L ook to the Positive ‘Feelings Follow Your Focus’	• The emotional brain is wired to the thinking brain. • What you focus on affects how you feel. • Upward or downward spirals.	Each day, write down three things that went well.	Identify someone you are grateful to and write and deliver them a gratitude letter; if possible, read it in person.	(Emmons & McCullough, 2003; Froh et al., 2008; Garland et al., 2010; Proyer et al., 2014; Seligman et al., 2005)

Wk	Topic	Overview	Daily Challenge	Weekly Challenge	References
6	Eat Nutritiously 'Food Feeds Your Mood'	- Gut bacteria are linked to mood. - Feed gut bacteria high fibre diet. - Plant-based foods are high fibre. - Eat a wide variety of fruit, vegetables, legumes, and grains.	Eat eight fist-full portions of fibre each day.	Prepare and share a high-fibre plant-based meal with one or more friends.	(Blanchflower et al., 2013; Jacka et al., 2017b; Quirk et al., 2013; White et al., 2013)
7	Rest in Sleep 'Rest to Feel Your Best'	- Sleep is fundamental for feeling upbeat, with 7-8 hours of sleep being optimal. - Blue light vs. yellow/orange light. - Caffeine, lack of physical activity and blue light can deprive sleep.	Spend eight hours in bed every night.	Spend an evening by firelight.	(Bedrosian & Nelson, 2013; Neckelmann et al., 2007)
8	Rest from Stress 'Stress Less'	- SMILER strategies, as previously described, provide stress relief. - For stress relief, focus on the SMILER strategies, emphasising physical activity, mindfulness, laughing, and taking a rest day.	Set aside fifteen minutes per day to sit in silence and focus on a mindful activity.	Take a guilt-free day off.	(Cornelissen et al., 2005; Heber et al., 2017; Keng et al., 2011; Smith-Gabai & Ludwig, 2011)
9	Serve others 'Giving is Living'	- Contributing/serving is emotionally uplifting. - Serve sustainably using your signature strengths.	Perform one or more random acts of kindness each day.	Use your identified significant strength/s to perform a significant act of service.	(Buchanan & Bardi, 2010; Seligman, 2013; Tkach, 2006)
10	What Does it Take to Flourish?	Five areas to flourish: Positive emotions, Engagement, Achievement, Relationships and Meaning (PEARM).	Spend time engaging in something you enjoy.	Create a list of goals and an action plan to achieve them.	(Seligman, 2013)

The behaviour change intervention encourages participants to modify lifestyle behaviours. Ajzen's (1985) Theory of Planned Behaviour (TPB) underpins the program and is a commonly used framework for health behaviour change interventions (Webb et al., 2010). The program developer engaged the pedagogical framework of Learn, Experience, Think and Share. Behaviour change was encouraged through two main methods: evidence-based video content and consolidation of learning through an experiential component in daily and weekly practical activities.

In 2017, the LMP was administered as an online program using a purpose-designed web-based learning management system (eLMS). The eLMS underwent continual refinement in design, and version two was released immediately before the commencement of this study in August 2018. This version included both an updated eLMS and a new mobile app called *MyWellness*. The app had all components of the web-based version, and all activity on the app synchronised with the web platform so participants could readily use either platform or a combination of both—view Appendix 1 for Web and mobile app images.

Participants accessed the LMP lessons free of charge through their private, password-protected eLMS or mobile app portal. Each participant's personalised dashboard provided access to the pre- and post-questionnaire used for baseline and post-intervention measures and all intervention resources. Resources provided weekly included approximately 30 minutes of audio-visual content, a downloadable lesson workbook (see the sample in Appendix 2) and the corresponding chapter of the program developer's accompanying book, *Live More Happy*, in PDF format. A brief video introduced the daily and weekly experiential challenges and extra resources, including videos demonstrating the resistance training, recipe demonstrations and various related articles. Other features of the eLMS and mobile app included a place to log daily and weekly experiential challenge activities, a place to view the points leaderboard where participants earned points for challenges completed, and access to a public feed that displayed what other participants were doing. Participants could also opt to turn the feed off.

Importantly, participants accessed materials through a lock/unlock system. Firstly, a new lesson was released each Sunday during the intervention period to

encourage participants to engage with the material as intended in the intervention design. Secondly, videos unlocked in sequence, with participants required to view all previous lesson content videos before the next lesson would open for viewing. Participants were encouraged to engage with the content by viewing one lesson weekly. A printable timetable outlined the recommended schedule to complete all the lessons within the set intervention timeframe (see Appendix 3).

3.4.1 Persuasive system design features of the intervention

Persuasive system design (PSD) refers to the intentional design of digital software or communication systems to persuade behaviour change (Oinas-Kukkonen & Harjumaa, 2009). Developers incorporated several PSD elements into the web and app design to induce positive behaviour change. The principles are classified under four key support areas: primary task support, dialogue support, system credibility support, and social support (Oinas-Kukkonen & Harjumaa, 2009). The PSD elements used in the design of the eLMS and app are summarised in Table 8.

Table 8. *PSD principles used in the design of the LMP intervention*

Support area	Principle ¹	LMP example
Primary task support	Reduction: simplification of a complex behaviour into smaller, achievable steps to encourage specific behaviours.	Provision of simple, practical activities to apply principles learned.
	Self-monitoring: provision for the user to keep track of their progress and monitor goal achievement.	Provision of a digital feature to record and track experiential activities engaged in each day.
	Rehearsal: provision of ways to rehearse desired behaviours.	Provision of daily and weekly experiential challenge activities.
Dialogue support	Rewards: rewarding specific behaviours.	Participants received virtual badge icons for performing specific target behaviours.
	Reminders: provision of reminders to complete target behaviours.	Participants received automated reminders to view content or record experiential activities.
System credibility support	Principles in this section refer to demonstrating authority, expertise, trustworthiness, and verifiability in how the eLMS and app are constructed and portrayed.	None. This area of PSD was not overtly used in the LMP intervention.
Social support	Social learning: viewing others performing that behaviour.	Provision of a public feed where participants could view what others were doing.
	Social facilitation: showing that others are performing the behaviour too.	Provision of the public feed for comparing behaviours of others.
	Competition: the natural desire of participants to compete with others.	Provision of a leaderboard so participants could see the points earned for completing experiential activities.

¹ Summarised from Oinas-Kukkonen & Harjumaa (2009)

3.5 Human Support

Human support elements included regular automated emails for all intervention participants. The S+pSMS group also received messages signed by the support person that addressed participants by their first name. The S+VCS group were invited to weekly facilitated videoconference support sessions.

Automated email support reminded and encouraged participants to view content and complete experiential activities on time. Likewise, the content of SMS support messages and videoconference sessions centred on inducing engagement and carefully adhered to fundamental principles endorsed by the Supportive Accountability Model (SAM)—a model for cultivating adherence (Mohr et al., 2011). The SAM advocates the development of a positive bond between support personnel and participants, providing support that focuses on process-based goals (i.e., engaging with content and completing activities) rather than outcome-based goals. The SAM also encourages support personnel to establish legitimacy by being trustworthy, benevolent, and consistent. Additionally, intrinsic motivation may be fostered through the provision of positive feedback, reliable communication that is judiciously timed, avoidance of pressure or coercion tactics and a focus on encouragement to adhere to the intervention processes (e.g., viewing videos, completing activities) while valuing participant autonomy (Mohr et al., 2011).

3.5.1 Human support before intervention commencement

3.5.1.1 Advertising phase

Throughout the three-month advertising period, from 1 June to 30 August 2018, a bulk SMS delivery app called *Hit Em Up* sent enrolees fortnightly, personalised SMS messages to acknowledge their enrolment application and alert them regarding the upcoming intervention start date.

3.5.1.2 Orientation & registration phase

The week before the intervention commenced was termed *orientation week*, and all enrollees were emailed a unique link to register onto the eLMS at the beginning of the orientation week. *Hit Em Up* was used to send two SMS prompts several days apart to remind participants to complete registration on the eLMS by the

end of the designated orientation week. The mobile phone number of the lead researcher was provided to all potential participants as a helpdesk to troubleshoot any difficulties encountered during orientation, registration, or the intervention.

On day one, in the first week of the intervention period, the *Hit Em Up* app was used a final time to send registered participants a welcome SMS message outlining the steps to access the first lesson. An email also delivered the same information. Notably, after day one, communication to registered participants adhered to the human support modes outlined for each group—automated emails and the helpdesk for all participants, the addition of regularly scheduled SMS messages for those in the designated SMS group (S+pSMS), and the opportunity to attend a weekly videoconference for participants allocated to that mode of support (S+VCS). All automated emails and personalised SMS messages were sent from within the eLMS platform after day one. *Hit Em Up* was only used to communicate with those who had not yet completed registration.

3.5.1.3 Late registrations

During the first two weeks of the intervention, four reminder emails and SMS messages were sent to those who failed to register during the recommended orientation period. After that, the reminders ceased.

3.5.2 Human support after intervention commencement

3.5.2.1 Group (S) – Standard - automated email support

The S group received automated emails only. Automated emails were the standard, built-in mode of communication for the online intervention, and specific rules determined when and what emails were dispensed. Firstly, all participants received a weekly email on Sunday. The email served as a reminder to engage with the next presentation. It included a 20-25 second motivational video by the main presenter alerting the participants to the interesting new topic. Three days after the new lesson was released, the system checked whether any experiential activity had been logged. If “Yes”, then participants were sent a positive feedback email validating their achievement. If “No”, a different email message encouraged the participant to log their activity. Finally, if participants had not viewed any video

content within eight days of its release, they received an email reminding them to engage with the content.

3.5.2.2 Group (S+pSMS) – Standard plus personalised SMS support

The S+pSMS group received automated email support plus personalised SMS messages at regular, scheduled intervals over the ten weeks. Participants received three messages weekly over the first three weeks—Sunday, Tuesday, and Thursday. During the final seven weeks, participants received two messages—Sunday and Thursday. The reduction in message frequency recognised that too many messages might be counterproductive, viewed as controlling, and undermining the commitment and autonomy of individuals to engage with an intervention (Mohr et al., 2011). Each SMS contained the participants' preferred first name as a salutation, a brief hook statement (e.g., Lesson 3 – Have you had your dose of lux today?), the link to the eLMS, and occasionally an inspirational quote or a tip for implementing the experiential activity. Messages included a phone number for helpdesk assistance and were signed by the support person. The eLMS platform dispersed the SMS messages. Although participants could not reply, they were able to request help by messaging the mobile helpdesk number.

3.5.2.3 Group (S+VCS) – Automated email plus videoconferencing support

Along with automated emails, the S+VCS group was invited to attend a weekly, facilitated online support session using the *Zoom* app. During orientation week, participants in the S+VCS group could attend a tech check session to ensure that the technology was operating correctly—nine time slots were made available across the week. Participants in the S+VCS group received a timetable that outlined the nine available time slots and the correct time for their respective regions, which spanned from the east coast of New Zealand to Western Australia. Participants were encouraged to attend any one of the nine sessions available each week. They received a reminder SMS and email with the Zoom link each Sunday during the intervention period.

The lead researcher, an experienced educator, facilitated discussion sessions that lasted approximately 30 minutes. The structure of each session included a brief recap of the previous week's content, group discussion regarding new learnings and

experiential activities, and dialogue regarding tips and tricks to incorporate newly learned behaviours into the rhythm of daily life.

3.6 Quantitative Measurement

3.6.1 Questionnaire - 7 Dimensions of Wellness Index

Participants completed an online questionnaire, called the *7 Dimensions of Wellness Index (7DWI)*, constructed to measure seven dimensions of well-being—emotional, physical, social, spiritual, vocational, intellectual, and environmental. Once completed, participants received a well-being score in each of the seven areas. The questionnaire included demographic and lifestyle-related questions, along with several freely available, validated instruments listed below:

- i. The 36-Item Short Form Survey (Brazier et al., 1992)
- ii. The Depression Anxiety and Stress Scales (Antony et al., 1998)
- iii. Flourishing Scale (Huppert and So, 2013)
- iv. Flourishing Scale (Diener et al., 2010)
- v. The Trait Emotional Intelligence Questionnaire—short-form (Petrides, 2009)
- vi. The Multidimensional Scale of Perceived Social Support (Zimet et al., 1988)
- vii. The WHO Quality of Life Spirituality, Religiousness and Personal Beliefs (The WHO Quality of Life Group, 1998)
- viii. The Duke University Religion Index (Koenig & Büssing, 2010)
- ix. The Satisfaction With Life Scale (Diener et al., 1985)

Mental well-being was the focus of this study. Therefore, the data reported in this dissertation were drawn from four of the validated instruments within the 7DWI questionnaire: the 36-Item Short Form Survey (SF-36), the Depression Anxiety and Stress Scales (DASS-21), Diener's Flourishing Scale and the Satisfaction With Life Scale (SWLS). Participants completed the pre-questionnaire during the orientation period and the post-questionnaire at 12 weeks, within two weeks of the intervention conclusion. Participants accessed the questionnaire on either the web-based eLMS platform or on the mobile phone app.

The following mental well-being domains were measured for the purpose of this study:

i.	Mental health	SF-36
ii.	Vitality	SF-36
iii.	Depression	DASS-21
iv.	Anxiety	DASS-21
v.	Stress	DASS-21
vi.	Flourishing	Flourishing Scale
vii.	Life satisfaction	SWLS

3.6.2 36-Item Short-Form Survey (SF-36)

The 36-item Short-Form Health Survey (SF-36) is deemed appropriate for use in general population surveys (Ware Jr & Sherbourne, 1992). Two subscales of the SF-36 were used for this study: the mental health (5-item) subscale and the vitality (4-item) subscale (Brazier et al., 1992). Good internal consistency and reliability have been described for the various subscales and the survey as a whole (Jenkinson et al., 1994). Additionally, scores for the Cronbach alpha are substantially above the recommended minimum reliability standard (0.50-0.70), with 0.90 recorded for the mental health subscale and 0.87 reported for the vitality subscale (McHorney et al., 1994).

3.6.3 21-Item Depression Anxiety and Stress Scale (DASS-21)

The 21-item Depression Anxiety and Stress Scale (DASS-21) is a commonly used instrument to measure the domains of depression, anxiety, and stress. Seven items measure each factor. Acceptable reliability has been established in clinical and non-clinical samples (Caplan et al., 2017; Le et al., 2017; Lovibond & Lovibond, 1995). The DASS-21 demonstrates good internal consistency, both as a full scale (Cronbach alpha of >.90) (Osman et al., 2012) and also for the three separate subscales, with Cronbach alpha scores in the range of 0.76 to 0.91 (Le et al., 2017; Lovibond & Lovibond, 1995).

3.6.4 Satisfaction With Life Scale

The 5-item Satisfaction With Life Scale (SWLS) is appropriate for use in various settings and amongst a wide range of age groups (Pavot et al., 1991). The SWLS measures global life satisfaction, and data from six studies demonstrated high

internal consistency with Cronbach alphas ranging from 0.79 to 0.89 (Pavot & Diener, 1993). Additionally, a meta-analysis of 62 articles by Vassar (2008) that tested the SWLS reported a mean Cronbach alpha of 0.78 and robust internal consistency.

3.6.5 Diener et al. (2010) Flourishing Scale

The Diener et al. (2010) Flourishing Scale (8-item) measures social-psychological prosperity. More specifically, the scale measures a person's self-perceived success in optimism, relationships, self-esteem, and purpose. The Flourishing Scale is an appropriate measure to use amongst non-clinical population groups. It demonstrated satisfactory internal consistency (Cronbach alpha ranging from 0.78 to 0.87) in early analyses (Diener et al., 2010; Silva & Caetano, 2013). The scale is unidimensional in structure and is strongly associated with other measures of psychological well-being (Diener et al., 2010).

3.7 Adherence Measurement

3.7.1 Dropout attrition

Early dropout attrition measured the total number of pre-enrolled participants who were randomised to an intervention group but then either requested an early withdrawal or failed to complete the pre-intervention questionnaire at the commencement of the study. Late dropout attrition referred to participants who completed the pre-intervention questionnaire but did not complete the post-intervention questionnaire, sometimes referred to as lost to follow-up.

3.7.2 Primary adherence

Viewing the weekly video content was regarded as primary adherence. Therefore, a participant received a primary adherence score out of ten lessons. Participants were required to play 80% of the video for the lesson to register as complete, triggering the unlocking of the following video.

3.7.3 Secondary adherence

Participants accumulated points through the completion of daily and weekly experiential challenge activities to consolidate learning. Daily challenges scored 10 points (i.e., 70 points per week), and weekly challenges scored 30 points. Therefore, participants could potentially score 100 points each week throughout the ten-week intervention. Entirely adherent participants scored a maximum of 1000 points. Measurement of secondary adherence occurred in two ways—the total score (outlined above) and the total number of weeks that a participant logged challenge score activity during the ten weeks.

3.7.4 Videoconference adherence

The videoconference facilitator kept an attendance register for all videoconference participants. Records were verified with automatically generated reports; a standard reporting feature of the Zoom app. Participants were encouraged to attend any one of nine different time-slots each week during the ten-week intervention period. Adherence to the videoconference support sessions was scored out of ten.

3.7.5 Participant preferences for human support

As part of the post-intervention questionnaire, participants indicated their preferred mode of human support out of four options—1=most preferred, 4=least preferred. Options to choose from include:

- i. Standard—automated emails and helpdesk.
- ii. Standard plus SMS.
- iii. Standard plus videoconference support.
- iv. Standard plus SMS and videoconference support—not offered in the study.

3.8 Statistical Analyses – Quantitative Measures

Quantitative data were cleaned and prepared for analysis using Microsoft Excel and imported into IBM's SPSS Statistics Software (version 25). The Fisher's exact test, measured as a P value, is suitable for use when sample sizes are small (Kim, 2017) and was used to test for non-random associations between the

categorical variables. Paired *t*-tests measured within-group changes in the designated variables over time from baseline—the pre-intervention questionnaire during orientation week—to the post-intervention questionnaire—within two weeks of the intervention ending. Repeated measures generalised linear models measured analysis of variance between the intervention groups, considering time and group effects. Data were reported using descriptive statistics, including means, standard deviations, *P* values, and Cohen's *d* effect sizes. All participants who completed the pre-intervention questionnaire were included in the analysis of categorical variables at baseline. Subsequent analyses included participants who completed both the pre-and post-intervention questionnaires.

3.9 Qualitative Measurement

3.9.1 Data collection

The post-intervention questionnaire included the collection of qualitative data. Participants responded to two adherence-related statements within an expanding text box with no word limit restrictions. The statements were:

Statement 1: Thinking about your personal experience as a participant in the *Live More Project* over the last 10 weeks, if it was easy for you to watch the video presentations and complete the daily and weekly challenges, please describe/list all the factors that contributed to this.

Statement 2: Thinking about your personal experience as a participant in the *Live More Project* over the last 10 weeks, if it was difficult for you to watch the video presentations and complete the daily and weekly challenges, please describe/list all the factors that contributed to this.

3.9.2 Qualitative data analysis

An inductive approach was adopted to analyse the qualitative data set, using reflexive thematic analysis (Braun & Clarke, 2006, 2019; Braun et al., 2018). Allowing themes to emerge from within the data, rather than viewing the data with a preconceived set of notions, was a desired fundamental principle and aligned with the inductive style—sometimes described as a bottom-up approach (Braun et al.,

2018). As the author was singularly responsible for all the analyses and coding procedures, it was essential to maximise objectivity by adopting a reflexive approach—a process of consciously reflecting, acknowledging, and examining personal bias and preconceptions (Braun & Clarke, 2019). As the author performed the analysis and many other roles in the intervention, two additional team members reviewed the data, themes, and codes at different time points—a practice recommended as part of the Standards for Reporting Qualitative Research (SRQR) (O'Brien et al., 2014).

The structured six thematic analysis data coding phases informed the coding process (Braun et al., 2018). A Microsoft Excel spreadsheet and the qualitative analysis software program NVivo assisted in collating, analysing, and coding the data. Identification numbers served as reference points after all identifying information was removed from the data. During the immersion and familiarisation phase of data analysis, the coder read through the data twice and made annotations regarding themes or concepts that were apparent. The second immersion consisted of a systematic and careful analysis of all comments. The Microsoft Excel spreadsheet was used for this phase with new columns added as needed and tentatively labelled as codes as the data revealed new concepts. As initial coding analysis, this phase required a combination of descriptive—thoughts as they were clearly stated in words—and interpretive—reading between the lines, making judgments about meaning—scrutiny. The focus remained on a systematic, inclusive, and thorough investigation that included coding of all comments. Immediately after initial coding completion, codes were reviewed and code names edited, as needed, to incorporate similar ideas.

After coding, the coder commenced collapsing and clustering columns by copying and pasting spreadsheet columns (i.e., codes) based on thematic similarities. The coder reviewed clustered codes to ensure that the data matched the emerging themes. Clusters were grouped and regrouped to form themes and sub-themes that eventually formed the thematic map (Braun et al., 2018). Themes and codes were reviewed repeatedly to ensure that the data accurately represented the specific theme. Two other researchers scrutinised the data and codes and discussed any mismatches between themes and sub-themes, particularly concerning the study's original intention. In collaboration, the coder and other research team members discussed

codes that may be deemed less relevant to the study's purpose and collaboratively eliminated codes that had very little participant data. The SRQR was adhered to in writing up the results of the qualitative analysis (O'Brien et al., 2014).

3.10 Ethics and Informed Consent

The Avondale Human Research Ethics Committee granted ethical approval for the study in 2018 (Approval No. 2018.09) before data collection. All participants received an Information Statement that outlined participant expectations (see Appendix 4). Participants were notified by email that registering onto the eLMS to commence the study would signify their informed consent to participate.

3.10.1 Registration of the study

The study was registered with the Australian and New Zealand Clinical Trial Registry (ANZCTR): 12619001009101.

<http://www.anzctr.org.au/ACTRN12619001009101.aspx>.

Chapter Four: Publication One - A Web and Mobile App-based Mental Health Promotion Intervention Comparing Email, Short Message Service and Videoconferencing Support for a Healthy Cohort: Randomised Comparative Study

4.1 Chapter Overview

This chapter focuses on the first research question of this dissertation—What is the influence of different modes of human support on the outcomes of a web and mobile app, lifestyle-based mental health intervention for a healthy adult cohort? The chapter is presented as a manuscript that was published in the Journal of Medical Internet Research (Impact Factor 5.43, Q1 ranking) in January 2020, titled ‘A Web- and Mobile App-Based Mental Health Promotion Intervention Comparing Email, Short Message Service, and Videoconferencing Support for a Healthy Cohort: Randomised Comparative Study’. The main objective of this study was to compare the influence of three different modes of human support on outcome measures. The 10-week, lifestyle-based mental health promotion intervention was delivered digitally for a healthy, community-based adult cohort. Outcomes measures involved changes in mental health, vitality, depression, anxiety, stress, life satisfaction, and flourishing. This study contributes to the scant body of knowledge about the human support needs of a general population group when participating in a digitally-delivered mental health promotion intervention. It is vital to ascertain the optimal human support requirements as the addition of human resources has scalability and cost implications. Chapter Seven also discusses the findings and conclusions of this study.

4.2 Contribution of Authentication Statement

I attest that Higher Degree Research candidate Melanie Renfrew contributed to the paper/publication entitled:

A Web and Mobile App-Based Mental Health Promotion Intervention Comparing Email, Short Message Service, and Videoconferencing Support for a Healthy Cohort: Randomised Comparative Study.

By:

- Leading the conception and design of the study
- Cleaning the data
- Leading the data analysis
- Interpretation of the data
- Leading the writing of the manuscript
- Submitted the manuscript for review
- Addressed reviewers' comments

Signature of Candidate:



Name of Candidate: Melanie Renfrew

Date: 30 September, 2021

Signature of Principal Supervisor:



Name of Principal Supervisor: Associate Professor Darren Morton

Date: 30 September, 2021

4.3 Abstract

4.3.1 Background

The rapid increase in mental health disorders has prompted a call for greater focus on mental health promotion and primary prevention initiatives. Web- and mobile app-based interventions present a scalable opportunity. Little is known about the influence of different modes of human support on the outcomes of these interventions.

4.3.2 Objectives

To compare the influence of three modes of human support on the outcomes (i.e., mental health, vitality, depression, anxiety, stress, life satisfaction and flourishing) of a ten-week, Web- and mobile app-based, lifestyle-focused, mental health promotion intervention among a healthy adult cohort.

4.3.3 Methods

Participants were recruited voluntarily from a faith-based community using a combination of online and offline advertising. They were randomised, unblinded, into three groups, differentiated by human support mode: Group 1 (n=201), standard – fully automated emails (S); Group 2 (n=202), standard plus personalised short message service (S+pSMS); Group 3 (n=202), standard plus weekly videoconferencing support (S+VCS), hosted by a trained facilitator. Participants accessed all intervention components, including the questionnaire, on a web-based learning management system or through a mobile app. The questionnaire, administered at pre- and post-intervention, contained self-reported measures of mental well-being, including the ‘mental health’ and ‘vitality’ sub-scales from the Short Form Health Survey (SF-36), Depression Anxiety and Stress Scales (DASS-21), Diener’s Satisfaction With Life Scale (SWLS) and Diener’s Flourishing scale.

4.3.4 Results

Of the 605 potential participants, 458 (S, n=157; S+pSMS, n=163; S+VCS n=138) entered the study by completing registration and the pre-intervention questionnaire. At post-intervention, 320 out of 458 participants (69.9%) (S, n=103;

S+pSMS, n=114; S+VCS, n=103) completed the questionnaire. Significant within-group improvements were recorded from pre- to post-intervention in all groups and in every outcome measure ($P=0<.001$). No significant between-group differences were observed for outcomes in any of the measures: mental health ($P=0.77$), vitality ($P=0.65$), depression ($P=0.93$), anxiety ($P=0.25$), stress ($P=0.57$), SWL ($P=0.65$) and flourishing ($P=0.99$). Adherence was not significantly different between the groups for the mean number of videos watched ($P=0.42$) and engagement with practical activities ($P=0.71$). Participation in videoconference support sessions (VCSSs) was low; 37 out of 103 (35.9%) participants did not attend any VCSSs, and only 19 out of 103 (18.4%) attended seven or more out of ten sessions. Stratification within the S+VCS group revealed that those who attended seven or more VCSSs experienced significantly greater improvements in the domains of mental health ($P=0.006$, $d=0.71$), vitality ($P=0.005$, $d=0.73$), depression ($P=0.04$, $d=0.54$), and SWL ($P=0.046$, $d=0.50$), compared to participants who attended less than seven.

4.3.5 Conclusions

A web- and mobile app-based, mental health promotion intervention enhanced domains of mental well-being among a healthy cohort, irrespective of human support. Low attendance at VCSSs hindered the ability to make meaningful between-group comparisons. Supplementing the intervention with VCSSs might improve outcomes when attendance is optimised.

4.3.6 Trial registration

Australian New Zealand Clinical Trials Registry (ANZCTR):
12619001009101; <http://www.anzctr.org.au/ACTRN12619001009101.aspx>

4.4 Introduction

4.4.1 Background

In 2012, the World Health Assembly requested a plan to address escalating mental distress, resulting in the Mental Health Action Plan 2013-2020, which asserts that there is ‘no health without mental health’ (WHO, 2013). Yet, as we approach 2020, mental well-being continues to deteriorate. Depression is the leading cause of disability worldwide (WHO, 2017a, 2018a). Its prevalence is rising (Jorm et al., 2017), evidenced by increasing antidepressant use (Stephenson et al., 2013) and the high rate of suicide—the second leading cause of death in the 15-29 age group internationally (WHO, 2018a). Comorbidity is common (O’Neil et al., 2015), and those with major depression have a 40-60% risk of dying prematurely (WHO, 2013). A 2018 review (Finley et al.) of 12 countries revealed that depression and anxiety are the third most common reason for visiting a general practitioner in the developed world.

Mental well-being, even in the seemingly healthy population, is compromised by mounting stress and anxiety. In the 2015 Australian Psychological Society’s Stress and Well-being Survey (2015), 35% of those surveyed reported significant distress levels, 26% reported above-normal anxiety, and 26% described themselves as having moderate to extreme depression levels. Therefore, the provision of mental health promotion interventions (MHPIs) may be an integral approach to enhance mental well-being amongst healthy (i.e., non-clinical), community-based cohorts.

There is a growing evidence base supporting the efficacy of MHPIs to improve the mental well-being of non-clinical population groups. These include interventions to alleviate stress (Harrer et al., 2018; Hintz et al., 2015; Hu et al., 2014), mindfulness training (Bhayee et al., 2016; Galante et al., 2018; Keng et al., 2011; Wahbeh & Oken, 2016), lifestyle medicine strategies such as nutrition (Blanchflower et al., 2013; White et al., 2013) and exercise (Mammen & Faulkner, 2013; Stubbs et al., 2016), and an array of positive psychology interventions (Gander et al., 2016; Lyubomirsky et al., 2011; Proyer et al., 2014). A recent analytic review (Morton, 2018b) highlighted strategies from the fields of positive psychology and lifestyle medicine that have demonstrated effectiveness in enhancing mental well-

being. Combining strategies from both fields, the same author devised a lifestyle-focused, multimodal intervention that has been piloted among university students on two occasions (Hinze & Morton, 2017; Morton et al., 2020), and more recently, as a web-based randomised controlled trial (RCT) for a healthy community cohort (Przybylko et al., 2021a). The web-based RCT demonstrated significantly greater improvements ($P<.001$) than the control group for all outcomes, with medium effect size improvements for the intervention arm in mental health ($d=0.52$), vitality ($d=0.56$), and stress ($d=0.45$). The same intervention was used for this study.

Web- and mobile app-based technology offers an unprecedented opportunity for disseminating MHPIs to healthy cohorts in community settings. Advantages, when compared to face-to-face interventions, include cost-effectiveness (Romero-Sanchiz et al., 2017; Woodworth et al., 2017), accessibility, and scalability (Choi et al., 2015; Ebert, Cuijpers, et al., 2017). Furthermore, up to 80% of potential users are “e-preferers” (Apolinário-Hagen et al., 2018). However, digital delivery also poses unique challenges (e.g., quality control, data control, high dropout attrition, low adherence) that require creative solutions (Ebert et al., 2018; Shim et al., 2017). Notably, the provision of human support (i.e., guidance) is recognised as a possible modulating influence on adherence and outcomes (Mohr et al., 2011; Shim et al., 2017).

4.4.2 Human support

Human support provision in web-based interventions has generally been associated with improved adherence and outcomes in clinical cohorts (Alkhaldi et al., 2016; Andersson & Cuijpers, 2009; Baumeister et al., 2014; Ebert et al., 2018; Johansson & Andersson, 2012; Richards & Richardson, 2012). A meta-analysis of twelve studies treating depression found effect sizes for studies that included human support were larger ($d=0.61$) in comparison to unsupported studies ($d=0.25$) (Andersson & Cuijpers, 2009). Nevertheless, some studies have found that the level of human support does not significantly influence outcomes (Dear et al., 2016; Königbauer et al., 2017; Mohr, Duffecy, et al., 2013; Titov et al., 2015; Titov et al., 2016). Further, variability in the provision of human support (e.g., mode, intensity, synchronicity) results in high heterogeneity, which makes comparisons between studies problematic (Alkhaldi et al., 2016; Shim et al., 2017).

It is imperative to investigate the role of human support among non-clinical groups. Support requirements may be markedly different among healthy cohorts. Symptomatic factors (e.g., apathy, weakened motivation, general malaise) that could impede a clinical cohort from completing a program may be non-existent or differ considerably for a non-clinical group. Conceivably, MHPIs may prove to be a credible pathway to enhance mental well-being and serve as a vital buffer to protect healthy populations against mental distress (Garland et al., 2010).

Studies comparing human support factors for healthy cohorts engaging in web- or mobile app-based mental well-being interventions are scarce, and outcomes are mixed. Several primary prevention studies (all classified as ‘indicated’ prevention) have reported no significant difference between supported and unsupported arms (Aardoom et al., 2016; Christensen et al., 2014; Saulsberry et al., 2013). Zarski and colleagues (Zarski et al., 2016) examined three support approaches and compared the effects on adherence to a stress management intervention. Monitoring and written feedback improved adherence. However, administrative support (i.e., access to a support team for technical assistance) had no positive effect (Zarski et al., 2016). Allexandre et al. (2016) compared no support, group support and group support with added expert clinical support for a stress management intervention. Group support was beneficial, but added clinical care contributed no extra benefit. However, the program content was web-based, and support was provided face-to-face in a work setting, making comparison problematic. Finally, a review and meta-analysis of 23 web- and computer-based interventions to alleviate stress found that supported interventions demonstrated greater effects on outcomes ($d=0.64$) than unsupported ($d=0.33$) (2017).

A confounder when drawing conclusions about the impact of human support on the effectiveness of web- and computer-based programs is that there are many modes and delivery styles classified as human support, which differ markedly in their resource requirements (e.g., time, cost, intensity). For this study, we chose three support modes to compare, based on low (automated emails), medium (personalised SMS messaging) and high (facilitated videoconference) resource requirements.

4.4.2.1 Email support

Emails are widely used (Shim et al., 2017) and easily incorporated into a web-based intervention as an asynchronous, low intensity, low-cost support method (Lancee et al., 2013). Notwithstanding, heterogeneity in the way emails are used reduces the ability for effective comparison, and results are mixed in clinical settings (Christensen et al., 2014; Kelders et al., 2015; Stefanopoulou et al., 2018; Titov et al., 2009). For instance, automated emails, often used as engagement prompts, may be built into the system design and require virtually no monitoring once set up. Conversely, personally tailored, individually written emails require effort and time on behalf of the support person and may be considered a more intense support mode (Lancee et al., 2013).

4.4.2.2 SMS support

Short message service (SMS) support varies in intensity depending on the method of dissemination (i.e., automated or individualised); however, it is easily accessible and portable (Yardley et al., 2016) through the widespread use of smartphones. Researchers have used SMS support to aid adherence to medication (Park et al., 2014; Quilici et al., 2013), support asthma treatment (Strandbygaard et al., 2010) and promote adherence to healthy lifestyle practices (Akhu-Zaheya & Wa'ed, 2017), among other uses. A systematic review and meta-analysis of web-based interventions that used additional support modes demonstrated that SMS had large effects ($d=0.81$) compared to phone ($d=0.35$) and email ($d=0.18$) (Webb et al., 2010). Nevertheless, users may ignore SMS prompts when perceived as impersonal, too frequent or automated (Wang et al., 2015).

4.4.2.3 Videoconferencing support

Videoconferencing most closely replicates the face-to-face setting yet requires a greater investment of time, cost, and human resources. Notwithstanding, it may provide a feasible, personal, and acceptable mode of support, similar to face-to-face settings, as long as technical assistance is available (Banbury et al., 2018). Participants value ease of accessibility and can still bond as a group despite the lack of various communication cues (e.g., body language) (Banbury et al., 2018). Videoconferencing has been successfully used to support caregivers (Damianakis et

al., 2016), patients with chronic disease (Marziali, 2009), new parents (Nyström & Öhrling, 2006), and bariatric surgery patients (Wild et al., 2015), among others.

Identifying the optimum input of human support resources to maximise program effectiveness is an important consideration for researchers designing MHPIs for non-clinical cohorts. This comparative study seeks to add to the evidence base by asking the question: What is the influence of different modes of human support on the outcomes of a web- and mobile app-based MHPI for a healthy, community-based cohort?

4.5 Methods

4.5.1 Recruitment

Participants were recruited from an Australian and New Zealand faith-based cohort. Advertising, conducted from June to September 2018, included offline marketing through periodicals, magazines and bulletins of the faith-based organisation, and online marketing using a combination of website, social media, and email strategies. Advertising material directed potential applicants to a webpage to examine the inclusion criteria (see Table 6. *Inclusion criteria*, located in the Methods chapter), acquaint themselves with participation expectations and fill out an enrolment application. An information statement, available on the advertising webpage, outlined that participation may include receiving regular text messages or a weekly 30-minute videoconference session.

Approved applicants were randomised into one of three intervention groups (see Figure 3 below) using computer generating software. An email notified applicants of acceptance into the study, group allocation, instructions detailing the steps to complete registration on the web-based learning management system (eLMS) and a unique link to activate the registration process. Informed consent was gained as part of the registration procedure. Once registered, users could opt to download the mobile app and access all features of the intervention, including self-reported questionnaires, from either the eLMS or from the mobile app.

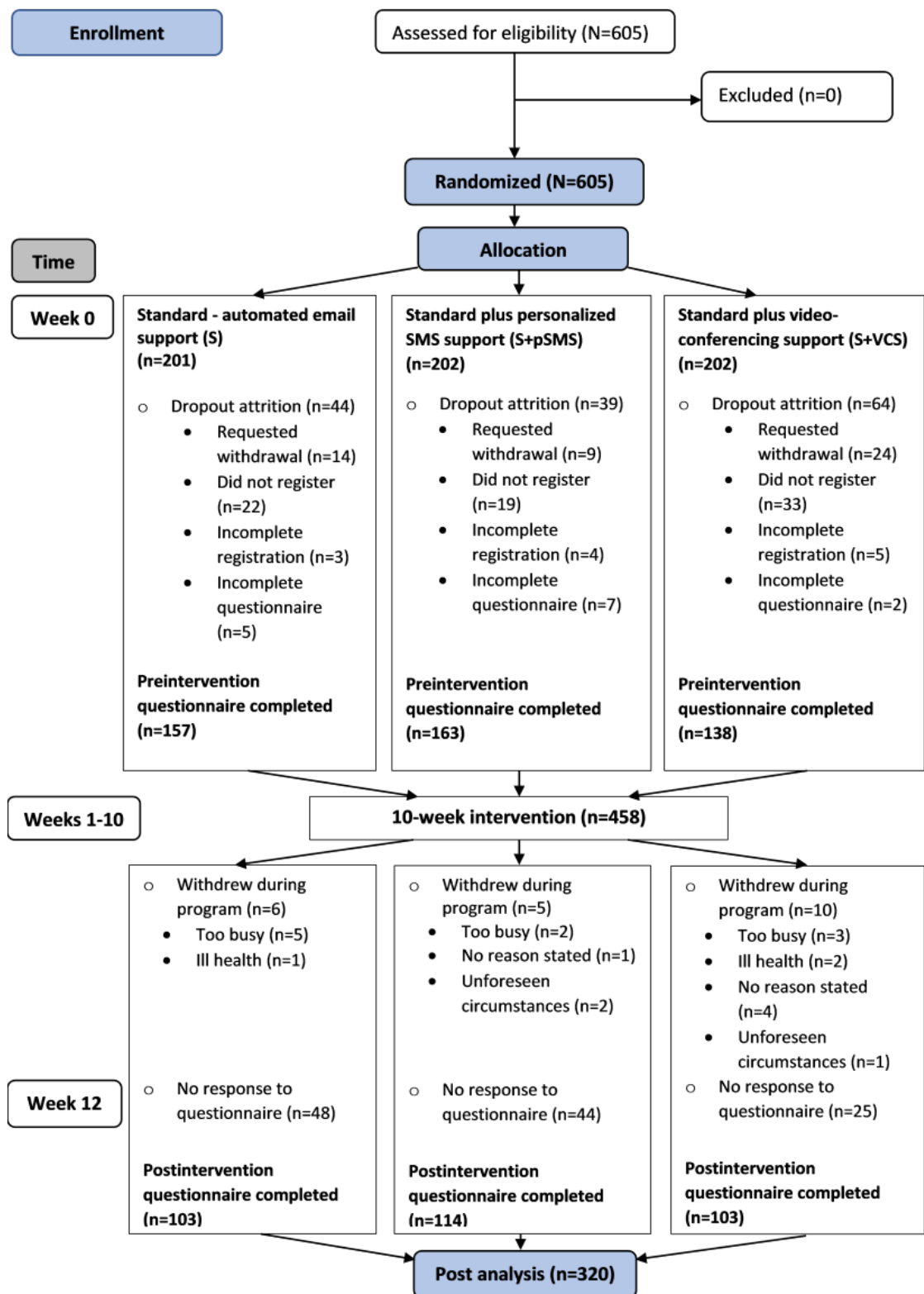


Figure 3. *Flow of participants*

To provide anonymity, participants were permitted to use a pseudo name for the duration of the intervention, if desired. In the S+VCS group, which involved videoconferencing using the application Zoom, the participants were given the option to choose a pseudo name and have the camera switched off.

4.5.2 Study design

The study was a multi-arm, randomised comparative design with three intervention groups that differed according to modes of human support:

- a) Group 1: Standard – fully automated emails (S).
- b) Group 2: Standard plus personalised SMS support (S+pSMS).
- c) Group 3: Standard plus videoconferencing support (S+VCS).

Figure 3 shows that participants in each group accessed the intervention simultaneously, from September to December 2018.

4.5.3 Intervention

The ten-week intervention is presented in an audio-visual format and was initially administered in 2017 as a web-based program on an eLMS. Version 2, released immediately before the commencement of this study (August 2018), included an updated eLMS and a mobile app called *MyWellness*. No new features were introduced during the study period.

The lifestyle-focused intervention is underpinned by the Theory of Planned Behaviour (TPB) (Ajzen, 1985), which has demonstrated substantial health behaviour change benefits (Webb et al., 2010). The intervention actively seeks to change behaviour through education and increase perceived control through easily attainable weekly challenges (Morton et al., 2020). Using the pedagogical framework of Learn, Experience, Think, Share (LETS), the participants were introduced to fundamental neuroscience and explored ten evidence-based strategies from lifestyle medicine and positive psychology for improving mental well-being.

Table 7 (located in the Literature Review chapter) outlines the weekly topics covered throughout the intervention.

Participants accessed the intervention free of charge by logging onto the eLMS or the mobile app. Each participant's personal dashboard provided access to the weekly lesson, which included approximately 30 minutes of audio-visual content, a downloadable workbook and extra reading materials relating to the topic (Morton, 2018b). The intervention emphasised experiential learning by encouraging participants to engage in daily and weekly challenges through which they could log their activity to earn challenge points. Participants were emailed a 'timetable overview' which outlined the recommended schedule to complete the intervention within the ten-week timeframe.

4.5.4 Persuasive Systems Design features

Features of Persuasive Systems Design (PSD) were key to the intervention, and numerous support principles were utilised on the Web platform and mobile app to encourage behaviour change. The PSD model, developed by Oinas-Kukkonen and Harjumaa (2009), is largely based on earlier work by Fogg (2003). The model outlines a taxonomy of twenty-eight principles, classified under four key areas of support, for designing completely digital behavioural change interventions. *Primary Task Support* components of PSD included the use of *reduction* to simplify key learnings into practical strategies for implementation, along with *self-monitoring* and *rehearsing* desired behaviours in the form of daily and weekly challenges that were recorded on the eLMS or app. An element of *Dialogue Support* (Oinas-Kukkonen & Harjumaa, 2009) utilised was *rewards* in the form of badge icons. *Social Support* elements of PSD (Oinas-Kukkonen & Harjumaa, 2009) provided opportunities for various forms of interaction. Participants could choose to post challenge activity to a public feed (viewable by other group members) providing *social learning* and *social facilitation* opportunities. Furthermore, challenges posted as public provided opportunity for interaction between group members. *Competition* and *social comparison* were aroused through a challenge points leaderboard.

4.5.5 Human support

Human support was crafted to reflect the Supportive Accountability Model (SAM) values, developed by Mohr, Cuijpers and Lehman (2011). They propose a range of support measures to improve adherence, including focusing on process expectations rather than outcome expectations, positive feedback provision, avoidance of controlling behaviour, timely communication, being trustworthy, facilitating engaging discussions, and the avoidance of pressure tactics (Mohr et al., 2011).

4.5.5.1 Advertising period

During the advertising period, the mobile app *Hit Em Up* was used to send enrolees (i.e., those who had registered interest in joining the study) weekly, personalised SMS communication to remind them of the upcoming program.

4.5.5.2 Orientation & registration period

During orientation week, all enrollees were sent an email link to register onto the eLMS to finalise registration and complete the pre-intervention questionnaire. Two SMS reminders were sent several days apart as reminders to register.

On the intervention start date, a ‘welcome’ email and SMS were sent to all registered participants outlining the steps to access the first lesson. Additionally, within the first two weeks of the intervention, those who had not yet completed registration were sent four reminder SMS and email messages inviting them to access the provided link to complete registration. Once participants completed registration, human support reverted to the constraints outlined for each group and the eLMS was used to send SMS and automated email messages to the registered participants.

4.5.5.3 Group 1 support: Automated emails – Standard (S)

Automated emails, which are the routine communication mode outside the research setting, were set up as part of the eLMS. All participants received a weekly email on the day prior to the next lesson commencing. The email included a link to a 20-25 second video by the presenter, inviting them to engage with the next presentation. Three days after a lesson was released, the system checked to see if the

participant had logged any challenges: if *yes*, participants were sent an email validating their participation; if *no*, an email prompted the participant to complete the relevant challenge. Eight days after a new lesson was released, participants, who had not watched the video, were sent an email reminder.

4.5.5.4 Group 2 support: Standard plus personalised SMS messages (S+pSMS)

The S+pSMS group received automated emails, plus SMS messages that were sent three times weekly for the first three weeks and then two times weekly for the remaining seven weeks. The reduction from three messages per week to two messages per week recognised the notion that support may have a threshold; too many messages may be seen as controlling and undermine the commitment of individuals, therefore impairing engagement (Mohr et al., 2011). The messages focused on process accountability (i.e., completing target behaviours such as viewing content and engaging in experiential learning) as opposed to outcome accountability, which may be detrimental and beyond an individual's control (Mohr et al., 2011).

Each SMS included the participant's first name, a predetermined message to prompt engagement and was signed by the research team member (MR), who also provided technical assistance. Specific message content included different combinations of the following: a brief hook sentence (e.g., Lesson Two - Learn three practical tips to calm your nerves, Lesson Three - Have you had your dose of lux today?), the link to log into the eLMS, an inspiring quote, tips for implementing challenge activity and a phone number for technical assistance.

4.5.5.5 Group 3 support: Standard plus videoconference support (S+VCS)

As well as automated email support, participants in the S+VCS group were invited to attend a synchronous videoconference session using the application Zoom. A weekly timetable provided nine different time possibilities, and participants were invited to attend any one of these. During orientation week, participants were encouraged to attend one of nine available 'tech check' sessions. Each week, participants were sent one reminder SMS and an email with a link to the online meeting. Discussion sessions lasted 20-30 minutes and were led by an experienced educator who holds a post-graduate degree in lifestyle medicine. The facilitator had previously hosted many preventative health videoconference sessions for participant groups doing the renowned Complete Health Improvement Program (CHIP). Prior

training included six mentoring sessions on how to facilitate successful videoconferences in a web-based setting. The videoconference support sessions included a recap of the weekly content by the facilitator, sharing new learnings and challenge experiences, plus dialogue on ways to incorporate strategies learned into everyday life.

4.5.6 Measurement – outcomes

Participants completed a self-report questionnaire, the ‘7 Dimensions of Wellness Index’ (7DWI), at pre-intervention (Week 0) and post-intervention (Week 12). The 7DWI combines demographic- and lifestyle-related questions with various, freely available, validated instruments that measure seven well-being domains (i.e., emotional, physical, social, spiritual, vocational, intellectual, and environmental). For the purpose of this study, the following instruments were utilised from the 7DWI to measure aspects of mental well-being:

4.5.6.1 36-Item Short Form Survey

The 36-item Short Form Health Survey (SF-36) is suitable for use in general population surveys (Ware Jr & Sherbourne, 1992), and two sub-scales of the SF-36 were used for this study: mental health (five items) and vitality (four items) (Brazier et al., 1992). Good internal consistency and reliability across the whole survey and sub-scales have been reported (Jenkinson et al., 1994). Cronbach’s alpha scores of 0.90 for the mental health subscale and 0.87 for the vitality sub-scale are well above the minimum reliability standard (0.50 - 0.70) (McHorney et al., 1994).

4.5.6.2 21 Item Depression Anxiety and Stress Scale

The 21-item Depression Anxiety and Stress Scale (DASS-21) is widely used to measure depression, anxiety, and stress (seven items per factor), and satisfactory reliability has been demonstrated for both clinical and non-clinical samples (Caplan et al., 2017; Le et al., 2017; Lovibond & Lovibond, 1995). The DASS has demonstrated adequate internal consistency as a total scale (Cronbach’s alpha >0.90) (Osman et al., 2012), and for the three sub-scales, with Cronbach’s alpha scores ranging from 0.76-0.91 (Le et al., 2017; Lovibond & Lovibond, 1995).

4.5.6.3 Satisfaction With Life Scale

Diener's 5-item Satisfaction With Life Scale (SWLS) measured global life satisfaction and was initially tested on a non-clinical group of university students (Diener et al., 1985). Good internal consistency was found (Cronbach's alpha 0.87) (Diener et al., 1985), and the SWLS was deemed suitable for a wide range of age groups and settings (Pavot et al., 1991). Data from six studies indicated that the scale has high internal consistency (Cronbach's alpha ranged from 0.79 to 0.89) (Pavot & Diener, 1993). Further, a meta-analysis of 62 articles provided 76 reliability coefficients testing the SWLS. The mean Cronbach's alpha was 0.78 – signifying good internal consistency (Vassar, 2008).

4.5.6.4 Flourishing Scale

Diener's brief 8-item Flourishing Scale was designed to measure 'social-psychological prosperity', is suitable for non-clinical cohorts, correlates highly with other measures of well-being and demonstrates good internal consistency under initial analysis (Cronbach's alpha 0.87) (Diener et al., 2010). The Flourishing Scale has a unidimensional factor structure, and more recent analysis, across two samples, also showed good consistency (0.78 and 0.83) (Silva & Caetano, 2013).

4.5.7 Measurement – adherence

Primary adherence was measured as the total number of weekly videos viewed out of a possible ten presentations. Challenge adherence was also measured, with participants able to accumulate points through practical daily and weekly challenge activities. Each daily challenge was worth ten points, and weekly challenges were worth 30 points. Participants could score a maximum of 100 points each week throughout the ten-week intervention, thereby accumulating a total of 1000 points to be considered fully adherent. Additionally, for the S+VCS group, videoconference attendance was recorded as a score out of ten.

4.5.8 Sample size

The a priori power analysis (i.e., a sample size calculation determined prior to conducting the study) indicated a required sample size of 148 participants in each arm of the study. This calculation was based on the following assumptions or

requirements and relied on data from previous studies (Morton et al., 2020; Przybylko et al., 2021a): (1) participants were to be allocated equally between the three arms; (2) an ability to detect a 15% improvement in the mental health and vitality scales, as this was considered a clinically significant outcome (Morton et al., 2020); (3) a 30% attrition rate, based on attrition rates observed in a prior similar study (Przybylko et al., 2021a); (4) a power level of $\geq 80\%$; (5) significance level of 0.05 (95% confidence interval); and, (6) a distribution standard deviation of 16.1 in the mental health subscale, based on a prior study (Morton et al., 2020).

4.5.9 Randomisation

Participants were randomised by a person not on the research team, using computer random number generation. Equitable distribution of age and gender was tested and confirmed, negating the need for further stratification. The three randomised groups were allocated to a study arm by the person who conducted randomisation. Researchers and participants were unblinded, and participants were notified of the mode of support they would receive during registration. As there was no control group, all groups were comparators of interest.

4.5.10 Statistical analysis

Data were analysed using the IBM SPSS Statistics Software (version 25). Within-group changes from baseline to post-intervention were calculated using paired *t*-tests, and repeated measures generalised linear models were used to measure analysis of variance between groups, considering time and group effects. Cohen *d* was used to measure effect size, and Fisher's Exact test was used to test for relationships between the categorical variables. The 458 participants who completed the pre-intervention questionnaire were included in the analysis of baseline characteristics. All remaining analyses included only the participants who completed both pre-intervention and post-intervention measures ($n=320$). This manuscript was prepared according to Consolidated Standards of Reporting Trials (CONSORT) guidelines (Eysenbach & CONSORT-EHEALTH Group, 2011) and utilised the CONSORT-EHEALTH checklist.

4.5.11 Ethics & informed consent

Ethics approval was granted from the Avondale Human Research Ethics Committee (Approval No. 2018.09). Prospective participants were emailed an *information statement* outlining the details of the study and an *informed consent statement* notifying them that choosing to register onto the eLMS would signify informed consent.

4.6 Results

4.6.1 Participants

Figure 3 records the flow of participants throughout the intervention period. Potential participants (n=605) enrolled through the information webpage and were randomised into three groups: S (n=202), S+pSMS (n=202) and S+VCS (n=201). A total of 458 participants registered on the eLMS, completed the pre-intervention questionnaire and were analysed for baseline characteristics (S = 157, S+pSMS = 163, S+VCS = 138). At 12 weeks, 320 out of 458 (69.9%) participants had completed both the pre- and post-intervention questionnaire required for post-analysis (S = 103, S+pSMS = 114, S+VCS = 103).

4.6.2 Baseline characteristics

Table 9 describes the demographic and mental health characteristics of the study group at baseline. Fisher's Exact test demonstrated no significant between-group differences in any of the categorical characteristics of the study population. With a mean age of 45.5 (± 13.7) years, participants were predominantly female (77.7%), white (76.9%) and had a tertiary education (78.0%). There were no significant differences between the groups in any of the psychometric measures at baseline (Table 9).

Table 9. *Baseline characteristics of the study population*

Factor	Standard automated email group (S: n=157)	Standard plus SMS message group (S+pSMS: n=163)	Standard plus videoconference support group (S+VCS: n=138)	Combined groups (N=458)	ANOVA or Fisher's Exact test P-value
Age (yrs), mean (SD)	45.6 (13.9)	46.5 (13.4)	44.3 (13.9)	45.5 (13.7)	0.19
Gender, n (%)					0.82
Female	124 (79.0)	126 (77.3)	106 (76.8)	356 (77.7)	
Male	33 (21.0)	37 (22.7)	31 (22.5)	101 (22.1)	
Other	0	0	1 (0.7)	1 (0.2)	
Education, n (%)					0.16
Primary School	0	2 (1.2)	0	2 (0.4)	
Secondary School	36 (22.9)	39 (23.9)	24 (17.4)	99 (21.6)	
Tertiary undergrad.	74 (47.2)	65 (39.9)	75 (54.3)	214 (46.7)	
Tertiary postgrad.	47 (29.9)	57 (35)	39 (28.3)	143 (31.3)	
Ethnicity, n (%)					0.34
White	124 (79.0)	118 (72.4)	110 (79.7)	352 (76.9)	
Maori/Pacific Is.	12 (7.6)	16 (9.8)	7 (5.1)	35 (7.6)	
Asian	5 (3.2)	11 (6.7)	2 (1.4)	18 (3.9)	
Black Afr. or Amer.	4 (2.5)	3 (1.8)	3 (2.2)	10 (2.2)	
Indigenous	0	0	1 (0.7)	1 (0.2)	
Span., Hisp., Latino	5 (3.2)	3 (1.8)	4 (2.9)	12 (2.6)	
Other	7 (4.5)	12 (7.5)	11 (8.0)	30 (6.6)	
Outcome Measures, mean (SD)					
Mental Health ^a	64.4 (17.3)	65.7 (17.5)	64.6 (16.5)	64.9 (17.1)	>0.99
Vitality ^b	58.5 (17.4)	60.2 (17.4)	58.6 (17.2)	59.1 (17.3)	0.59
Depression ^c	3.8 (3.7)	4.0 (4.1)	3.9 (3.5)	3.9 (3.8)	0.50
Anxiety ^d	2.8 (2.9)	2.5 (2.6)	2.5 (2.8)	2.6 (2.7)	0.83
Stress ^e	5.7 (3.6)	5.7 (3.6)	5.9 (3.4)	5.7 (3.5)	0.67
Flourishing ^f	45.2 (7.1)	45.1 (6.8)	44.5 (6.3)	45.0 (6.7)	0.10
Life Satisfaction ^g	23.4 (6.9)	22.5 (7.3)	22.5 (7.0)	22.8 (7.1)	0.73
^{a, b} Scored out of 100, ^c Normal range (0-4), ^d Normal range (0-3), ^e Normal range (0-7), ^f Score range, 8 (low) – 56 (high), ^g Score range, 5 (low) – 35 (high)					

4.6.3 Measurement – outcomes

Significant within-group improvements were recorded from pre- to post-intervention in all groups and across all domains of mental well-being measured (Table 10). Within-group improvements ranged from medium to large effect sizes (Cohen d), with flourishing ($d=0.64$), mental health ($d=0.67$) and vitality ($d=0.74$) demonstrating the largest effect. No significant between-group differences were observed for any of the outcome measures (Table 10).

Table 10. *Pre- to post-changes in outcome measures of participants, and between-group differences*

Outcome Measure	N	Pre, mean (SD)	Post, mean (SD)	Mean Change	Change (%)	Within-group change (P value)	Within-group Change (Cohen d)	Between-group difference (P value)
Mental Health								0.77
Gr 1 Standard –	103	65.2	74.8	9.6	14.7	<0.001	0.72	
Gr 2 Standard plus	114	67.3	76.1	8.8	13.1	<0.001	0.69	
Gr 3 Standard plus	103	66.0	74.2	8.2	12.4	<0.001	0.61	
Combined	320	66.2	75.1	8.9	13.4	<0.001	0.67	
Vitality								0.65
Gr 1 Standard –	103	58.7	69.6	10.9	18.6	<0.001	0.78	
Gr 2 Standard plus	114	61.8	71.9	10.1	16.3	<0.001	0.81	
Gr 3 Standard plus	103	60.1	69.2	9.1	15.1	<0.001	0.63	
Combined	320	60.3	70.3	10.0	16.6	<0.001	0.74	
Depression								0.93
Gr 1 Standard –	103	3.5	2.2	-1.3	-37.1	<0.001	0.44	
Gr 2 Standard plus	114	3.5	2.1	-1.4	-40.0	<0.001	0.51	
Gr 3 Standard plus	103	3.6	2.2	-1.4	-38.9	<0.001	0.50	
Combined	320	3.5	2.2	-1.3	-37.1	<0.001	0.48	
Anxiety								0.25
Gr 1 Standard –	103	2.7	1.5	-1.2	-44.4	<0.001	0.52	
Gr 2 Standard plus	114	2.1	1.4	-0.7	-33.3	<0.001	0.35	
Gr 3 Standard plus	103	2.2	1.3	-0.9	-40.9	<0.001	0.43	
Combined	320	2.3	1.4	-0.9	-39.1	<0.001	0.43	
Stress								0.57
Gr 1 Standard –	103	5.8	4.3	-1.5	-25.9	<0.001	0.46	
Gr 2 Standard plus	114	5.5	4.1	-1.4	-25.5	<0.001	0.47	
Gr 3 Standard plus	103	6.0	4.2	-1.8	-30.0	<0.001	0.60	
Combined	320	5.7	4.2	-1.5	-26.3	<0.001	0.51	
Life satisfaction								0.65
Gr 1 Standard –	103	23.2	25.6	2.4	10.3	<0.001	0.50	
Gr 2 Standard plus	114	23.1	26.0	2.9	12.6	<0.001	0.64	
Gr 3 Standard plus	103	22.9	25.5	2.6	11.4	<0.001	0.57	
Combined	320	23.1	25.7	2.6	11.3	<0.001	0.58	
Flourishing								0.99
Gr 1 Standard –	103	45.2	48.1	2.9	6.4	<0.001	0.61	
Gr 2 Standard plus	114	45.1	48.1	3.0	6.7	<0.001	0.65	
Gr 3 Standard plus	103	44.8	47.8	3.0	6.7	<0.001	0.64	
Combined	320	45.0	48.0	3.0	6.7	<0.001	0.64	

4.6.4 Measurement – adherence

Adherence was not significantly different between groups for mean videos watched ($P=0.42$) or mean total challenge points scored ($P=0.71$). However, there was notable variability in responses as indicated by the large standard deviations: videos watched out of ten ($S = \text{Mean } 6.05 \text{ (SD } 4.0)$), S+pSMS = 6.48 (SD3.9), S+VCS 6.75 (SD3.8); challenge scores out of 1000 ($S = \text{Mean } 369 \text{ (SD } 362)$), S+pSMS = 340 (SD 339), S+VCS = 377 (SD 354).

In the S+VCS group, mean VCSS attendance was 2.8/10, and 37 out of 103 participants (35.9%) had zero attendance. Just 19 out of 103 participants (18.4%) attended seven or more VCSSs. Secondary analysis revealed participants who attended more than seven VCSSs, compared to those who attended six or less, demonstrated significantly greater improvements in the measures of mental health ($P=0.006$, $d=0.71$), vitality ($P=0.005$, $d=0.73$), depression ($P=0.04$, $d=0.54$) and satisfaction with life ($P=0.046$, $d=0.50$).

4.7 Discussion

4.7.1 Principal findings

This study compared the influence of three modes of human support on the outcomes of a web- and mobile app-based, lifestyle-focused mental health intervention for a healthy adult cohort. Significant improvements in all domains of mental well-being were recorded in all groups, but the mode of human support had no effect. However, attendance at the VCSSs was low, hindering the ability to draw comparisons.

The study population could be classified as healthy (i.e., normal), as evidenced by baseline DASS scores that were within the normal range: depression, mean=3.5 (normal 0-4); anxiety, mean=2.1 (normal 0-3); stress, mean=5.7 (normal 0-7). Notably, despite the *healthy* starting point, medium to large effect size improvements were observed. The results of the present study are similar to two pilot trials (Hinze & Morton, 2017; Morton et al., 2020) and a randomised controlled trial (Przybylko et al., 2021a) using the same intervention. Medium to large effects may be due, at least in part, to the multimodal nature of the intervention producing a

compounding effect (Morton et al., 2020). As the intervention embeds a combination of evidence-based strategies from lifestyle medicine and positive psychology for improving mental well-being, the overall effect of the intervention could be expected to exceed that of a single modality approach.

Videoconferencing has been successfully used as a form of support in various settings, but the sessions were not well attended in this study. Previous research highlights the benefits of videoconferencing as a feasible and acceptable mode of support if technology assistance is provided (Banbury et al., 2018). Benefits include enhanced group bonding, peer observation, personal sharing and a higher social presence when compared to other forms of digital support (Banbury et al., 2018). However, although videoconferencing has been used as an effective method to support caregivers (Damianakis et al., 2016), chronic disease patients (Marziali, 2009), new mothers (Nyström & Öhrling, 2006) and post-surgical patients (Wild et al., 2015), it was under-utilised in this intervention.

Several factors may have contributed to the under-utilisation of the VCSSs. Firstly, web-based interventions are essentially *pull* technologies, relying on the participant to initiate access to the intervention (Mohr, Burns, et al., 2013). Conversely, human support features generally *push* participants to engage with a digital intervention (Mohr, Burns, et al., 2013). Within this study, automated emails and SMS messages served as *push* strategies, requiring no effort on the part of the participant. However, videoconferencing support is a *pull* device that requires participants to actively seek engagement by attending the scheduled session, and this may have been a contributing factor in low engagement. Secondly, to overcome potential scheduling barriers, nine sessions were offered within a week, but this did not translate into higher levels of participation and may have negatively impacted the development of group dynamics and peer interaction. Participants could choose to attend any of the nine sessions offered, which meant group bonding, a known videoconference advantage (Banbury et al., 2018), may have been impeded by a lack of continuity in attendance within each time slot. Notwithstanding, a myriad of other factors may have negatively impacted VCSS engagement, such as time constraints, confidence to use technology, privacy/exposure concerns and perceptions about effectiveness (Banbury et al., 2018; Christensen et al., 2009). Undoubtedly, adherence is dynamic in nature (Yardley et al., 2016), and many interindividual

variations are still unexplained (Zarski et al., 2016). The low attendance at the VCSSs highlights the need to investigate engagement facilitators and barriers more thoroughly. Given that the majority of the S+VCS group participants (82%) did not engage regularly with the support provided, this group, in effect, received a comparable level of support to the S group (automated emails) hampering between-group comparability.

Stratified within-group analysis in the S+VCS group showed significantly greater improvement in depression, mental health, vitality, and satisfaction with life metrics for those who attended seven or more VCSSs. Nevertheless, the results need to be treated with caution because the stratified sub-group is self-selected, no longer randomised, and therefore subject to bias. Additionally, the small number of participants and unknown contributing factors (e.g., motivation) make drawing conclusions problematic. Elucidating the reasons why participants chose to engage or not with videoconferencing support would be an important topic for further research.

Despite the lack of influence of human support in this study, the multimodal intervention demonstrated statistically significant improvement across all groups in all outcome measures, with medium to large effect sizes. Strengthened by results of previous pilot studies (Hinze & Morton, 2017; Morton et al., 2017) and the RCT in 2017 (Przybylko et al., 2021a), it may be feasible to trial the lifestyle-based intervention in primary prevention or clinical settings in the future to attenuate symptoms for those who are at high-risk or already suffering from a disorder.

4.7.2 Strengths & limitations

The intervention, web design and additional human support used in this study were underpinned by theoretical models, including the TPB (Ajzen, 1985), a framework for PSD (Oinas-Kukkonen & Harjumaa, 2009) and key principles of the SAM (Mohr et al., 2011). Consistency in the VCSSs was enhanced by using one experienced, online group facilitator rather than multiple facilitators of varying skill levels. Additionally, the study population included a large homogenous cohort, and this was further strengthened by a wide range of age groups from 18–81yrs.

Limitations included low attendance at VCSSs, which meant that many S+VCS group members probably experienced the intervention similar to the S group

(i.e., automated emails), negatively impacting the ability to make meaningful between-group comparisons. Notably, the previous RCT conducted in 2017 (Przybylko et al., 2021a) demonstrated similar statistically significant improvements within the intervention group to what was seen within the three groups of this study. Both the RCT and this study commenced with cohorts who were considered ‘normal’ (indicated by the DASS scores). Conceivably, in adding human support, a ceiling effect was observed and gauging further improvements above and beyond the benefits of the intervention itself were not realistically measurable.

The cohort was predominantly Seventh-day Adventist church members, which diminishes generalisability to other population groups due to commonly held lifestyle practices (e.g., no alcohol or tobacco). Furthermore, participants were skewed towards white females and those who held a tertiary qualification. While such demographics are commonly portrayed in digital interventions (Mitchell et al., 2009; Waters et al., 2011), these factors limit the generalisability of findings to the broader population. Participants were unblinded, and the study relied on self-reporting for all instruments, which comes with the risk of reporting biases (e.g., poor recall), and participants are sometimes unaware of their own personal motives and behaviour (Yardley et al., 2016).

Other limitations include the failure to measure how participants engaged with automated emails or SMS messages. In addition, we did not gather data regarding the proportion of participants who accessed the program using the mobile app as an alternative to the web-based platform, which would have been a useful comparison. In future applications, a post-intervention survey should include questions regarding use and preferences for the delivery systems (i.e., computer or mobile app), plus participant perceptions regarding the influence of and personal engagement with email and SMS messaging. It would also be important to administer the intervention to a broader population sample to improve generalisability.

4.7.3 Conclusions

The findings of this study strengthen the rationale for web- and mobile app-based interventions as easily accessible and scalable mental health promotion

initiatives. The study demonstrated that a lifestyle-focused intervention improved the mental well-being of a healthy cohort, irrespective of human support. Low VCSS attendance reduced the ability to draw meaningful between-group comparisons and hence the influence of different human support modes, although SMS messages provided no significant benefit over automated email support. The stratified analysis demonstrated that regular attendance at a VCSS might be a possible method to enhance outcomes; however, more research is needed regarding factors that influence engagement with that mode of support.

Chapter Five: Publication Two - The Influence of Three Modes of Human Support on Attrition and Adherence to a Web- and Mobile app-based Mental Health Promotion Intervention in a Non-Clinical Cohort: Randomised Comparative Study

5.1 Chapter Overview

This chapter focuses on the second research question of this dissertation—*What is the influence of different modes of human support on attrition and adherence to a web and mobile app, lifestyle-based mental health intervention for a healthy adult cohort, including the influence of participant preference?* The chapter is presented as a manuscript that was published in the *Journal of Medical Internet Research* (Impact Factor 5.43, Q1 ranking) in September 2020, titled ‘The Influence of Three Modes of Human Support on Attrition and Adherence to a Web- and Mobile App-Based Mental Health Promotion Intervention in a Nonclinical Cohort: Randomized Comparative Study’. This study compared the influence of the three different modes of human support on attrition and adherence behaviour of a general population cohort throughout the digital mental health promotion intervention. The study contributes vital knowledge regarding the optimal conditions required for digital mental health promotion interventions to maximise intervention cost-effectiveness and scalability. Chapter Seven also discusses the findings and conclusions of this study.

5.2 Contribution of Authentication Statement

I attest that Higher Degree Research candidate Melanie Renfrew contributed to the paper/publication entitled:

The Influence of Three Modes of Human Support on Attrition and Adherence to a Web- and Mobile App-Based Mental Health Promotion Intervention in a Non-Clinical Cohort: Randomised Comparative Study.

By:

- Leading the conception and design of the study
- Cleaning the data
- Leading the data analysis
- Interpretation of the data
- Leading the writing of the manuscript
- Submitted the manuscript for review
- Addressed reviewers' comments

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Date: 30 September, 2021

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Date: 30 September, 2021

5.3 Abstract

5.3.1 Background

The escalating prevalence of mental health disorders necessitates a greater focus on web and mobile app-based mental health promotion initiatives for non-clinical groups. However, knowledge is scant regarding the influence of human support on attrition and adherence and participant preferences for support in non-clinical settings.

5.3.2 Objectives

This study compared the influence of three modes of human support on attrition and adherence to a digital mental health intervention for a non-clinical cohort. It evaluated user preferences for support and assessed whether adherence and outcomes were enhanced when participants received their preferred support mode.

5.3.3. Methods

Subjects participated in a 10-week, digitally-delivered mental health promotion intervention and were randomised into three comparative groups: standard—automated emails (S); standard plus personalised short message service (S+pSMS); standard plus weekly videoconferencing support (S+VCS). Adherence was measured by the number of video lessons viewed, points achieved for weekly experiential challenge activities and the total number of weeks that participants recorded a score for challenges. In the postquestionnaire, participants ranked their preferred human support mode from 1 to 4 (S, S+pSMS, S+VCS, S+pSMS & VCS combined). Stratified analysis was conducted for those who received their first preference. Pre-intervention and post-intervention questionnaires assessed well-being measures (i.e., mental health, vitality, depression, anxiety, stress, life satisfaction, and flourishing).

5.3.4 Results

Interested individuals (N=605) enrolled on a website and were randomised into 3 groups (S, n=201; S+pSMS, n=202; S+VCS n=201). Prior to completing the prequestionnaire, 24.3% (147/605) dropped out. Dropout attrition between groups was significantly different ($P=0.009$) (S = 21.9%, 44/201; S+pSMS = 19.3%,

39/202; S+VCS = 31.6%, 64/202). The remaining 75.7% (458/605) registered and completed the prequestionnaire (S, n=157; S+pSMS, n=163; S+VCS, n=138). Of the registered participants, 30.1% (138/458) failed to complete the postquestionnaire (S n=54; S+VCS n=49, S+VCS n=35) but there were no between group differences ($P=0.24$). For the 69.9% (320/458) (S, n=103; S+pSMS, n=114; S+VCS, n=103) who completed the postquestionnaire, no between-group differences in adherence were observed, calculated by: mean number of videos watched ($P=0.42$); mean challenge scores recorded ($P=0.71$); or the number of weeks that challenge scores were logged ($P=0.66$). Fifty-six participants (17.5%, 56/320) received their first preference in human support (S, n=22; S+pSMS, n=26; S+VCS, n=8). No differences were observed, between those who received their first preference and those who did not, for: video adherence ($P=0.91$); challenge score adherence ($P=0.27$); or any of the well-being measures including, mental health ($P=0.86$), vitality ($P=0.98$), depression ($P=0.09$), anxiety ($P=0.64$), stress ($P=0.55$), life satisfaction ($P=0.50$) and flourishing ($P=0.47$).

5.3.5 Conclusions

Early dropout attrition may have been influenced by dissatisfaction with allocated support mode. Human support mode did not impact adherence to the intervention and receiving the preferred support style did not result in greater adherence or better outcomes.

5.3.6 Trial registration

Australian New Zealand Clinical Trials Registry (ANZCTR):
12619001009101; <http://www.anzctr.org.au/ACTRN12619001009101.aspx>

5.4 Introduction

The burden of mental distress is pervasive globally and includes common mental health disorders such as depression and anxiety. Approximately 300 million people worldwide are affected by depression—the principal cause of global disability (WHO, 2021a). Depression is frequently comorbid with other diseases and severely compromises effective functioning for individuals, negatively impacting family and work environments (WHO, 2021a). Furthermore, indicators suggest that even the general population increasingly suffer mental distress, including severe stress, anxiety, depressive symptoms, a sense of isolation and feeling overwhelmed (Australian Psychological Society, 2015; Kvalsvig, 2018).

While a growing repertoire of digitally-based interventions is improving accessibility to treatment options for people with common mental health disorders, there is also an urgent need for easily accessible mental health promotion interventions (MHPIs) to improve the mental well-being of non-clinical population groups. MHPIs that focus on enhancing psychological well-being may provide an important buffer against mental distress, potentially attenuating the mental health burden. Furthermore, lifestyle-focused MHPIs might also ameliorate symptoms for those who have already been diagnosed with a CMHD (Walsh, 2011).

Innovative web- and mobile app-based technology allows MHPIs to be disseminated widely and cost-effectively to maximise accessibility. However, despite the many advantages of digitally-based interventions, both high dropout attrition (i.e., participants who dropout early or who are lost to follow-up) and non-usage attrition (i.e., nonadherence) are persistent problems (Mohr, Burns, et al., 2013; Mohr et al., 2011; Rickard et al., 2016).

In his formative publication titled ‘The Law of Attrition’, Eysenbach (2005) called for the methodical study of attrition in eHealth interventions because, unlike drug trials, it is usually easy for participants to both join and withdraw from a digital intervention, especially when they are not critical to life—sometimes described as “easy-in” and “easy-out” (Lehr et al., 2016). Maximizing adherence, defined as “the degree to which the user followed the program as it was designed” (Donkin et al., 2011), is a complex challenge for researchers and health care providers.

Additionally, definition differences and measurement heterogeneity between studies is problematic (Beatty & Binnion, 2016; Ryan et al., 2018; Sieverink et al., 2017). Nevertheless, many factors affecting adherence have been identified.

Influences on adherence are multifactorial, and consistency in adherence patterns have been elusive (Ryan et al., 2018; Zarski et al., 2016). A 2018 review of theoretical perspectives on adherence suggested the need for interdisciplinary collaboration to better understand patterns of adherence due to a diverse range of technological, environmental, and individual influences (Ryan et al., 2018). For instance, technological factors may include website design, persuasive systems design (Asbjørnsen et al., 2019; Oinas-Kukkonen & Harjumaa, 2009), behaviour change techniques (Short et al., 2014), human support factors (Akhu-Zaheya & Wa'ed, 2017; Beatty & Binnion, 2016; Eysenbach, 2005; Kelders et al., 2012; Mohr et al., 2011), personalised content (i.e., tailoring) (Beatty & Binnion, 2016), frequent updates and dialogue support (i.e., praise, rewards, reminders) (Kelders et al., 2012) and gamification techniques (Brown et al., 2016). Environmental influences consist of factors such as socioeconomic status, employment status, the education level (Leung et al., 2017), internet or computer accessibility (Christensen et al., 2009), literacy (Johansson et al., 2015; Leung et al., 2017), culture, the healthcare system, family and community support (Brouwer et al., 2011), and time availability (Beatty & Binnion, 2016; Christensen et al., 2009). Examples of individual factors include whether a person self-selects into a study and invests effort (Lyubomirsky et al., 2011), planning and self-efficacy (Leung et al., 2017; Zarski et al., 2018), compatibility with personal values (Eysenbach, 2005), motivation factors (Christensen et al., 2009; Mohr et al., 2011), focus on immediate benefit rather than long term goals, perceived treatment credibility (Alfonsson, Olsson, & Hursti, 2016; Beatty & Binnion, 2016), receiving preferences (Lindhiem et al., 2014), health status, psychological vulnerability (Christensen et al., 2009; Johansson et al., 2015; Leung et al., 2017), user expectations (Beatty & Binnion, 2016; Johansson et al., 2015; Mohr et al., 2011), gender (Beatty & Binnion, 2016; Leung et al., 2017), and age (Leung et al., 2017; Short et al., 2014).

5.4.1 Human support and adherence

5.4.1.1 Clinical settings

Despite the broad range of factors listed, adherence has frequently been positively associated with human support (i.e., guidance) in clinical settings. A systematic qualitative review of 64 studies reported that adherence was improved by the support of counsellors, peers, phone, and email contact (Brouwer et al., 2011). A 2012 systematic review and meta-analysis concluded that supported interventions yielded better retention and outcomes (Richards & Richardson, 2012). Other randomised controlled trials (RCTs) have also reported similar links between human support and adherence (Mohr, Duffecy, et al., 2013; Zarski et al., 2016), although greater adherence does not always translate to better outcomes, and adherence may be problematic for individuals with depression, irrespective of the support received (Mohr, Duffecy, et al., 2013).

A 2017 scoping review (Shim et al., 2017) analysed 19 RCTs from 2000-2016 that considered human support factors in internet-based interventions for depression and anxiety. The review identified seven different human support factors (guided versus unguided, therapist expertise, human versus automated, scheduled versus unscheduled, support mode, synchronicity, and support intensity) and analysed them for improvement in clinical outcomes and adherence. While just one human support factor (scheduled support) was associated with significantly improved outcomes, results were mixed in relation to adherence, with human support improving adherence in only four out of nine studies (Shim et al., 2017).

Recent web-based interventions for CMHDs, comparing supported and unsupported arms, have found that well designed self-guided interventions achieve significant improvements in outcomes and maintain high adherence rates irrespective of support provided (Dear et al., 2016; Dear, Fogliati, et al., 2018; Titov et al., 2016). Notably, treatment satisfaction was higher in supported arms (Alfonsson et al., 2015; Dear, Fogliati, et al., 2018), and some participants perceived support as necessary to success (Kobak et al., 2015).

Human support requirements to encourage adherence may be vastly different in non-clinical populations compared to clinical cohorts who experience symptoms

that may preclude them from engaging with an intervention. Therefore, it is vital to determine if human support adds value to an intervention for a non-clinical cohort because unsupported interventions can be administered at a lower cost and be more easily distributed in a scalable manner.

5.4.1.2 Non-clinical settings

Studies evaluating the influence of human support on adherence to MHPIs among non-clinical populations are scant in comparison to clinical cohorts. A study involving a mindfulness intervention targeting college students and young working adults found that despite telephone or email support, adherence was poor, and non-adherers were lower in mental well-being, energy, and treatment expectancy (Mak et al., 2017). The researchers suggested a greater need for collaboration between health professionals and information technology experts to improve the “personalisation” of digital interventions to enhance adherence (Mak et al., 2017). A Swedish study that implemented an internet-based relaxation program found that human support did not affect treatment outcomes or adherence (Alfonsson et al., 2015; Alfonsson, Olsson, & Hursti, 2016). Outcomes were positively associated with completing homework (i.e., behavioural tasks) but not engagement with the online aspect of the program. Early attrition was predicted by low belief in the treatment, and non-adherence was associated with increased stress symptoms, lower levels of intrinsic motivation and a greater focus on immediate consequences of behaviour as opposed to long-term gains. Conversely, adherence was predicted (positively) by education level and treatment credibility.

In a pooled analysis of three web-based studies (Zarski et al., 2016), researchers investigated the influence of three types of support: content-focused (i.e., personalised email feedback), adherence-focused (i.e., monitoring adherence and sending reminders) and administrative support (i.e., access to contact details to ask for technical assistance). Those who received content- and adherence-focused support completed more modules than those who received only administrative support. However, the researchers concluded that even after taking human support and other demographic variables into consideration, most interindividual variations in nonadherence remained largely unsolved (Zarski et al., 2016). A web-based mindfulness and stress management RCT (Allexandre et al., 2016) compared the

effects of no support, group support only and group support with added clinician support on engagement and outcomes. Group support improved outcomes and adherence, but extra clinician support added no benefit. Notably, although the program was web-based, support was provided face-to-face in the workplace.

We have previously reported the mental health outcomes of the current study and found that no difference was observed between groups; improvements in outcomes were obtained irrespective of the differing modes of human support offered (Renfrew et al., 2020a). This study focused on examining attrition and adherence patterns between the groups. We also evaluated user preferences for human support and assessed whether adherence and mental health outcomes were enhanced when participants received their preferred mode of human support. The outcomes of the study contribute toward understanding the value of human support on adherence to a web- and mobile app-based MHPI targeting a non-clinical cohort. This is vital information for researchers and clinicians in order to inform the optimal delivery of digital MHPIs in a cost-effective, accessible, and scalable manner.

5.5 Methods

This section provides a summary of the methods used. For a detailed explanation, refer to our previous article that reported the influence of human support mode on mental well-being outcomes, published in January 2020 (Renfrew et al., 2020a).

5.5.1 Study design

The multi-arm, randomised, comparative study design included three intervention groups that varied by human support mode: standard – fully automated emails (S); standard plus personalised SMS text messaging support (S+pSMS); standard plus videoconferencing support (S+VCS).

5.5.2 Recruitment & randomisation

The study was advertised to members of a faith-based organisation using a combination of methods (e.g., email, social media, bulletins, magazines), and interested individuals were directed to a website to apply. After randomisation,

eligible participants were emailed their group allocation, a participant information document, and instructions on how to complete registration onto the web-based learning management system (eLMS), signalling consent. Figure 3 (in the previous chapter) demonstrates the flow of participants through the study.

5.5.3 Intervention

The 10-week interdisciplinary intervention introduced participants to a range of evidence-based strategies for enhancing mental well-being, from the disciplines of lifestyle medicine and positive psychology. Participants logged onto the eLMS or mobile app to access the intervention, which included video content and a place to log daily and weekly experiential challenges (view screenshots in Appendix 1). The website and mobile app were designed using a range of Persuasive System Design (PSD) principles to increase engagement (Oinas-Kukkonen & Harjumaa, 2009). Each week, participants were encouraged to view one lesson, perform small daily challenges and complete one larger weekly challenge. A detailed, week-by-week summary of the content and experiential challenge activities can be found in Table 7 (within the Methods chapter).

5.5.4 Human support

The study was structured to compare the value of increasingly greater levels of human support on adherence. Principles of the adherence-focused Supportive Accountability Model (SAM) (Mohr et al., 2011) underpinned interactions between the support coach and the participants. As the lowest form of support, one automated email was sent to the participants each week, consisting of their first name as a salutation, a couple of sentences to encourage them to view the content and a link to an introductory video by the presenter. A reminder email was sent if a participant had not logged experiential activity for three days or viewed video content after eight days. The second level of support involved SMS messages that were written and sent from a support coach who focused on ensuring content was process-focused, messages were sent regularly, and tone exuded positivity. Messages addressed the recipient by the first name and were signed by the support coach. They were sent three times weekly for the first three weeks and twice weekly for the remaining seven weeks. In the highest level of support, the opportunity to develop key tenets of

the supportive accountability model (e.g., bond and legitimacy) was provided through weekly videoconferencing sessions (nine weekly time slots). The focus was given to facilitating a supportive, respectful environment where participants could share experiences safely. The facilitator sought to build trust through benevolent engagement with participants.

5.5.5 Measurements

5.5.5.1 Dropout attrition

Dropout attrition was measured as the total number of randomised participants who did not complete either the pre-intervention (i.e., early dropout) or the post-intervention (i.e., lost to follow-up) questionnaire.

5.5.5.2 Adherence measures

Primary adherence – videos viewed

Primary adherence was measured as the total number of weekly videos viewed out of a total of ten. A video was considered *viewed* when at least 80% of the presentation had been played.

Secondary adherence – experiential challenge activities

Participants were encouraged to accumulate points through daily and weekly challenge activities that involved putting the new learning into practice. Engagement with challenges was measured in two ways: the total weekly challenge score and the total number of weeks out of ten in which an engagement with a challenge was recorded. Each daily challenge was worth ten points (i.e., a total of 70 points weekly), and weekly challenges were worth 30 points. Therefore, participants could score a maximum of 100 points each week throughout the 10-week intervention, thereby accumulating a total of 1000 points to be considered fully adherent for the experiential challenge activities.

Videoconference adherence

Attendance records were kept for the videoconference support sessions for those in the S+VCS group. Each participant was invited to attend one session each week, out of a possible nine available time-slots. Participants were able to receive a maximum adherence score of 10 over the 10-week intervention.

5.5.5.3 Well-being measures

A self-report questionnaire termed the ‘7 Dimensions of Wellness Index’ (7DWI) was completed by all participants on the web-based eLMS or on the mobile app, at pre-intervention (Week 0) and post-intervention (Week 12) (Figure 3). Demographic and lifestyle associated questions were combined with freely accessible validated instruments to measure the participant’s well-being in several domains: physical, emotional, social, vocational, intellectual, spiritual, and environmental. Validated instruments utilised for this study on mental well-being included: two sub-domains from the 36-item Short Form Health Survey (SF-36) (i.e., mental health and vitality) (Brazier et al., 1992), the 21 question Depression Anxiety and Stress Scales (DASS-21) to measure depression, anxiety and stress (Lovibond & Lovibond, 1995), Diener’s flourishing scale (Diener et al., 2010) and Diener’s Satisfaction With Life Scale (SWLS) (Diener et al., 1985; Pavot & Diener, 2008). Well-being measures are reported in detail in the previous article (Renfrew et al., 2020a).

5.5.5.4 Preferences

Participants rated four different human support options from most preferred to least preferred (1 = most preferred, 4 = least preferred) as part of the post-intervention questionnaire. Support options were: standard – automated email only, standard plus SMS only, standard plus VCS only, or standard plus SMS & VCS combined (not offered in the study). Stratified analyses were conducted to measure adherence and outcomes for participants who received their desired human support preference.

5.5.6 Statistical analysis

Analyses were conducted using IBM SPSS Statistics Software (version 25). Pre-intervention to post-intervention changes were calculated using paired *t*-tests. Descriptive statistics, involving means and standard deviations, measured patterns of adherence. Analysis of variance (ANOVA) was used to compare adherence between groups. Fisher’s Exact test was utilised to analyse relationships between categorical variables and Cohen *d* measured effect size.

5.5.7 Ethics & informed consent

Avondale Human Research Ethics Committee granted ethics approval for the study (Approval No. 2018.09), and it was registered with the Australian and New Zealand Clinical Trial Registry (ANZCTR12619001009101). An email containing an *Information Statement* and a *Participant Consent Form* was sent to all prospective participants. The email explained that choosing to register onto the eLMS would signify informed consent.

5.6 Results

5.6.1 Participants

Potential participants (N=605) enrolled on the information website and agreed to participate in the study irrespective of randomisation allocation. Subjects were randomised into three arms [S (n=201), S+SMS (n=202) and S+VCS (n=202)] (Figure 3). During a 1-week period, after being notified of group allocation and before the intervention commenced, 24.3% (147/605) of participants dropped out. Early dropout attrition between groups was significantly different ($P=0.009$). A total of 21.9% (44/201) withdrew from the S Group, 19.3% (39/202) from the S+pSMS group and 31.6% (64/202) from the S+VCS group. Table 11 shows that dropout was significantly different between groups when the S+VCS group was compared; differences were not significant between the S and S+pSMS groups.

Table 11. *Dropout attrition between groups*

Group comparison	<i>P</i>-value
Comparison between all groups	0.009
Comparison between S group & S+VCS group	0.026
Comparison between S+pSMS group & S+VCS group	0.004
Comparison between S group & S+pSMS group	0.521

A total of 75.7% (458/605) of randomised participants registered on the eLMS and completed the initial questionnaire (S n=157; S+pSMS n=163; S+VCS n=138). Notably, there were no significant differences between the groups in age ($P=0.19$), gender ($P=0.82$), education ($P=0.16$) or ethnicity ($P\leq 0.34$). Of the

registered participants, 69.9% (320/458) completed the post-intervention questionnaire (S, n=103; S+pSMS, n=114; S+VCS, n=103), resulting in 30.1% (138/458) being lost to follow-up; there was no difference between groups ($P=0.241$).

5.6.2 Adherence

5.6.2.1 Primary adherence – videos viewed

As shown in Table 12, the number of videos viewed was not significantly different between the groups ($P=0.42$). Almost half of all participants in each group were fully adherent (i.e., watched all ten video lessons), with less than 10% of individuals in each group viewing no videos. Furthermore, the percentage of participants at any level of adherence did not differ significantly between groups.

Table 12. *Primary adherence percentages and between-group comparisons*

	Standard (S) support (N = 103)	S+pSMS support (N = 114)	S+VCS support (N = 103)	Between Group Difference <i>P</i> value
Number of videos viewed %				
10 videos	45	48	49	0.58
8-9 videos	4	5	5	0.38
5-7 videos	12	13	17	0.54
1-4 videos	32	27	20	0.55
0 videos	7	7	9	0.95
Mean videos viewed (SD)	6.0 (4.04)	6.5 (3.87)	6.8 (3.75)	0.42

5.6.2.2 Secondary adherence – challenges

No significant differences were recorded between the groups in the mean challenge points scored ($P=0.71$) or the mean number of weeks that challenge scores were recorded ($P=0.66$) (Table 13). There was an overall lack of adherence to experiential challenges, as indicated by mean challenge scores less than 400 out of a possible 1000 points. Additionally, challenge scores were logged in less than half of the weeks for the 10-week intervention.

Table 13. *Secondary adherence scores for experiential challenge activities*

	Standard (S) support (N=103)	S+pSMS support (N=114)	S+VCS support (N=103)	<i>P</i> value
Challenge variable (SD)				
Mean challenge points (out of 1000)	368.7 (361.6)	340.2 (339.0)	377.5 (354.0)	0.71
No. of weeks challenge scores were logged (out of 10)	4.5 (3.7)	4.4 (3.4)	4.8 (3.6)	0.66

Figure 4 shows weekly mean challenge scores by group, and Figure 5 portrays what percentage of participants were logging challenges each week over the 10-week intervention. The mean number of challenge points scored was greatest in the first three weeks for the three groups. Additionally, scores declined in a graded manner from Week 3 to Week 10 in each group, as illustrated in Figure 4. During the first three weeks of the intervention, between 59–72% (67-74) participants in each group were logging challenges. The number of participants logging challenges was greatest in Week 1 for the S group, highest in Week 2 for the S+VCS group, and highest in Week 3 for the S+pSMS group, although between-group differences were not significant. Figure 5 illustrates the steady decline in participants logging challenges from Lesson 3 to Lesson 10 for all groups.

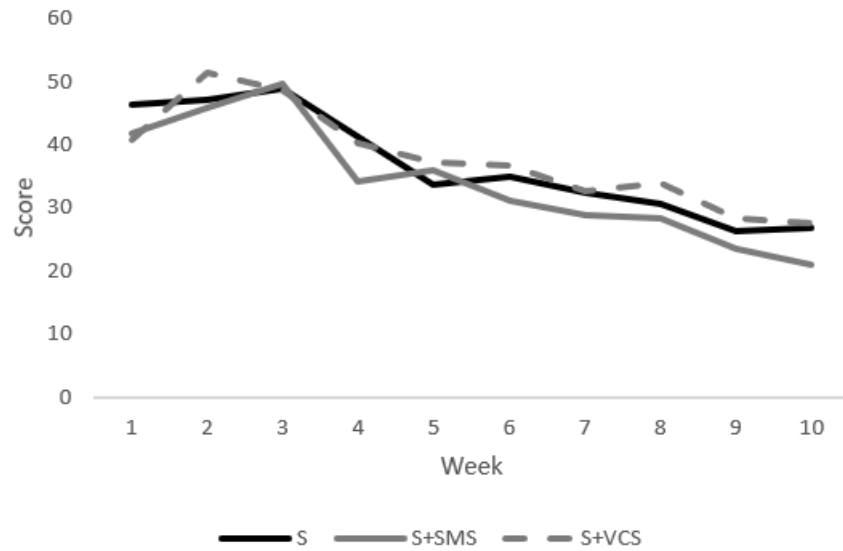


Figure 4. *Group based mean challenge scores over 10-weeks.*

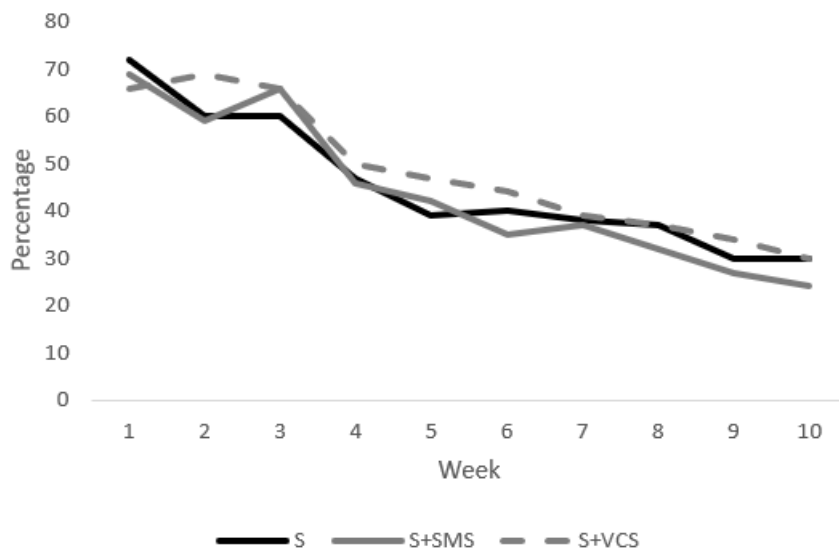


Figure 5. *Percentage of participants who logged challenges over 10-weeks.*

5.6.2.3 Videoconference adherence

Participation in videoconferencing support was low, with 35.9% (37/103) of participants (in the S+VCS group) not attending any support sessions and only 18.4% (19/103) attending seven or more out of ten sessions.

5.6.3 Preferences

Table 14 specifies the preferred mode of human support for each group. A total of 88.7% (284/320) of participants indicated a valid human support preference. Almost half of participants within each group indicated a preference for combined support (i.e., automated emails, pSMS and VCS); however, the combined support alternative was not offered as part of the study. In comparison, the preference for solely S+VCS support was low across all the groups, with only between 7% to 8% choosing it from each group. Table 14 also indicates that 24% (22/91) in the Standard group, 27% (20/96) in the S+pSMS group and 8% (8/97) in the S+VCS group received their preferred mode of support.

Table 14. *Preferences for the mode of human support in percentages*

	Standard (S) support (n = 91)	S+pSMS support (n = 96)	S+VCS support (n = 97)
Support Mode Preference			
Standard	24	22	19
Standard plus pSMS support	27	27	24
Standard plus VCS support	7	7	8
Standard plus pSMS & VCS support	42	44	49

Secondary analysis was conducted to determine if those who received their first preference for support mode scored better adherence or outcomes than those who did not receive their first choice. Participants (n=128) who chose the combined support as their first preference (an option not included in the comparative study) were excluded from the analysis, and the remaining participant data (n=156) were analysed. Table 15 outlines the results between those who did not receive their first preference in human support mode and those who did. There was no significant difference between the two groups in either adherence or well-being measures.

Table 15. *Preferred human support mode - effect on adherence & outcomes.*

Variable	Preference - no (n=100) M ± (SD)	Preference - yes (n=56) M ± (SD)	Between Group Difference (P value)	Between Group Difference (Cohen <i>d</i>)
Adherence				
Videos watched (out of 10)	6.1 (3.9)	6.5 (4.0)	0.91	0.09
Challenge points (out of 100)	339.9 (352.2)	388.6 (385.9)	0.27	0.13
Outcomes				
Mental Health	8.4 (14.4)	9.8 (13.3)	0.86	0.10
Vitality	9.5 (15.2)	10.6 (13.8)	0.98	0.08
Depression	-1.3 (3.4)	-1.6 (2.5)	0.09	0.10
Anxiety	-.6 (1.9)	-1.2 (2.6)	0.64	0.26
Stress	-1.0 (3.5)	-1.6 (2.8)	0.55	0.19
Life Satisfaction	2.2 (4.6)	1.9 (4.8)	0.50	0.06
Flourishing	.14 (.53)	.21 (.53)	0.47	0.13

5.7 Discussion

5.7.1 Principal results

Higher early dropout attrition occurred in the group who were allocated videoconferencing as a mode of human support. However, the mode of human support made no impact on attrition or adherence after the commencement of the intervention. Moreover, for participants who received their first preference in human support, compared to those who did not, no differences were observed in adherence. Preference for VCS support alone was low, yet almost half of the participants indicated they would prefer all forms of human support, although this was not an option in this study.

In this study, after the initial email notified participants of their group allocation, a disproportionate number of participants allocated to the S+VCS group withdrew from the study, with a significant between-group difference ($P=0.009$). The early dropout attrition may have been influenced by dissatisfaction with the assigned support mode. Figure 3 (i.e. the participant flow chart listed in Chapter Four) shows that, in the S+VCS group, 57 participants either requested withdrawal or

failed to register compared to 36 in the email group (S) and 28 in the S+pSMS group. Of the 24 participants who requested a withdrawal from the S+VCS group, ten stated that time was a factor, eight provided no specific reason, four stated personal illness, one mentioned work commitments, and one participant stated they did not want to be involved in videoconferencing.

No differences in adherence between the groups were detected, and, in a previous report (Renfrew et al., 2020a), we documented that no differences were observed between the groups in the well-being measures either. However, in observing that almost half (150/320, 46.9%) of the entire cohort were 100% adherent—had viewed all ten videos—we conducted the stratified analysis to compare well-being measures of those who were fully adherent ($n=150$) with those who were not ($n=170$). Significantly greater improvements were observed in the fully adherent group for life satisfaction ($P=0.011$; $d=0.15$) and flourishing scores ($P=0.012$; $d=0.15$). The ‘vitality’ domain demonstrated a trend towards significance ($P=0.062$; $d=0.21$), yet, effect sizes for the three measures were small.

While the primary aim of human support is usually to foster greater adherence (Ebert, Lehr, et al., 2016a; Ebert et al., 2018; Zarski et al., 2016), support did not influence adherence behaviour for the participants in this study. While earlier research among clinical cohorts have indicated that supported interventions yielded better adherence and outcomes (Baumeister et al., 2014; Johansson & Andersson, 2012; Richards & Richardson, 2012), numerous studies have also shown that human support made no difference (Berger, Caspar, et al., 2011; Berger, Hämmerli, et al., 2011; Dear et al., 2016; Dear et al., 2015; Dear, Fogliati, et al., 2018; Dear, Gandy, et al., 2018; Farrer et al., 2011; Shim et al., 2017). Considering the extensive repertoire of previously identified factors affecting adherence, it is plausible that, in this non-clinical group, a wide range of variants may have influenced adherence at the individual level (Zarski et al., 2016), reducing the potential impact of human support as a single factor. Therefore, exploring participants’ perceptions regarding influences on adherence is an important topic for further investigation.

The S+VCS alone was the least preferred support mode (7%), and low VCS attendance reflected the low preference for this type of support. Exploring reasons for the disinterest in videoconferencing as a mode of support may be a topic for

further research as it has been used successfully in other group contexts (Banbury et al., 2018; Damianakis et al., 2016; Marziali & Donahue, 2006; Nyström & Öhring, 2006; Wild et al., 2013) and has proved useful so long as technical support was provided (Banbury et al., 2018). Albeit, in a recent German study, 64% of patients were resistant to videoconferencing as a method of communication with health professionals. Notably, less than 1% reported previous experience with its use (Paslakis et al., 2019).

The S+VCS group allocation required an extra time commitment on behalf of participants compared to the other groups. Both email and SMS support required no effort by the participant—support was “pushed” to devices (Mohr, Burns, et al., 2013). Conversely, videoconference support attempted to “pull” participants to an extra event, requiring effort and time to gain benefit from the support offered. Conceivably, the time and energy required to engage with that mode of support, loss of anonymity, technological barriers, unfamiliarity with videoconferencing software, or concerns about the group interaction may have been a barrier that facilitated significantly greater dropout. Additionally, further research should investigate if the preference for S+VCS would have been higher if support had been provided on an individual rather than a group basis.

For participants remaining in the S+VCS group, many demonstrated low engagement with the videoconferencing support. Consequently, by not engaging in the VCS support, they experienced a similar level of support to those in the S group (i.e., automated emails only). This hindered the ability to draw meaningful between-group comparisons regarding the influence of human support offered through videoconferencing on adherence.

Receiving their first preference in human support mode did not translate to participants reporting better adherence or outcomes in this study. We were unable to locate comparable studies for non-clinical groups. However, previous research among clinical cohorts has demonstrated that receiving support preferences may impact patient perceptions about the usefulness of an intervention (Williams et al., 2016) and improve adherence (Dunlop et al., 2017; Lindhiem et al., 2014). While a meta-analysis revealed that patients receiving their preferences demonstrated improved treatment satisfaction, adherence and outcomes, with moderate effect sizes

(Lindhiem et al., 2014), other research found that receiving the preferred option does not always impact outcomes (Beasley et al., 2017; Dunlop et al., 2017). A 2019 study (Hadjistavropoulos et al., 2019) of patients with anxiety and depression compared adherence and outcomes when patients chose their preferred support. Interestingly, 78% chose the maximal support option, regular weekly support, and just 22% chose optional support (i.e., support by request only). Yet, both groups achieved similar improvements in anxiety and depression scores, and there were no differences in adherence. Contact between participants and therapist was much less for those who chose optional support, suggesting that similar results can be achieved with less time and cost investment.

Although combined human support (i.e., access to automated emails, SMS, and videoconferencing) was not offered in the study, it is interesting that almost half of the participants in every group chose this as their preferred support option. While the reasons for this are unclear, it is hypothesised that it is a common trait of human nature to want accessibility to everything possible, even although the available options are not necessarily utilised or needed. Further research exploring participant perceptions regarding human support modes and preferences is warranted.

5.7.2 Strengths and limitations

The intervention and its implementation were supported by established theory. While the intervention itself was underpinned by the Theory of Planned Behaviour (Ajzen, 1985), the design components of the intervention for the web- and mobile app-based platform were informed by the Persuasive Design Model (Oinas-Kukkonen & Harjumaa, 2009) and human support elements reflected the SAM (Mohr et al., 2011). The use of a sole facilitator as a support person provided consistency in the participant's experience regarding technical assistance, messaging, and videoconference facilitation. The study attracted a large cohort with a broad range of ages (18-81 years old), and adherence data was easily collected through the eLMS and mobile app, avoiding the possibility of human error. Despite the addition of human support elements, the administration of the intervention using the eLMS and the mobile app provided acceptable scalability, portability, and accessibility, demonstrating the potential for broad-based mental health promotion.

Several limitations should be noted. The study attracted mainly white, well-educated women. While this is often seen in digital health interventions (Mitchell et al., 2009; Waters et al., 2011), it limits the ability to generalise more widely. Data gathering relied on self-reporting, which may be subject to bias, and self-selection into the study may have resulted in a cohort skewed by factors such as technological ability and motivation to achieve better mental health. Bias may have been introduced by the disproportionate number of participants who withdrew from the S+VCS group after being notified of their group allocation, reducing the validity of the randomisation process. In asking participants to rank human support preferences, analyses were limited by including a preference option in the questionnaire that was not included in the study (i.e., combined support involving email, SMS, and VCS). Almost half of the participants ranked combined support as their first preference and were consequently excluded from further investigation, reducing the power of the analyses. Additionally, some factors that would have been useful for group comparison were not measured. For example, asking participants to indicate their level of engagement with SMS and emails, and collecting data regarding preference for the use of the mobile app compared to the web-based experience, would have provided an indication of engagement with the human support offered.

5.7.3 Conclusions

The findings of this study indicate that a web and mobile app-based MHPI for a non-clinical cohort can be designed and implemented to maximise accessibility, scalability, and adherence without the additional cost of human support. While early dropout attrition may have been influenced by displeasure with allocated support, adherence to a ten-week MHPI for a healthy cohort was not impacted by different modes of human support. Engagement with videoconference support was sub-optimal, hindering the ability to draw meaningful between-group comparisons; however, SMS support demonstrated no added value compared to automated email support. Adherence was not impacted by participants receiving their first preference for support. Future research should explore participant perspectives on adherence behaviours.

5.8 Acknowledgements

The Seventh-day Adventist Church of the South Pacific Division funded the development of the eLMS and mobile app. They provided the intervention cost-free to participants and offered technical support throughout the duration of the study.

5.9 Conflict of interest

DM operates a “profit-for-purpose” trust that administers the delivery of a version of the intervention; no personal remuneration is received. GP is employed by the South Pacific Division of the Seventh-day Adventist Church, which administers the intervention among members of the organisation, including the participants of this study. No authors have a financial interest in the initiative, and there are no other conflicts of interest to declare.

Chapter Six: Publication Three - Participant Perceptions of Facilitators and Barriers to Adherence in a Digital Mental Health Intervention for a Non-Clinical Cohort: Content Analysis

6.1 Chapter Overview

This chapter focuses on the third research question of this dissertation—What do healthy adult participants perceive as the facilitators of, and barriers to, adherence to a web and mobile app, lifestyle-based mental health intervention? The chapter is presented as a manuscript published in the Journal of Medical Internet Research (Impact Factor 5.43, Q1 ranking) in April 2021, titled ‘Participant Perceptions of Facilitators and Barriers to Adherence in a Digital Mental Health Intervention for a Non-Clinical Cohort: Content Analysis’. The objective of this qualitative analysis was to evaluate the perceptions of participants concerning what they believed to be the facilitators and barriers influencing their adherence to the digital mental health promotion intervention (DMHPI). The study contributes to the currently scant understanding of factors that healthy community-based participants perceive as either facilitating or hindering their adherence to a DMHPI. Chapter Seven also discusses the findings and conclusions of this study.

6.2 Contribution of Authentication Statement

I attest that Higher Degree Research candidate Melanie Renfrew contributed to the paper/publication entitled:

Participant Perceptions of Facilitators and Barriers to Adherence in a Digital Mental Health Intervention for a Non-Clinical Cohort: Content Analysis

By:

- Leading the conception and design of the study
- Cleaning the data
- Leading the data analysis
- Interpretation of the data
- Leading the writing of the manuscript
- Submitted the manuscript for review
- Addressed reviewers' comments

Signature of Candidate:



Name of Candidate: Melanie Renfrew

Date: 30 September, 2021

Signature of Principal Supervisor:



Name of Principal Supervisor: Associate Professor Darren Morton

Date: 30 September 2021

6.3 Abstract

6.3.1 Background

Digital mental health promotion interventions present a scalable opportunity to attenuate the risk of mental health distress among non-clinical cohorts. However, adherence is frequently suboptimal and little is known about participants' perspectives concerning facilitators and barriers to adherence in community-based settings.

6.3.2 Objectives

To examine participants' perceptions of facilitators and barriers to adherence in a web- and mobile app-based mental health promotion intervention for a non-clinical cohort.

6.3.3 Method

This qualitative study used inductive, reflexive thematic analysis to explore free-text responses in a post-intervention evaluation of a 10-week digital mental health promotion intervention. The intervention was administered using a web/mobile app from September to December 2018. Participants (N=320) were Australian and New Zealand members of a faith-based organisation who self-selected into the study, owned a mobile phone with messaging capability, had an email address and internet access, were fluent in English, provided informed consent, and gave permission for their data to be used for research. The post-intervention questionnaire elicited participant perceptions of facilitators and barriers to adherence during the intervention period.

6.3.4 Results

Key factors that facilitated adherence were: engaging content, time availability and management, ease of accessibility, easy or enjoyable practical challenges, high perceived value, and personal motivation to complete the intervention. The primary perceived barrier to adherence was the participants' lack of time. Other barriers included: completing and recording practical activities, length of video content, technical difficulties, and a combination of personal factors.

6.3.5 Conclusions

Time scarcity was the foremost issue for the non-clinical cohort engaged in this digital mental health promotion intervention. Program developers should streamline digital interventions to minimize the time investment for participants. This may include condensed content, optimising intuitive web and app design, simplified recording of activities, and greater participant autonomy in choosing optional features. Nonetheless, participants identified a multiplicity of other interindividual factors that facilitated or inhibited adherence.

6.3.6 Trial registration

Australian New Zealand Clinical Trials Registry (ANZCTR):
12619001009101.

6.4 Introduction

6.4.1 Background

Mental distress and disorders are increasingly prevalent (Jorm et al., 2017), and mental health promotion interventions (MHPIs) present opportunities to enhance the well-being of non-clinical groups, decreasing the risk of mental health distress. The widespread availability of digital technology offers unprecedented accessibility, portability, and cost-effectiveness for implementing such interventions on a wide scale. However, adherence, defined by Kelders et al. (Kelders et al., 2012) as “The extent to which individuals should experience the content (of the intervention) to derive maximum benefit from the intervention, as defined or implied by its creators”, is often suboptimal (Linardon & Fuller-Tyszkiewicz, 2020) and little is known about participant perceptions regarding facilitators and barriers to adherence for non-clinical cohorts in community-based settings.

Considerable research has been undertaken by researchers and program developers to facilitate optimum adherence to digital health initiatives. Methods used to promote participant adherence have included the adoption of a robust set of persuasive system design principles (Asbjørnsen et al., 2019; Kelders et al., 2012; Oinas-Kukkonen & Harjumaa, 2009), provision of rewards/incentives, positive feedback (Mohr et al., 2011), implementing gamification techniques (Brown et al., 2016; Schmidt-Kraepelin et al., 2020), and various forms of human support (Shim et al., 2017). However, adherence to digital interventions remains problematic (Linardon & Fuller-Tyszkiewicz, 2020), and there is a paucity of research elucidating participant perspectives on the factors that impact adherence (Esponda et al., 2020) in community-based, non-clinical groups. Importantly, factors that may hamper adherence in a clinical population (e.g., disease/disorder symptoms) (Beatty & Binnion, 2016; Glowacki et al., 2017) may be dissimilar to the influences on adherence for healthy non-clinical cohorts.

Several qualitative studies have addressed participant perspectives on perceived barriers and facilitators to adherence in MHPIs for non-clinical cohorts in workplace settings. A stress management intervention, using mindfulness training, found that participant attitudes (e.g., motivation, prior interest in mindfulness,

positivity towards change), awareness of treatment effectiveness, curiosity, and alignment with personal preferences for managing stress were facilitators of adherence (Banerjee et al., 2017). Conversely, barriers included not enough detail or evidence provided as a rationale for the strategy used, length of time required for completing activities, and program intensity (Banerjee et al., 2017). Carolan and de Visser (2018) explored employee perspectives on workplace digital mental health interventions and found lack of time was considered the core barrier to adherence. Notably, anonymity, convenience, and flexibility were deemed to have dual impacts (i.e., considered both a facilitator and a barrier). Employees described their ideal workplace intervention as one that was short, easily accessible, available for an indefinite time period, updated regularly, and that provided some form of e-coaching support (Carolan & de Visser, 2018). Research by Blankenhagel et al. (2019), which focused on the perspectives of various stakeholders to digital stress management programs, found certain requirements of interventions were needed for non-clinical users who often have substantial work responsibilities. These intervention requirements were: prioritising time efficiency (5-15-minute sessions), splitting larger goals into smaller goals, providing flexibility for users to design their own personal notification/reminder schedule, featuring an intuitive and simple web or app design, prioritising individualisation (i.e., tailoring), providing high autonomy, fostering some degree of human interaction, facilitating comparability to peers, and offering high mobility (Blankenhagel et al., 2019). The abovementioned requirements related to a work-based setting for a non-clinical cohort; however, while there may be similarities, variant influences on adherence may be present in a community-based context.

This study sought to broaden the understanding of factors that both facilitate and hinder adherence for a non-clinical cohort participating in a digital MHPI within a community-based situation. The study builds on quantitative data collected during a randomised comparative study that examined the impact of different levels of human support on well-being outcomes (Renfrew et al., 2020a) and attrition and adherence (Renfrew et al., 2020b) to a digital MPHPI for a non-clinical cohort. The quantitative data revealed improvements in mental well-being irrespective of the level of human support offered, and adherence did not differ significantly between the groups. Notably, using the previously mentioned definition of adherence by

Kelders et al. (2012), participants were advised to view one video weekly and complete daily and weekly experiential activities over a ten-week period to gain optimal benefit from the intervention. Overall, attrition and adherence were suboptimal (Renfrew et al., 2020b). A total of 605 subjects indicated an interest in the intervention by filling out a preliminary web-based enrolment form, with 24.3% (147/605) of these subjects not fully registering through failing to complete the prequestionnaire. Of those who completed the prequestionnaire (n=458), a further 30.1% (138/458) did not complete the postquestionnaire, resulting in a completion rate of 69.9% (320/458). Primary adherence was measured by the number of videos viewed, with 34.0% (109/320) of the cohort watching less than half of the videos, 18.9% viewing 5-9 videos (60/320) and 47.1% (151/320) viewing all 10. Secondary adherence was measured by points scored for completing assigned daily and weekly activities. Participants could score a total of 1000 points (i.e., 100 points weekly throughout the 10-week intervention) to be considered fully adherent. The mean points score for the cohort was 362, indicating a low adherence to the challenge activities (Renfrew et al., 2020b).

6.4.2 Objectives

This study aims to increase knowledge regarding participant adherence in digital MPHIs by revealing perceptions from participants about the facilitators and barriers to watching the videos and their completion of daily and weekly experiential activities. The findings will assist researchers and developers to refine and improve the design and implementation of interventions to optimise the adherence of participants in future MPHIs in non-clinical settings.

6.5 Methods

This qualitative study stems from the abovementioned study, which reported on the quantitative results of the intervention (Renfrew et al., 2020a; Renfrew et al., 2020b). The qualitative responses were recorded as part of the postquestionnaire administered at the conclusion of the intervention. Participants were allocated a two-week period, immediately after the intervention period, to complete the postquestionnaire on either the provided app or web platform. Therefore, the following section of this article is a summary of the methods used in the

aforementioned study, with details only provided for those areas related to the qualitative components of the study.

6.5.1 *Setting and participants*

Advertising was used to direct potential participants (Australian and New Zealand members of the Seventh-day Adventist Church) to a website that explained the intervention, outlined the inclusion criteria and provided an opportunity to self-enrol as a potential participant. To be included in the study, subjects were required to be over 18 years old, own a mobile phone with SMS capability, have internet access, be an Australian or New Zealand resident, be fluent in English, provide informed consent, and give permission for their data to be used for research (Renfrew et al., 2020a). Participants who completed the MHPI were invited to provide free-text responses to two statements within the postquestionnaire.

6.5.2 *Intervention*

The intervention program, known as the *Live More Project* or *Lift Project*, introduced participants to aspects of neuroscience and a combination of evidence-based strategies to enhance mental well-being from the disciplines of lifestyle medicine and positive psychology. Designed to be implemented as one weekly lesson for ten weeks, the content of the program was shared in a 30-minute audio-visual presentation followed by participation in daily and weekly practical activities to consolidate learning. Video lessons were released weekly with a lock/unlock system, so that participants watched the presentations in sequential order. The intervention and activity overview are provided in Table 7 (located in Chapter Three).

Subjects chose to access the program on a web-based learning management system (eLMS) or a mobile app. Along with the audio-visual content, the eLMS/mobile app included: a place to complete the pre and postquestionnaire, a section to log experiential activity and earn points, an opportunity to interact with other participants through a public feed, and gamification strategies (e.g., points on a leaderboard, badges) to induce adherence. As an optional extra, previously introduced experiential activities could be repeated and logged in the forthcoming weeks to earn extra points. This resulted in an increasingly long list of activities to

complete as the intervention progressed. Screenshots of the web and mobile app design are shown in Appendix 1.

Participants were divided into three groups that differed according to the mode of human support allocated. The first group received automated email support only, the second group received automated email support and text messages (two to three times weekly), and the third group received weekly videoconference support and email support (Renfrew et al., 2020a).

6.5.3 Data collection

After completing the intervention, each participant was asked to complete the postquestionnaire within a two-week period on either the web or mobile app. As part of the postquestionnaire, participants responded to two adherence-related statements in an expanding text box with no imposed word limits. These statements were:

Statement 1: Thinking about your personal experience as a participant in the *Live More Project* over the last ten weeks, if it was *easy* for you to watch the video presentations and complete the daily and weekly challenges, please describe/list all the factors that contributed to this.

Statement 2: Thinking about your personal experience as a participant in the *Live More Project* over the last ten weeks, if it was *difficult* for you to watch the video presentations and complete the daily and weekly challenges, please describe/list all the factors that contributed to this.

6.5.4 Data analysis

An inductive, reflexive thematic analysis (RTA) approach (Braun & Clarke, 2006, 2012, 2019) was used to extract meaning from the data set. The inductive approach is sometimes described as “bottom-up”, or data-driven, as the themes are generated from within the data itself (Braun & Clarke, 2012). The RTA method suited one researcher (MR) performing the initial coding, followed by two additional coders reviewing the progress. MR had multiple roles in the study and functioned as the technical support person, so this approach, in which multiple coders reviewed the data—as recommended by O’Brien et al. (2014)—reduced the possibility of personal bias.

The coding researcher adopted Braun and Clarke's six phases of thematic analysis (Braun & Clarke, 2012) as a structured approach and used a spreadsheet (Microsoft Excel) and a qualitative analysis program (NVivo Software) to assist in the collation, analysis, and coding of the de-identified data. All identifying information was removed before coding, and participant identification numbers were used instead. In phase one, the researcher read through the dataset twice to maximise familiarity with the data. During phase two, all comments were systematically analysed by constructing and labelling codes in a descriptive and interpretive manner until all data were coded. In an additional immersion stage, coding was reviewed, and code names edited. In the third phase, the researcher scrutinised the codes for patterns, relationships, and similarities. Codes were clustered together under broad themes. During phase four, after repeated scrutiny to ensure that the code names accurately matched the data and that the developing themes represented the participants' descriptions of their most typical experiences, clusters were formed into broad themes and several sub-themes to develop a thematic map, as recommended by Braun and Clarke (2006). To ensure that the themes and sub-themes accurately reflected the original data set as a whole, and the coded data, a final revision of the themes and codes was undertaken by the original coding researcher in consultation with two other researchers. During this process, the coders analysed the themes and sub-themes in relation to the original intention of the study. This procedure enabled the coders to identify any mismatches between theme and sub-theme names and the original data. Furthermore, the coders identified any themes, sub-themes, codes or data within codes that were deemed of low relevance to the overall themes or this study's intention. This relevance-based scrutiny was followed by an analysis of any codes that were characterised by very few participant quotes. In this way, we were able to determine the *weightiness* or key ideas across the whole dataset. In cases where relevance and the number of participant responses were considered to be low, the sub-theme or code was discarded from the overall thematic map.

In the final phase of coding, the original coder and consulting coders collaboratively identified the main focus and extent of each theme. Some names of the main themes and sub-themes were also modified to increase alignment between the documented theme and sub-theme labels and the data they each contained. This refinement of theme and sub-theme definitions informed the final write up phase.

The Standards for Reporting Qualitative Research checklist was used as a guide for reporting, and ethics approval was granted by the Avondale Human Research Ethics Committee (Approval 2018.09).

6.6 Results

The majority of participants were female (82%, 262/320), and half of the participants (50.3%, 161/320) were aged 40-60 years. Almost one-third of the cohort were aged 25-39 years (28.4%, 91/320), 15.6% (50/320) were 61-81 years of age, and just 5.6% (18/320) were aged 18-24 years of age. Two-thirds of the cohort (66.2%, 212/320) worked either full- or part-time, 6.2% (20/320) identified as students, and the remaining 27.6% (88/320) identified as being unemployed or responsible for home duties. The majority of the cohort (75%, 240/320) provided a codable response describing facilitators of adherence, and almost all participants (98%, 314/320) provided codable responses relating to barriers.

Since the participants were asked to respond to two separate statements (one that focused on facilitators and the other that focused on barriers), responses to these two statements were analysed separately. However, in some cases, participant responses overlapped and issues were reported as both a facilitator and a barrier. Broad themes that emerged were: time, program components, personal factors, system design, technology, and human support. Notably, comment frequency regarding barriers to adherence were more than double the comments specifying facilitators of adherence. Table 16 (facilitators of adherence) and Table 17 (barriers to adherence) outline the thematic framework of responses.

Table 16. *Perceived facilitators of adherence - themes, sub-themes and codes.*

Themes	Sub-themes	Codes/Category (no. of comments)
Time	Availability	Opportune circumstances (20) Weekend (12)
	Efficiency	Priority & planning (14) Multitasking (10)
Program	Videos	Highly engaging (70) Length (5)
	Challenge/experiential factors	Achievable (18) Enjoyable (12) Part of normal lifestyle (6) Accountability (5)
	Overall program	Easy/Engaging (8) Quality (5)
Personal factors	Motivation	High interest in personal health (9) Commitment to complete (5)
	Perceived value	Personally beneficial (11) Reinforcement of positive habits (5)
System design	Convenience	Accessibility (16) App (14)
	Usability	Extra features (7) Ease of use (7)

Table 17. *Perceived barriers to adherence - themes, sub-themes and codes.*

Themes	Sub-themes	Codes/Category (no. of comments)
Time	Daily Life	Lack of time in general (129) Work & study combination (58) Family responsibilities (40) Travel (16) Full schedule (8) Work & family combination (6)
	Life Event	Death (9) Medical (6) Relocation (5) Other major change (5)
	Period	Christmas (15) Holiday travel (6)
Program components	Experiential Challenge Factors	Perceived as difficult (33) Time-consuming (22) Too many activities (19) Disliked recording/logging activity (18) Forgot to implement or record (n=10) Confusion (n=5)
	Video Factors	Length (17) Unappealing content or style (10) Extra segments (7)
Personal factors	Well-being	Illness (16) Fatigue (10) Mental health distress or disorder (7) Stress (5)
	Capacity	Lack of motivation (18) Lagging behind (17) Not a priority so forgot (16)
System design		Lock restrictions (10) Features missing (9) Gamification (8) Login & navigation (8) Video playback (5) Recording activity (5)
Technology	Internet	Internet & data access (28)
	Personal device	Faulty (18) Interrupted viewing (6)
Human support		Videoconferencing difficulties (11) Lack of prompts (8) Lack of accountability (6) Prefer face-to-face (5)

During the development of the thematic map, it became evident that there was a strong alignment between themes and sub-themes in both sets of responses. That is, the thematic map illustrates the two-fold nature of most themes, with the order of reporting of the themes reflecting the most important themes first, as assessed by the coding researcher, according to relevance and volume of comments received. The issue of time emerged as a dominant theme in the data, with the vast majority of participants mentioning ‘time’ across their responses.

6.6.1 Facilitators of adherence

6.6.1.1 Time

Time was perceived as a facilitator of adherence when participants believed they had time available and efficiency was optimised. Each weekly lesson was released on a Sunday, and this timing was viewed positively. Expediency afforded through being retired, living alone or not working also facilitated adherence.

I liked that the videos were released on Sunday, even if some Sundays were busy and we couldn't make time to watch them that day. Sunday is a day it's easier to make time to watch the full set of lesson videos. [ID 2614]

Some participants prioritised, scheduled, and multitasked to ensure that the program components were completed each week. Specific factors that permitted time availability or efficiency included being at home, not travelling, completion of usual duties, incorporation of tasks into daily activities, a high level of organisation/planning, and having children in a regular sleep routine.

When I made specific time to sit down and watch the program it made it easier to participate and plan how I can incorporate the challenges. [ID2278]

6.6.1.2 Program components

This theme refers specifically to video content and completing practical activities. Three sub-themes related to the program’s components emerged from the analysis: the overall program, video presentations and experiential activity.

While some participants perceived that the overall program was of high quality, easy to understand and engaging, the key program components perceived as facilitators of adherence were the video presentations and the experiential challenges. Engaging video content has been frequently reported as a facilitator of adherence. Terms used to describe the videos included *humorous*, *entertaining*, *interesting*, *motivating*, and *easy to understand*. Participants appreciated the light-hearted presentation style that included just enough information and interesting facts to avoid information overload.

The videos were funny and engaging. Had enough info to be interesting but not overly filled with over-your-head stuff. [ID2380]

The daily and weekly experiential challenges that participants completed and recorded were perceived as fostering adherence because they were relevant, easy to accomplish, enjoyable, simple to log/record, and could be readily incorporated into daily life. Some challenges could be easily doubled up and, for some participants, recording their challenge activity provided a sense of accomplishment.

The small daily challenges were able to be absorbed into the day without having to find extra time and it felt like many could become habits. [ID2302]

I found a lot of the challenges crossed into another which made it easier such as being in the green and blue and going for a walk covered two challenges [ID2550]

6.6.1.3 Personal factors

There are numerous personal reasons that may influence adherence, including beliefs, motivation, personal well-being and a broad array of diverse circumstances. During coding, several key personal sub-themes were developed that included motivational factors, beliefs about the value/relevance of the program, level of personal well-being, and individual capacity.

Motivation and perceived value were identified as sub-themes positively influencing adherence at a personal level. Participants reported positive motivation through a high level of readiness, commitment to the intervention, and a personal

desire to improve their health. Some participants were motivated to maintain their adherence to the program by their belief that the intervention would be personally beneficial to them. They recognised a number of enabling aspects of the program, including the way it reinforced positive lifestyle choices; recognised that even small changes would be worthwhile; and identified the value of immediate effects. Participants also benefitted from the multifactorial approach.

I looked forward to the video presentations because they were so relevant to my life, very interesting and well presented. I have been experiencing problems with sleep issues for many years and even taking herbal sleeping supplements, but after applying the information I received from the Live More sessions, I've been a good 7 to 8 hours sleep every night. This has been mainly the result of all the walking I've been doing - between 1 to 2 hours a day and more. I'm now taking more notice of nature and enjoying more green and blue. Having recently moved from [name of Country], I had no friends and felt lonely. So, I went to the local Library and Community Centre and got a booklet with the different activities for retired people. I joined a group of like-minded people and enjoyed the activities they provided. [ID2419]

6.6.1.4 System design

This theme relates to the various design and accessibility features of the web or mobile app and primarily includes the methods used to disseminate weekly video content and record experiential activities in the digital setting. Extra features such as gamification (i.e., earning points), the ability to view what others were doing and accessibility to extra resources are also included. Similar to other themes, the system design facilitated adherence for some participants and was perceived as a barrier for an almost equal number.

Two key design concepts were reported by users as positive influences on adherence: accessibility and the convenience of the mobile app. Participants appreciated flexible access to view and review the content. This was amplified with easy portability through a mobile app.

I could do it when it was suitable for me. Whether 10pm or 6am. The flexibility made it possible. [ID 2195]

6.6.2 Barriers to adherence

6.6.2.1 Time

Participants overwhelmingly perceived lack of time as problematic to adherence, with noticeably more comments referencing time as a barrier to adherence rather than a facilitator. Furthermore, time was mentioned substantially more often than any other factor recognised as a barrier. Three sub-themes generated in relation to lack of time were daily life, life events and the intervention time period.

The demands of daily life were the foremost barriers and predominantly included work, study and family commitments, and various combinations of all three.

Small child needing attention, lack of help from spouse due to work commitments; other extra-curricular activity; helping my elderly parents with household tasks and other daily activities. [ID 2538]

Major life events were perceived as hindering adherence and included the death of a loved one, relocation, major illness, or a combination of trials that consumed major amounts of time.

The timing of this project was the one of the busiest 10 weeks in my life! Moved house. Solo parented for 4 weeks. My sister's wedding. School holidays. The sickest our family has been in 10 years. Term 4 after-hours school events as part of my work responsibilities. We moved house the week the program started and then went straight into school holidays of which we were away the whole time. Then we were really sick for three weeks whilst I was solo parenting. So I just never got the chance to get started. [ID 2214]

The intervention was conducted from September to early December 2018. The lead up to Christmas and the added pressures that often accompany the Christmas period in the work and social environment were deemed barriers. In

addition, for this cohort (i.e., a faith-based population), church activities were perceived as adding further to the time pressures already experienced at this time of year.

Making a commitment at this time of year was more difficult than I thought; this time of year is hectic for my job which also probably means my answers at the end could actually be worse than at the start, because of how tired I have been. [ID 2630]

If it was at another time of year I probably would have completed it. This time of year is crazy for me at work, I'm a preschool assistant, and I am involved with helping with Road to Bethlehem [Christmas program]. The last few weeks I just found it difficult to think much about what I was doing. [ID 2417]

6.6.2.2 Program components

Some users deemed the overall program as too intense and too long. Video segments were perceived as lengthy, and some users found the content unappealing and disliked the presentation style, describing it as *cliché, corny* and *over the top*.

The videos were too long. I'd prefer 2-3 shorter ones per topic. That would be easier to watch while in train or fitting between other things I had to do. [ID 2318]

While the actual science was interesting, much of the video content felt patronising and the jokes fell flat. [ID2142]

Most perceptions about the program components were directly related to difficulties with the experiential/challenge activities. Time was viewed as a hindrance for both completing and logging the activity, and some participants perceived the activities as being too hard. While some participants completed the daily and weekly experiential challenges, they disliked recording their activities, felt overwhelmed by the increasingly growing list of activities to record, or simply forgot to log their activity.

Having the challenges compound each week to record them meant that it was too overwhelming and I gave up logging on to record. I think having reminders about the previous weeks challenges is great, but filling in that many challenges every day is too hard! [ID 2287]

6.6.2.3 Personal factors

Numerous personal factors hindering adherence were grouped under two sub-themes: personal well-being and capacity. Personal illness was the dominant factor affecting well-being. Other influences included the presence of a mental disorder, stress, and fatigue, with several respondents specifically identifying screen fatigue. Comments regarding capacity were equally divided amongst three key areas: a reported lack of motivation, discouragement at lagging behind in viewing content or completing experiential activities, and simply not prioritising the intervention.

When I had down time, I didn't have the motivation to intently watch the videos & do the thinking & work required so it was easy to fall behind. [ID 2204]

Also, with working full time (looking at a screen) all day, I really didn't want to sit in my home office to look at another screen, so I failed to keep on top of the weekly presentations. [ID 2563]

6.6.2.4 System design

Several design features and difficulty navigating the website were perceived as negative influences on adherence. The majority of comments were made in relation to the lock restrictions, the lack of some desirable features, dissatisfaction with the gamification setup and the perceived tedious system for logging experiential activity. While participants were provided with a recommended ten-week schedule for engaging with the intervention content, some participants emphatically opposed the lack of autonomy in how and when they consumed the information.

I don't mind having to unlock videos - just please don't constrict it to a week at a time!!! And let me do any or all of the challenges at the start or when I unlock things in my own time - don't make me wait 7 days / a

fortnight / 3 weeks etc to engage in all the challenges just because! Let me unlock them at my pace. [ID2142]

Desirable features that were noted as missing included an audio-only option, the ability to pre-download the video content and the option to read the material instead of viewing a video. A readable script was actually provided, although it was not explicitly recommended as an alternative to viewing the video content. Although gamification was included as a way to enhance adherence, for some participants it was perceived negatively and as a deterrent to further adherence.

It's very demotivating having a leaderboard for someone who's not near the top. [ID2549]

The system set-up for recording experiential activity was seen as a barrier because it was perceived as difficult to use, with one participant describing it as *glitchy and not particularly intuitive with long and clunky lists* [ID2142].

Prompts on challenge input boxes were too vague about what the user needs to write. Should the user explain anything or just state that the challenge was completed? It was not clear whether the user's statement in the challenge input box would be shared with others (user had to just try it and see what happens during the first session). I could not log more than one challenge on the interface at a time (I had to change to another page and then come back to the challenges to log another one). [ID2391]

6.6.2.5 Technology

Technology (i.e., data availability, internet access and device suitability) was deemed a barrier, mainly because of poor internet accessibility or personal device problems. Internet access problems included slow download speeds, internet outages and no internet access at home. Personal device problems included old or faulty smartphones that could not download the mobile app, small screen size, sound problems, and perceived inability to correctly operate the device.

We had some difficulty watching the videos on my tablet, the volume is not loud enough, we really need a PC or to data project to a bigger screen for optimal viewing/listening. [ID 1767]

6.6.2.6 Human support

Human support offered to participants varied, depending on the group allocation they received. All participants received automated email reminders to engage with video content and to record their practical activity. One group received regular text messages, and another group were offered weekly videoconference sessions as an extra measure of support. Despite human support being a focus of the original study (Renfrew et al., 2020a), perceptions about the support offered did not feature strongly. However, some participants reported that adherence was impeded due to human support factors or lack thereof. A lack of prompting and accountability were stated as reasons for difficulty in adherence. In the group who received videoconferencing support, some of the group reported that videoconferencing support was problematic for a range of reasons, most commonly that the meetings were held at an unsuitable time.

Timing of online groups sessions didn't work for me with my responsibilities during that time period. I needed a later evening session. 9pm! Or a 5:30am session. The timing of the first 5 weeks would have been difficult for me regardless. [ID 2214]

6.7 Discussion

6.7.1 Principal findings

This study provides novel insights into participant perspectives regarding facilitators and barriers to adherence in a digital MHPI for a community-based, non-clinical population. Themes often had dual impacts, considered both facilitators and barriers. Facilitators of adherence included: engaging video content, achievable experiential activities, time availability, user-friendly web and mobile app design, and high personal interest or motivation. Conversely, the foremost barrier to adherence was a perceived lack of time. Completing and logging practical activities, a range of personal influences, problematic design features, technological issues, and a lack of support/prompting were also identified as barriers.

As barriers were the predominant focus of participants' perspectives, it is clear that an MHPI is a difficult endeavour for a non-clinical group and that time is

the foremost issue in relation to adherence. Similarly, other qualitative studies in workplace settings (Blankenhagel et al., 2019; Carolan & de Visser, 2018) have concluded that time scarcity is a major inhibitor for adherence and that participants need interventions requiring only small-time commitments. It is evident that certain features or problems (e.g., difficult website navigation and restrictions on video viewing) consumed inordinate amounts of the participants' time, thus impacting negatively on their adherence. Similarly, such issues have previously been exposed as barriers to the success of online learners in educational settings (Markova et al., 2017; Muilenburg & Berge, 2005). Therefore, time efficiency must be a core consideration by researchers in every aspect of intervention design. It is vital to design interventions to minimise time and energy investment for participants while concurrently optimising outcomes.

An important element that underpinned the data was the desire by participants to easily incorporate core components of the program (i.e., videos, challenge activities) into their everyday lives. A key priority in the design and development of future interventions should be to collaborate with potential users in designing interventions that enable autonomous, optimal integration of the essential intervention elements into daily life. Practical examples may include the provision of multiple options to access the content (e.g., video, print, audio), choice in methods to log activities, and recommendations on combining some activities to make optimal use of time.

The preponderance of dual themes in this study shed more light on an important element identified previously (Zarski et al., 2016); that is, individual differences substantially influence adherence in MHPIs. Although previous research by Banerjee, Cavanagh and Strauss (2017) identified several twofold themes in a qualitative study focusing on engagement with a mindfulness intervention, a study by Zarski et al. (2016) on adherence to a digital stress management intervention noted that, even after accounting for socioeconomic demographics, personal well-being status and human support, many individual variances in nonadherence were inexplicable. This study highlights some of those differences.

Understandably, the high prevalence of individual variance confounds efforts to crystallise a precise set of factors influencing adherence in digital interventions.

Plausibly, future research should embrace individual differences by examining ways to prioritise participant autonomy in tailoring interventions according to personal preference. This could be achieved by offering an eclectic, self-directed approach that encourages participant choice in activating or deactivating a range of optional features (e.g., gamification, type and frequency of human support) as desired. This constructivist-style approach, commonly used in educational settings, is well supported by research as an efficacious method (Schrader, 2015; Swan et al., 2009).

The original study, from which this qualitative study was derived, focused on the influence of varying levels of human support on outcomes and adherence to an MHPI (Renfrew et al., 2020a; Renfrew et al., 2020b). However, in this qualitative analysis, human support did not feature as a strong influence on adherence. Considering that the quantitative analysis revealed that different levels of support did not impact adherence and that participants achieved improvements in outcomes irrespective of human support provided, this is not surprising. Although numerous studies have demonstrated that human support may improve outcomes (Baumeister et al., 2014; Heber et al., 2017; Shim et al., 2017), there is substantial evidence that well designed, self-guided interventions can be successful without added human support (Dear et al., 2016; Dear, Fogliati, et al., 2018; Ebert, Heber, et al., 2016; Hadjistavropoulos et al., 2019; Shim et al., 2017) and their associated costs.

6.7.2 Strengths and limitations

The large cohort and inclusive age range (18-81 years) of participants were a strength of this study. Furthermore, participants were not restricted in the length of their responses and could write as little or as much as desired. All comments were coded, and participants received no guidance in what topics to comment on, eliminating preconceptions by researchers.

Recruitment bias could be seen as a potential limitation to this study as participants self-selected into the study, and the target group were Seventh-day Adventist Church members who typically share common health practices (e.g., abstinence from alcohol or smoking) and may be more inclined to take a greater interest in health than the general population. Additionally, recruits were largely tertiary educated (262/320, 82%), white (280/320, 88%) and female (262/320, 82%).

While a high female proportion is characteristic of an internet intervention (Mitchell et al., 2009; Waters et al., 2011), it limits transferability to the wider population. Additionally, participants were not given the opportunity to indicate whether they used the web-based platform, the mobile app, or a combination of both, which prohibited a comparison of the data based on the different delivery methods.

By allowing participants to comment freely on an open-ended statement, the assumption must be made that participants only reported on factors most relevant to their personal experiences. Therefore, the study does not contain all views of the participants. As researchers, we adopt the position that the predominant issues were exposed and that the volume of comments depicts saturation on crucial issues.

Notably, two other factors may have inadvertently influenced the perceptions of participants. Firstly, barriers, particularly ‘time’, may have been augmented by the period that the intervention was conducted (mid-September to early December 2018). Avoiding administering an intervention that ends in December is a key learning for future implementation. Secondly, the website and mobile app design, in permitting recording of an increasing array of experiential activities as the weeks progressed (rather than just the activities for the current week), may have augmented dissatisfaction with the logging/recording component, introducing an element that went beyond the intentions of the original intervention design.

6.7.3 Conclusions

Although there are a diversity of factors influencing adherence, highly engaging content encourages adherence and time efficiency is a principal consideration for a non-clinical, community-based cohort. Therefore, intervention designers should place a concerted focus on streamlining interventions to reduce the time investment required from participants and simplify all program elements. Other considerations to increase adherence include allowing participants to create their own experience through choosing what optional features to include or exclude; enhancement of the website and mobile app to facilitate a more intuitive experience; shorter video presentations that are easily accessible and provide high autonomy in the way they are consumed; simplified and limited recording of experiential activities; and options for personal choice in accountability. Future research will be

vital to consider users' views concerning adherence and respond with an adequate level of agility that assures an ever-improving experience for participants to ensure optimal adherence and sustainability.

6.8 Acknowledgements

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6.9 Author's contributions

MR and DM conceptualised the study. MR completed the data analysis in consultation with DM and MN. All authors contributed to the revision and editing of the manuscript.

6.10 Conflicts of interest

DM manages a “profit-for-purpose” Trust that utilizes a version of the intervention without receiving personal remuneration. GP is employed by the South Pacific Division of the Seventh-day Adventist Church (administrator of the intervention). No other authors have any financial interest or conflict of interest to declare.

Chapter Seven: Discussion, Conclusions, Future Directions, and a Review (Publication Four)

7.1 Chapter Overview

The principal aim of this dissertation was to develop a greater understanding of the influence of human support in fostering adherence and improving outcomes in digital mental health promotion interventions (DMHPIs) for general, community-based population groups. Three research questions investigated the aim through the design and implementation of an online, randomised comparative study. Quantitative and qualitative data, gathered at pre-and post-intervention, were analysed to publish a coherent sequence of papers that addressed the research questions. The first publication (Chapter Four) investigated the influence of different modes of human support on the outcome measures of the DMHPI. The second publication (Chapter Five) evaluated the impact of human support on attrition and adherence behaviour during the intervention period. Also, it investigated the effect of participants receiving their preferred mode of human support. The third publication (Chapter Six), a qualitative content analysis, evaluated participants' perceptions regarding the influences on adherence behaviour throughout the intervention. The final publication, a review included at the end of this chapter, contextualised the findings of this study to the ongoing Coronavirus disease 2019 (COVID-19) pandemic and emphasised the potential of DMHPIs to attenuate the deterioration in the mental well-being of the general population.

This concluding chapter summarises and discusses key findings of the dissertation and provides recommendations for future implementation and research. The chapter is in three sections:

- i. Key findings in addressing the research questions.
- ii. Discussion of key findings, future directions, and conclusions.
- iii. Review article publication, "The Influence of Human Support on the Effectiveness of Digital Mental Health Promotion Interventions for the General Population" (Published in *Frontiers in Psychology*, August 2021).

7. 2 Key Findings in Addressing the Research Questions

7.2.1 Research Question One (Publication One, Chapter Four): What is the influence of different modes of human support on the outcomes of a web and mobile app, lifestyle-based mental health intervention for a healthy adult cohort?

The study findings demonstrated that the addition of human support, over and above the built-in, automated email support, did not improve the outcomes—confer greater improvements in mental health and well-being—of a DMHPI implemented amongst a healthy adult cohort. The study compared the influence of three different modes of human support: standard automated emails (S), standard plus personalised SMS messages (S+pSMS), and standard plus videoconference sessions (S+VCS). Domains of mental well-being—mental health, vitality, depression, anxiety, stress, life satisfaction, and flourishing—were measured using an online questionnaire administered immediately before and after the intervention. Statistically significant improvements were observed in every intervention arm, and in every domain measured ($P \leq 0.001$), with a range of moderate to large effect sizes (measured using Cohen d) in each group: anxiety ($d=0.35-0.52$), depression ($d=0.44-0.51$), stress ($d=0.46-0.60$), life satisfaction ($d=0.50-0.64$), flourishing ($d=0.61-0.65$), mental health ($d=0.61-0.72$) and vitality ($d=0.63-0.81$). However, no significant between-group differences were detected, indicating that the addition of SMS or videoconferencing support did not affect outcomes.

The majority of the S+VCS group experienced human support in the same way as the S group, as attendance at videoconference support sessions (VCSSs) was low—36% of the S+VCS group never attended a session, and 18% attended more than seven sessions out of 10. Nevertheless, there were no differences in outcomes detected between the S+pSMS group and either of the other two groups, signifying that personalised SMS support did not improve outcomes in this study. However, stratified analysis within the S+VCS group revealed a significant variation in outcomes associated with attendance at VCSSs. Participants who attended seven or more sessions achieved significantly better outcomes in four of the mental health metrics than those who had participated in less than seven sessions: mental health ($P=0.006$; $d=0.71$), vitality ($P=0.005$; $d=0.73$), depression ($P=0.04$; $d=0.54$), and life satisfaction ($P=0.046$; $d=0.50$). Notwithstanding, while an interesting association

was evident between higher attendance at VCSSs and improved outcomes for that sub-group, an association does not represent causation, and it was not possible to draw any conclusions. The stratified analysis is no longer randomised, which introduces the risk of bias. Furthermore, numerous other factors (e.g., motivation) may have played a role in the improved outcomes for that group.

The findings indicated that the online version of the interdisciplinary *Live More Project* intervention used in this study could be applied successfully in general community settings without the need for extra human support. These findings are similar to two other recent studies conducted in online settings for general community groups demonstrating positive outcomes with little or no benefit from added human support (Alfonsson, Olsson, Linderman, et al., 2016; Morledge et al., 2013). While some meta-analytic reviews have shown that supported interventions tend to achieve larger effect sizes than unsupported (Fischer et al., 2020; Phillips et al., 2019), this was not the case with the comparative study reported in this dissertation. The findings, as mentioned above, have important implications as implementing an online intervention that does not require additional human components is more scalable and cost-effective to implement.

7.2.2 Research Question Two (Publication Two, Chapter Five): What is the influence of different modes of human support on attrition and adherence to a web and mobile app, lifestyle-based mental health intervention for a healthy adult cohort, including the influence of participant preference?

Attrition and adherence behaviour and the impact of receiving a preferred mode of human support was compared between the three intervention groups. The findings demonstrated that allocation to videoconferencing support negatively impacted early dropout attrition but not late attrition. No statistically significant differences in adherence were detected between the intervention groups, indicating that the addition of human support had no impact on adherence behaviour. Furthermore, this study found that participants who received their first preference for human support did not do any better in terms of outcomes or adherence than those who did not receive their preferred support mode.

In this study, being randomised to the highest level of human support (i.e., the S+VCS group) appeared to be perceived as the least desired support mode by participants, and it caused an unforeseen, negative impact on early dropout attrition (i.e., withdrawal before completing the first questionnaire). Within hours of emails being dispatched, notifying participants of their respective group allocations, a disproportionate number of participants allocated to the S+VCS group withdrew from the study or failed to finalise registration. Consequently, early dropout attrition was significantly different between the intervention groups ($P=0.009$). Conversely, there were no between-group differences in late dropout attrition ($P=0.24$)—participants not completing the final questionnaire.

The early dropout attrition rate of 24% and 30% lost to follow-up in this study is not unusual compared to other studies of online interventions. The attrition rate was comparable to a similar RCT conducted in 2017 using the same intervention where early dropout attrition was 15%, and 29% were lost to follow-up (Przybylko et al., 2021). Similarly, in a study by Alfonsson et al. (2016) assessing the efficacy of an internet-based relaxation program, almost 25% dropped out before completing the first week, and 39% had dropped out before the post-analysis. Zarski et al. (2016) conducted a pooled analysis of three RCTs that compared variant human support conditions for a stress-management intervention targeting employees. Early dropout attrition was relatively low (5 – 7%) in all three RCTs, and non-completion ranged from 25-42%.

Different modes of human support had no impact on adherence behaviour in this study. No between-group differences were observed for any adherence measures, which included the mean number of videos viewed ($P=0.42$), the mean challenge points recorded ($P=0.71$), and the mean number of weeks that participants logged points ($P=0.66$). Interestingly, almost half (47%) of the entire cohort were 100% adherent in viewing the videos, with no observed differences between groups. Stratified analyses compared the outcome measures between those who were fully adherent with those who were not. Significantly greater improvements were observed in the fully adherent group in the domains of life satisfaction ($P=0.011$, $d=0.15$) and flourishing ($P=0.012$, $d=0.15$); however, effect sizes were small, and the risk of bias is high in sub-group analysis where the sample is no longer randomised.

The findings of this study concerning adherence are similar to two other studies that have found that adherence behaviour was not affected by differences in human support (Alfonsson, Olsson, & Hursti, 2016; Alfonsson, Olsson, Linderman, et al., 2016). Notably, there is evidence for a diverse range of factors that impact adherence and many interindividual differences that are yet to be elucidated (Ryan et al., 2018; Zarski et al., 2016). Notwithstanding, the third research question of this dissertation sought to illuminate adherence-related influences from participants' perspectives. The topic will be discussed in more detail in Section 7.2.3.

Participants who received their preferred mode of human support did not achieve better adherence or outcomes than those who did not receive their preferred mode. A total of 17.5% of participants who completed the pre-and post-questionnaires were randomised to their preferred mode of human support. However, stratified analysis revealed no differences in video adherence ($P=0.98$) or recorded challenge points ($P=0.27$) compared to participants who did not receive their preferred support mode. Furthermore, no differences in any outcome measures were observed between those who received their preference and those who did not. Interestingly, almost half (45%) of all participants specified a preference for access to *all* human support options when doing an online intervention—a combination of automated emails, SMS messages, and videoconference support. The reasons for such a large contingent of participants indicating a preference for access to all types of human support are unclear. However, it may offer an insight into human nature and the desire to have accessibility to everything, even when all options may not be required.

7.2.3 Research Question Three (Publication Three, Chapter Six): What do healthy adult participants perceive as the facilitators of, and barriers to, adherence to a web and mobile app, lifestyle-based mental health intervention?

The qualitative study elicited user perceptions regarding facilitators of, and barriers to, adherence. The majority (75%, $n=240$) of participants typed a codable response that described perceived facilitators of adherence, and 98% ($n=314$) entered codable responses related to barriers. Notably, human support did not feature as a perceived facilitator of adherence. Instead, the main perceived facilitators of adherence were highly engaging presentations, time availability and judicious time

management, ease of accessibility, easy or interesting experiential activities, and personal motivation augmented by the perception that the intervention would be highly valuable.

Overwhelmingly, the findings of the qualitative analysis showed that the most significant perceived barrier to adherence was lack of time—303 of 660 coded responses included a time-related barrier. Time as a considerable barrier to adherence in digital interventions has been reported by other recent studies delivered in workplace settings (Blankenhagel et al., 2019; Carolan & de Visser, 2018) and in digital psychological interventions for various clinical cohorts (Beatty & Binnion, 2016). Other barriers evident in this study, some of them also time-related, were presentation length, time-consuming system design elements, technical issues, and a wide array of interpersonal factors that generally related to personal well-being (e.g., illness) or capacity (e.g., motivation). Human support was mentioned as a barrier by a few participants. The comments mostly related to the videoconference sessions being at an unsuitable time, dissatisfaction with the lack of prompts, a desire for more accountability measures, and expression of preference for the face-to-face delivery mode. Notably, human support is not likely to assist in overcoming the main barriers mentioned or further enhance the perceived facilitators of adherence. Rather, the findings of this study signified that intervention design that comprehensively focuses on time efficiency might be a critical topic for future attention.

7.3 Discussion of Key Findings

The findings of this dissertation add fresh insights to the identified knowledge gap regarding the influence of human support in DMHPIs for the general population. Several main findings may assist in designing future digital interventions for general population groups.

7.3.1 Finding One: *The addition of human support does not influence outcomes*

The findings of this study indicate that DMHPIs that include automated emails provide adequate support to a general population cohort, and additional human support may not further improve outcomes.

The findings, including statistical significance and effect sizes, confirmed the conclusions from an earlier, comparable RCT that used the same online intervention without added human support (Przybylko et al., 2021a). In the RCT, the intervention group experienced significant improvement in all outcomes measured compared to the control group. Within-group improvements were statistically significant ($P < 0.001$), and moderate effect sizes ($d = 0.39$ – 0.54) were recorded for mental health, vitality, depression, anxiety, stress, and life satisfaction. Additionally, a combined analysis using data from the present study and data from the previously mentioned RCT demonstrated that flourishing improved significantly in automated support-only conditions. The provision of additional human support added no increased benefit (Przybylko et al., 2021b).

Similarly, other studies also indicated comparable findings. Mira et al. (2017) compared a waitlist control group to two intervention conditions—automated human support only and automated support plus a weekly supportive phone call. Both intervention groups improved significantly, and adherence was equivalent between groups—a similar result to this present study in which no differences in adherence were detected between conditions. Like the current intervention, other studies have noted that the addition of various human support components has not resulted in significant improvements to outcomes (Alfonsson, Olsson, Linderman, et al., 2016; Morledge et al., 2013).

7.3.2 Finding Two: Human support is not a critical moderating influence on adherence

This study—both quantitatively and qualitatively—found that human support was not a critical moderating influence on adherence to a DMHPI for a general population cohort. The primary objective of the addition of human support is generally to encourage maximum adherence to optimise outcomes (Ebert, Lehr, et al., 2016b; Ebert et al., 2018; Ryan et al., 2018; Zarski et al., 2016); however, the provision of additional human support did not impact adherence in this study. Early research among clinical cohorts demonstrated the positive influence of human support on adherence in online interventions (Andrews et al., 2010; Baumeister et al., 2014; Richards & Richardson, 2012; Richardson et al., 2010). However, a scoping review focused on human support elements reported mixed findings regarding the effect of support on adherence (Shim et al., 2017).

Several researchers (Ryan et al., 2018; Zarski et al., 2016) have highlighted the extensive array of factors that impact adherence. Ryan et al. (2018) classified factors into the broad areas of technological, environmental, and individual, stating that an interdisciplinary approach is required to elucidate the diversity of influences on adherence. Zarski et al. (2016), while finding that human support did improve adherence in a pooled analysis of three RCTs for employees involved in a stress management intervention, also noted that many other elusive factors impacted adherence. It is plausible that in this study of a non-clinical cohort, an extensive range of variables impacted adherence at the individual level, reducing any potential impact of human support as a single moderating factor. The qualitative study in this dissertation explored participant perceptions about facilitators of and barriers to adherence and exposed various influences discussed in Finding Four.

7.3.3 Finding Three: Receiving preferred human support mode had no effect

Participants who experienced their first preference in human support mode did not attain greater adherence or outcomes in this study. The author is unaware of other research specifically examining the influence of receiving human support preferences on adherence or outcomes in a general population group. Nevertheless,

the above finding does not negate the possibility that maximising participant choice may have other positive repercussions.

Other studies, mostly in clinical groups, have evaluated the effect of participants receiving preferences. For example, in an uncontrolled preferential trial for patients with anxiety and depression who were allowed to choose their preferred level of support, 78% chose the maximum support option—weekly contact with a therapist. The remaining 22% chose minimum support—by request only (Hadjistavropoulos et al., 2019). Both groups achieved comparable outcomes, and there was no difference in adherence. However, the time investment needed by the support personnel to assist those who chose the minimum support was much less, translating to cost savings. Furthermore, those with milder symptoms tended to select the less intensive support option, intimating that users, given a choice, may choose the support most suitable for their circumstances.

Providing the opportunity for participants to choose specific preferences may impact their perceptions about the usefulness of interventions (Williams et al., 2016), which can result in improved adherence in some cases (Dunlop et al., 2017; Lindhiem et al., 2014). Notwithstanding, improved adherence does not always translate to improved outcomes (Dunlop et al., 2017). Notably, a meta-analysis of clinical studies showed improved adherence, outcomes, and treatment satisfaction for those who received their preferred treatment options (Lindhiem et al., 2014). While treatment options are not necessarily related to human support, maximising autonomy, choice, and engagement with users in decision-making is an important concept to consider. Indeed, there is a growing imperative for intervention designers to collaborate more closely with users about an array of preferences (Phillips et al., 2021), a practice that requires further research as it may reduce hesitation, increase motivation, and possibly optimise adherence and outcomes.

An unexpected finding of this study was that almost half of all participants indicated that their preference for human support would include all the options possible—automated emails, SMSs, and videoconferencing). The *all support* option was not offered in the study, and the reasons for participants desiring access to the full range of support options is unclear. Perhaps it is simply human nature to desire access to all alternatives, regardless of whether they will be used or required. Perhaps

providing users with more choice regarding a range of intervention components, particularly discretionary features such as human support options, will serve a similar purpose in ensuring that participants perceive that they have access to a broad repertoire of possibilities. Provision of choices may optimise a sense of autonomy—a key pillar of Self-determination Theory—and boost intrinsic motivation to adhere. Maximising autonomy through the provision of more user choice is worthy of further exploration.

7.3.4 Finding Four: The influences on adherence are multifactorial and complex

The qualitative analysis in this study demonstrated an extensive and eclectic array of perceived factors impacting adherence and exposed the presence of dual themes, which is a phenomenon seen previously (Banerjee et al., 2017). Dual themes emerged—participants identified some factors as *both* facilitators and barriers. For instance, users reported highly engaging videos as crucial facilitators of adherence; yet, numerous participants found the videos too long, disliked the presentation style, and said they were a barrier to adhering to the intervention. Notably, dual themes highlight the diversity of interindividual differences that confound attempts to extrapolate the factors influencing adherence.

Other studies, both quantitative and qualitative, have identified a range of factors influencing adherence. Alfonsson et al. identified barriers to adherence that included low perceived treatment credibility, sub-optimal intrinsic motivation, baseline stress indicators, and a focus on instant behaviour consequences instead of long-term goals (2016). Mak et al. stated that those who did not adhere tended to exhibit lower expectations about the program's benefits and scored lower on mental well-being measures than those who did complete the intervention (2017). Beatty and Binnion documented in a systematic review that age, baseline symptoms, and group allocation demonstrated mixed findings as adherence predictors. However, being female, having sufficient time, personalised content, and higher treatment expectancy positively impacted adherence (2016). Adherence has also been correlated positively with high intrinsic motivation, education level, and perceived intervention credibility (Alfonsson, Olsson, & Hursti, 2016; Alfonsson, Olsson, Linderman, et al., 2016). The studies mentioned above, the presence of dual themes, and the wide range of perceived influences on adherence listed in the qualitative

analysis of this study highlight a previously acknowledged issue—there is vast variability in interindividual differences that influence adherence to DMHPIs (Ryan et al., 2018; Zarski et al., 2016).

While the focus of this dissertation has been on human support and its moderating effect on adherence and outcomes, the qualitative analysis demonstrated that participants did not perceive human support as a strong influence, either positively or negatively. Considering that neither adherence nor outcomes were significantly affected by human support in this study and that substantial improvements in outcomes occurred in all groups, the lack of narrative in participant responses regarding human support is unsurprising. Mixed findings (Alfonsson, Olsson, Linderman, et al., 2016; Shim et al., 2017) and growing evidence demonstrate that it is possible to implement judiciously-designed interventions without added human support. Evidence is apparent in clinical settings (Dear et al., 2015; Dear, Fogliati, et al., 2018; Dear, Gandy, et al., 2018; Eimontas et al., 2018; Titov et al., 2015; Titov et al., 2016; Zagorscak et al., 2018) and is emerging in non-clinical settings (Allexandre et al., 2016; Carolan et al., 2017; Morledge et al., 2013). Automated forms of human support may be sufficient.

In summary, the broad-ranging individual differences in perceptions about adherence make it extremely difficult to generalise and provide a simple solution regarding adherence behaviour. Perhaps future research should embrace individual diversity by exploring ways to maximise the opportunity for participants to self-tailor an intervention to meet their personal needs and circumstances.

7.3.5 Finding Five: Time availability is a critical adherence influencer

Time appears to be a critical influencer in this study, and heterogeneity in perceived time availability may have greatly underpinned participant perceptions about facilitators of and barriers to adherence. For instance, early dropout attrition in the S+VCS group may be attributable to participants perceiving that they could not spare the extra time required for videoconferencing. Yet, those who invested time in the videoconference sessions achieved better outcomes, signifying a possible benefit from deeper engagement when time allowed. Notably, low attendance by the S+VCS group may also indicate a perceived time lack rather than a dislike for

videoconferencing support per se. Therefore, interindividual differences in perceptions about time give credence to the idea of providing choice so participants can engage in a way that fits with their perceived time availability. Providing access to various forms of support (as desired by almost half of the participants) allows participants to consider their alternatives according to perceived time availability and other interindividual variables.

About one-fifth of participants reported time as a vital facilitator of adherence. Life circumstances such as being retired or living alone and efficient time management through multitasking and time-scheduling resulted in the successful incorporation of the intervention into daily life. However, the qualitative analysis revealed that adhering to a DMHPI was difficult for most participants, and lack of time was a pervasive factor.

Similarly, other qualitative analyses amongst non-clinical cohorts in workplace settings have referenced time scarcity as the primary inhibitor to adherence (Beatty & Binnion, 2016; Blankenhagel et al., 2019; Carolan & de Visser, 2018). Users suggested that small daily time requirements of 5 to 15 minutes each day would be optimum for healthy, working individuals (Blankenhagel et al., 2019). While this study was not administered in a workplace setting—a setting that has additional unique pressures affecting adherence to an intervention (Carolan & de Visser, 2018; Stratton et al., 2017)—the cohorts are similar in that they are generally healthy adults who are often juggling family, work, study, and other commitments, where time is always scarce.

Numerous barriers to adherence mentioned in this study had a common problematic factor, in that they consumed inordinate amounts of time. Such time-waster examples include difficulty navigating the website, time spent dealing with technical issues, perceptions about how time-consuming it was to log/record challenge activities, the length of the videos and the difficulties experienced transitioning from one video to another. Similarly, participants in a mindfulness intervention viewed the length of experiential activities as a barrier to adherence intervention (Banerjee et al., 2017). Lack of time is also a common purported barrier in educational settings (Markova et al., 2017; Muilenburg & Berge, 2005). This study has highlighted that time scarcity is critical for a general population cohort, and

optimising time efficiency must underpin all elements of intervention planning and design.

7.4 Future Directions

The findings presented in this dissertation indicate that although the addition of human support is desired by a non-clinical, general community cohort when participating in a DMHPI, it is not a critical moderating factor on either adherence or outcomes. In brief, inbuilt, automated support appears to be sufficient. Future research might include evaluating a range of automated, in-built support conditions. Specifically, it would be judicious to compare generic forms of automated support—identical automated support for all participants—with conditions where participants choose from a range of automated support options according to personal needs or desires.

Provision for participants to choose specific support elements may be considered a constructivist approach—a method used successfully in education settings (Schrader, 2015; Swan et al., 2009). The constructivist approach provides greater scope for participants to be active agents in their own learning experiences, therefore fostering autonomy and intrinsic motivation. Participants in a DMHPI might customise their intervention experience by choosing to activate or deactivate a range of optional features (e.g., gamification settings, automated support options). They might also self-tailor human support features from various automated options and nominate the frequency, method, timing, and intensity of the support desired. Autonomy—along with relatedness (i.e., connection) and competence—is identified in SDT as one of humans' three core basic needs. When fostered well, autonomy creates the supportive conditions for optimising intrinsic motivation (Ryan & Deci, 2000). Importantly, greater intrinsic motivation has been linked to improved adherence (Alfonsson, Olsson, & Hursti, 2016; Mohr et al., 2011; Yardley et al., 2016).

This study illuminated the many variables impacting adherence in DMHPIs and highlighted that time availability is a critical influence on adherence for a general population group. Therefore, future research should also focus on judicious development and testing of time-efficient DMHPIs. Optimising time efficiency for

the user may include simple, intuitive web and app design, concise and engaging content delivery, and straightforward, streamlined methods to log/record activities. Future research should determine optimal time parameters that include the ideal length of intervention, how many lessons/sessions are required to achieve optimal outcomes and the minimal amount of time needed for participants to engage in specific experiential activities to gain a positive benefit.

7.5 Conclusions

The literature review contained in this dissertation exposed a significant research gap. Very few studies had examined the influence of human support on adherence and outcomes of a DMHPI when engaged by a general population group. The findings reported in this dissertation answered three research questions and added novel insights to the identified research gap. Firstly, the findings demonstrated that human support to a DMHPI was unnecessary to improve adherence or outcomes. Automated or built-in forms of human support were equally as effective as more labour-intensive forms. Secondly, although many participants desired human support, receiving their preferred human support mode made no difference to adherence level or outcomes achieved. Thirdly, this dissertation confirmed the emerging body of evidence that a broad-ranging interplay of diverse variables impacts adherence behaviour. While human support may be one of the many influences on adherence, general population participants do not perceive it as a critical moderating factor. Instead, time availability was perceived as the chief influence when participating in a DMHPI.

Future studies should evaluate the efficacy of well-designed, time-efficient, self-guided DMHPIs that include a range of automated support options. It is feasible that enhancing participants' autonomy through choice to individualise or self-tailor their own intervention experience may foster greater intrinsic motivation, which is well recognised to increase adherence. The possible transition to a constructivist, self-tailoring approach signifies many advantages. It enables greater participant autonomy, inspires intrinsic motivation, maximises scalability, optimises cost-effectiveness, and frees up scarce human resources for those with clinical significance needs. By far, the greatest rationale for such an intervention is the potentially significant enhancements in the mental well-being of members of the

population who, while not diagnosed as unwell, are struggling under enormous stress and anxiety. Efficacious DMHPIs are a promising antidote to quell the burgeoning escalation of mental health distress. The need for only automated forms of human support in such interventions indicates a tantalising opportunity with almost unlimited scalability.

7.6 Publication Four - Overview

The following section is a review titled ‘The Influence of Human Support on the Effectiveness of Digital Mental Health Promotion Interventions for the General Population’. The manuscript was published in *Frontiers in Health Psychology* (Impact Factor 2.99, Q2 ranking) in August 2021. The publication reviews the overall outcomes of this dissertation and synthesises the results with other relevant literature regarding the influence of human support on adherence and outcomes to DMHPIs in general population settings. The review was contextualised to the Coronavirus disease 2019 (COVID-19) pandemic and recognised the drastic escalation in mental health distress amongst the general population due to the pandemic. The review evaluated the effectiveness of human support to influence adherence and outcomes for general population groups in both workplace and community settings. Overall, mixed findings and limited evidence, including the conclusions of this dissertation, indicated that human support had limited influence. DMHPIs may be implemented in the community to mitigate against the COVID-19 induced escalation in mental distress without additional human support. Program designers might optimise motivation and adherence by providing autonomy for participants to self-select a range of automated options, including support.

7.7 Contribution of Authentication Statement

I attest that Higher Degree Research candidate Melanie Renfrew contributed to the paper/publication entitled:

The Influence of Human Support on the Effectiveness of Digital Mental Health Promotion Interventions for the General Population.

By:

- Leading the conception and design of the study
- Interpretation of the data
- Leading the writing of the manuscript
- Submitted the manuscript for review
- Addressed reviewers' comments

Signature of Candidate:



Name of Candidate: Melanie Renfrew

Date: 30 September, 2021

Signature of Principal Supervisor:



Name of Principal Supervisor: Associate Professor Darren Morton

Date: 30 September, 2021

7.8 Publication Four: The Influence of Human Support on the Effectiveness of Digital Mental Health Promotion Interventions for the General Population

7.8.1 Abstract

Mental well-being amongst the general population is languishing—exacerbated by the Coronavirus Disease 2019 (COVID-19) pandemic. Digital mental health promotion interventions that improve mental health literacy and encourage the adoption of evidence-informed practical strategies are essential. However, attrition and non-adherence are problematic in digital interventions. Human support is often applied as an antidote; yet, there is a paucity of randomised trials that compare different human support conditions amongst general population cohorts. Limited trials generally indicate that human support has little influence on adherence or outcomes in DMHPs. However, providing participants autonomy to self-select automated support options may enhance motivation and adherence.

7.8.2 Introduction

As the world deals with the Coronavirus Disease 2019 (COVID-19) pandemic, a parallel crisis in mental well-being is emerging. Prior to the pandemic, depression was a leading cause of global disability (WHO, 2019) and, in high-income countries, depression and anxiety were the third and fourth highest reasons, respectively, for visiting a primary care physician (Finley et al., 2018). Furthermore, treatment coverage for mental health disorders was already extremely low, particularly in low-income nations (WHO, 2019). Alarmingly, extensive deterioration in mental well-being has been detected globally since the pandemic began (Ammar et al., 2020; Pera, 2020) across all sectors (e.g., general public, health workers and those with pre-existing psychological conditions) (Vindegaard & Benros, 2020), with one study reporting that mental distress had doubled since the pandemic (Fisher et al., 2020).

The ensuing mental health crisis requires urgent, evidence-based and interdisciplinary action (Campion et al., 2020; Holmes et al., 2020), and the use of digital technologies such as computers, tablets and smartphones offers opportunities for the delivery of digital (i.e., Web- and app-based) interventions that are highly portable, accessible and scalable. With primary care services urgently required to assist patients in clinical settings, evidence-informed digital mental health promotion interventions (DMHPIs) provide a pathway to enhance the mental health of the general population (Campion et al., 2020; Holmes et al., 2020; Marshall et al., 2020; Przybylko et al., 2021a; Renfrew et al., 2020a).

DMHPIs may improve the mental/emotional well-being of general population groups through a range of diverse approaches that enhance resilience and relieve stress, anxiety, and depressive symptoms. Suitable interventions may incorporate strategies from the fields of psychology (e.g., cognitive behaviour therapy) (Cuijpers et al., 2019; Karyotaki et al., 2021; Lau et al., 2017), positive psychology (e.g., practising gratitude, writing positive experiences, kindness) (Bolier et al., 2013; Dickens, 2017; Drozd et al., 2014; Galante et al., 2014; Hendriks et al., 2020; Koydemir et al., 2020), lifestyle medicine (e.g., physical activity, nutrition, access to green space) (Cohen-Cline et al., 2015; Conner et al., 2015; Cooney et al., 2014; Dale et al., 2014; Jacka et al., 2017a; Penedo & Dahn, 2005; Quirk et al., 2013;

Sarris et al., 2015; Sarris et al., 2014) and various other practices which cross over several of the abovementioned fields (e.g., mindfulness, meditation) (Galante et al., 2021; Spijkerman et al., 2016).

Despite the advantages of digital delivery, high attrition (i.e., dropout) and low adherence (i.e., participants not engaging with the intervention as intended by designers) often compromise the outcomes of digitally-delivered interventions (Couper et al., 2010; Kelders et al., 2012; Kohl et al., 2013; Linardon & Fuller-Tyszkiewicz, 2020; Mohr et al., 2011; Mohr, Duffecy, et al., 2013; Richards & Richardson, 2012; Short et al., 2014; Spijkerman et al., 2016). While there are numerous theoretical perspectives on factors that improve attrition and adherence (Ryan et al., 2018), a commonly purported facilitator is human support, often referred to as *guidance* (Alkhaldi et al., 2016; Baumeister et al., 2014; Ebert et al., 2018; Linardon & Fuller-Tyszkiewicz, 2020; Mohr et al., 2011; Ryan et al., 2018). It is important to evaluate the evidence regarding human support as a modifying factor in attrition and adherence to DMPHIs, as the addition of human support has cost implications (Drozd et al., 2014; Michie et al., 2017; Mohr, Burns, et al., 2013; Morledge et al., 2013), limits scalability, and requires the time of scarce human personnel (Mohr, Burns, et al., 2013). On the other hand, human support may improve adherence through prompting participants to engage, fostering participant accountability, strengthening motivation, and therefore optimising outcomes (Mohr et al., 2011; Schueller et al., 2016).

This mini-review evaluated the effectiveness of adding human support to DMHPs for employees and general community groups. A search (using PubMed, reviews and other sources) revealed a paucity of randomised trials that directly compared supported with unsupported conditions for non-clinical groups in work and community settings. Hence, the search was widened to include suitable meta-analytic reviews to evaluate trends between guided and unguided conditions in the workplace and the general community. This review also appraised the findings from recent studies conducted by the authors that compared different human support conditions amongst a general community cohort.

7.8.3 Human support

While early studies among clinical cohorts suggested that adding human support to digital interventions improved outcomes (Baumeister et al., 2014; Richards & Richardson, 2012), more recent studies have demonstrated mixed results (Shim et al., 2017). For example, in several clinical studies (e.g., for patients with generalised anxiety disorder and social anxiety disorder) no differences have been observed in the outcomes of self-guided versus supported digital interventions (Dear, Fogliati, et al., 2018; Dear, Gandy, et al., 2018; Eimontas et al., 2018; Ivanova et al., 2016; Mira et al., 2017; Titov et al., 2015; Titov et al., 2016; Zagorscak et al., 2018). Moreover, it is feasible that the requirement for added human support elements in DMHPs for healthy non-clinical population groups may be different to unwell clinical population cohorts where symptoms of disease or disorder (e.g., general malaise, compromised motivation) may impede adherence (Deady et al., 2017; Karekla et al., 2019; Karyotaki et al., 2021; Mohr, Duffecy, et al., 2013).

7.8.3.1 Workplace settings

Meta-analytical reviews

Systematic reviews and meta-analyses regarding the effectiveness of workplace DMHPs, present mixed evidence regarding the influence of the addition of human support (Phillips et al., 2019; Stratton et al., 2017). For example, in a systematic review and meta-analysis, by Phillips et al. (2019), guided interventions consistently demonstrated higher effect sizes than unguided in all the areas of measurement: stress (Hedges $g=0.76$ for guided and $g=0.27$ for unguided), depression ($g=0.48$ and $g=0.23$), anxiety ($g=0.48$ and $g=0.26$), burnout ($g=0.69$ and $g=0.33$), insomnia ($g=1.00$ and $g=0.53$), mindfulness ($g=0.57$ and $g=0.36$) and well-being (no guided studies, unguided $g=0.35$). However, the authors recommended caution, as heterogeneity was high in the pooled analysis of 22 RCTs and subgroup analyses were underpowered. Conversely, Stratton et al. (2017) demonstrated that supported conditions ($g=0.27$) were similar in effects to unsupported ($g=0.22$). However, different types of approaches revealed heterogeneous effects concerning human support. Cognitive behaviour therapy demonstrated low effects in both conditions. Stress management showed small effects for supported conditions but negative effects in unsupported conditions. Mindfulness, which was only

administered in unsupported conditions, demonstrated moderate effects (Hedges $g=0.59$).

Carolan et al. (2017) conducted a systematic review of 21 digital psychological interventions for employees and reported similar outcomes for both supported and unsupported interventions (guided $g=0.39$, self-guided $g=0.34$). Notably, in further examination of seven studies that reported the highest adherence and lowest attrition, human support was only one of four common elements: human support (used in 5/7 studies); use of persuasive system design principles (all studies); 6- or 7-week program length (a mean of 6.6-week length compared to a mean of 8.1 weeks in the other 14 studies); and, the use of ‘secondary modalities’ (e.g., emails, text messaging) in intervention delivery (6/7 studies).

Randomised trials

Two randomised trials compared human support conditions in workplace settings. Allexandre et al. (2016) compared three support conditions (i.e., no support, group support and group support plus therapist support) in a workplace digital mindfulness and stress management intervention. The addition of therapist support added no benefit, but general group support improved both outcomes and adherence compared to those who received no support. Albeit, overall, adherence was low—50% of participants never logged on to the intervention. Additionally, the intervention was digitally-delivered, but support was provided face-to-face.

A pooled analysis of three RCTs (Zarski et al., 2016) compared human support in a digital stress management workplace intervention. Researchers identified that ‘content’ support (i.e., personalised written feedback for tasks completed) and ‘adherence’ support (i.e., monitoring module completion and sending reminders) did improve adherence behaviour in comparison to only ‘administrative’ support (i.e., provision of contact details for technical support). Although there were no significant differences in adherence between the ‘content’ and ‘adherence’ focused support, the time investment required by support personnel for the adherence-focused support was considerably lower, which highlights substantial cost implications dependent on different support variables (e.g., mode, intensity, and frequency).

7.8.3.2 Community-based settings

Meta-analytical reviews

Meta-analytical reviews of studies in community settings generally demonstrated improved effects in supported conditions; although, authors of one meta-analytical review (Deady et al., 2017) refrained from evaluating differences between supported and unsupported conditions due to high heterogeneity. In a meta-analysis (Koydemir et al., 2020), which included 68 RCTs of positive psychology interventions for community cohorts, some delivered digitally and some delivered face-to-face, significant differences were found between self-guided interventions and those facilitated face-to-face. The effect size for the face-to-face condition ($d=0.32$) was almost twice the self-guided condition ($d=0.17$), although effect sizes were in the lower range for both conditions. A meta-analysis by Heber et al. (2017) evaluated the efficacy of web- and computer-based studies for stress management amongst generally healthy adults. Sub-group analysis showed that supported and unsupported conditions demonstrated positive effects, although supported conditions (Cohen $d=0.64$) were almost double the effect size of unsupported ($d=0.33$).

Randomised trials

While access to human support is often desired by non-clinical DMHPI users (Carolan & de Visser, 2018; Renfrew et al., 2020a), its effectiveness in improving adherence or outcomes is less convincing, based on three randomised studies that compared human support variables and targeted general community cohorts. In a three-pronged RCT (Morledge et al., 2013), participants from the general population were recruited to assess the effectiveness of a digital mindfulness intervention. Participants in one intervention group completed the activities with no added human support, while those in a second intervention group were encouraged to interact through an online message board that was hosted by a facilitator. Both groups demonstrated significant improvements compared to the control group; yet, no significant differences in measurement outcomes were observed between the two intervention groups. Notably, 85% of those in the message board group reported that the message board was of little or no value (Morledge et al., 2013). Mira et al. (2017), in an RCT designed to assist participants in coping with difficulties and depressive symptoms, compared an automated human support condition with the

same condition plus weekly phone calls. Both groups improved significantly compared to control, and no differences in attrition, adherence or outcomes were observed. Furthermore, participant satisfaction was high in both intervention groups.

In a digital relaxation training intervention (Alfonsson, Olsson, & Hursti, 2016), self-selected participants from the general population were randomised to either 'normal' treatment (i.e., black/white text files, weekly support from a trained therapist) or 'enhanced' treatment (i.e., colour text, video format, daily therapist support). Participants in both treatments improved significantly, irrespective of differing levels of support. The participant relationship with the support therapist did not predict adherence; rather, attrition and nonadherence were predicted by low intrinsic motivation, low perceived treatment credibility, baseline stress symptoms and the focus on immediate behaviour consequences rather than long term goals. Conversely, adherence was positively correlated with intrinsic motivation, education level and treatment credibility, including belief in the effectiveness of the online format.

Recent research by the authors

We have previously reported the results of a 10-week DMHPI that was implemented in a general population setting. The interdisciplinary intervention that integrated strategies from the fields of positive psychology and lifestyle medicine compared the influence of three different modes of human support on outcomes (Renfrew et al., 2020a) and adherence (Renfrew et al., 2020b). Participants were randomised into groups that received differing levels of human support: automated email support only, automated email support with added personalised text messaging, and automated email support plus a weekly, facilitated, group videoconference session. Significant pre- to post-intervention improvements in outcomes were recorded in every group irrespective of the human support condition. Similarly, adherence (i.e., viewing weekly video content and completing daily and weekly experiential activities) was not significantly different between the groups. Further, no differences in either adherence or improvements in well-being metrics were observed between those participants who were randomised to their first preference for human support and those who were not (Renfrew et al., 2020b). Nonetheless, despite the apparent lack of effect of human support, 45% of the entire

study cohort indicated they would prefer to have *all* forms of human support available to them. The reasons for this are unclear, and it may be that participants like the autonomy to choose from a broad range of choices, even when they have no interest in accessing all options.

We reported low attendance at videoconference support sessions, with 36% of the participants allocated to this group never attending a session and only 18% attending seven or more of the ten sessions (Renfrew et al., 2020a). Consequently, the human support experience for many participants in this group was effectually the same as for those in the automated emails only group. Nevertheless, the secondary analysis revealed that participants who attended seven or more videoconference sessions did experience significantly greater improvements in overall mental health, vitality, depression, and life satisfaction compared to those who attended less than seven sessions. However, numerous variables (e.g., motivation level) may have contributed to this difference.

We also examined the influence of a DMHPI on the experience of ‘flourishing’ (Przybylko et al., 2021b), which is a construct used to express a high level of human functioning. We found that the inclusion of text messaging support, or weekly videoconferencing support, had no additional benefit in the enhancement of flourishing. Notably, in our research, we have observed the highest attrition rates among participants who were randomised to a treatment group that involved the greatest level of human support. Participants in the aforementioned human support comparative study had agreed to take part regardless of which arm of the study they were allocated to; however, 32% of those assigned to the videoconferencing group—the highest level of human support offered—withdraw upon receiving notification of their allocation (Renfrew et al., 2020b). The dropout attrition was significantly greater ($P=0.009$) than attrition in the other two arms of the study that involved mostly automated support. Furthermore, videoconferencing alone was the least desired form of support by participants—just 7% indicated it as their preferred support method. Interestingly, 22% of participants preferred email support, 26% preferred emails plus text messaging, and the remaining 45% desired access to all support forms.

To gain further insight into participant perspectives, we conducted a qualitative study (Renfrew et al., 2021) using inductive thematic analysis to examine user perceptions regarding facilitators and barriers to adherence. The provision of human support did not feature as a perceived facilitator of adherence. Rather, perceived facilitators were engaging presentations, time availability, ease of accessibility, easy or interesting experiential activities, and personal motivation augmented by the perception that the intervention would be highly valuable. Overwhelmingly, the largest perceived barrier to adherence was lack of time, which is similar to that reported by other recent studies in workplace settings (Blankenhagel et al., 2019; Carolan & de Visser, 2018). Other barriers, some of them also time-related, were presentation length, time-consuming system design elements, technical issues and a wide array of interpersonal factors that generally related to well-being (e.g., illness) or capacity (e.g., motivation). Notably, the addition of human support is not likely to assist in overcoming the abovementioned barriers or further enhance the perceived facilitators of adherence.

The emerging but limited body of evidence indicates that human support is not the panacea for attrition, adherence, and outcomes in DMHPIs for a general community cohort; rather, the influences on adherence are multifactorial and complex. In a scoping review, Ryan et al. (2018) concluded that adherence to digital interventions is impacted by a range of technological, environmental, and individual influences that require interdisciplinary cooperation (Ryan et al., 2018). Zarski et al. (2016) likewise concluded that many interindividual differences related to adherence remain unknown.

7.8.4 Discussion

The evidence in this mini review indicates that DMHPIs may be implemented among work-based and general community cohorts without the need for added human support. While the meta-analytical reviews generally demonstrated that human support improved adherence and augmented positive effects, the few randomised trials indicated that self-guided conditions were comparable, in adherence and outcomes, to conditions that included human support. Notwithstanding, the indication that general population cohorts often desire access to

human support signifies that it is a desirable element that should be considered as an automated component in intervention design.

One possible option to incorporate automated human support is a flexible, elective approach in which intervention creators provide participants with substantial autonomy to customise support along with other discretionary features (e.g., gamification). For instance, self-tailoring or personalising an intervention might include choosing human support options from a range of automated modes (e.g., text message reminders, email notifications) and choosing the intensity and frequency of support based on individual preference.

Identified in Self-determination Theory as one of three core basic needs for humans—*autonomy*, along with *relatedness* (i.e., connection) and *competence*—when fostered well, create the supportive conditions for intrinsic motivation to be optimised (Ryan & Deci, 2000), and greater intrinsic motivation has been linked to improved adherence (Alfonsson, Olsson, & Hursti, 2016; Mohr et al., 2011). Importantly, the autonomy to choose from different automated support options, along with providing choice in other discretionary features, may assist in stimulating intrinsic motivation to adhere to a program (Yardley et al., 2016), resulting in improved outcomes.

Finally, evidence that adding human support improves attrition, adherence, and outcomes of DMHPIs for general population groups is limited and mixed. Furthermore, it is evident that well designed, self-guided interventions can be effective in enhancing mental well-being. Nevertheless, human support is generally desired by intervention participants. Providing autonomy for participants to individualise or self-tailor an intervention by selecting personal preferences for automated support and other discretionary features might enhance participant experience and also bolster intrinsic motivation to adhere to a program—an area for further research. Carefully designed DMHPIs that include automated forms of human support should be urgently implemented in community settings to alleviate the COVID-19 pandemic-related decline in mental well-being.

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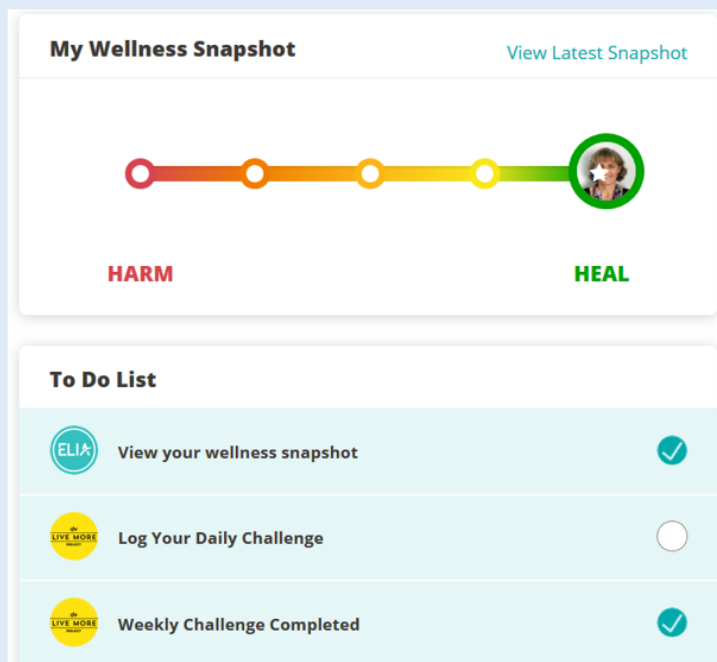
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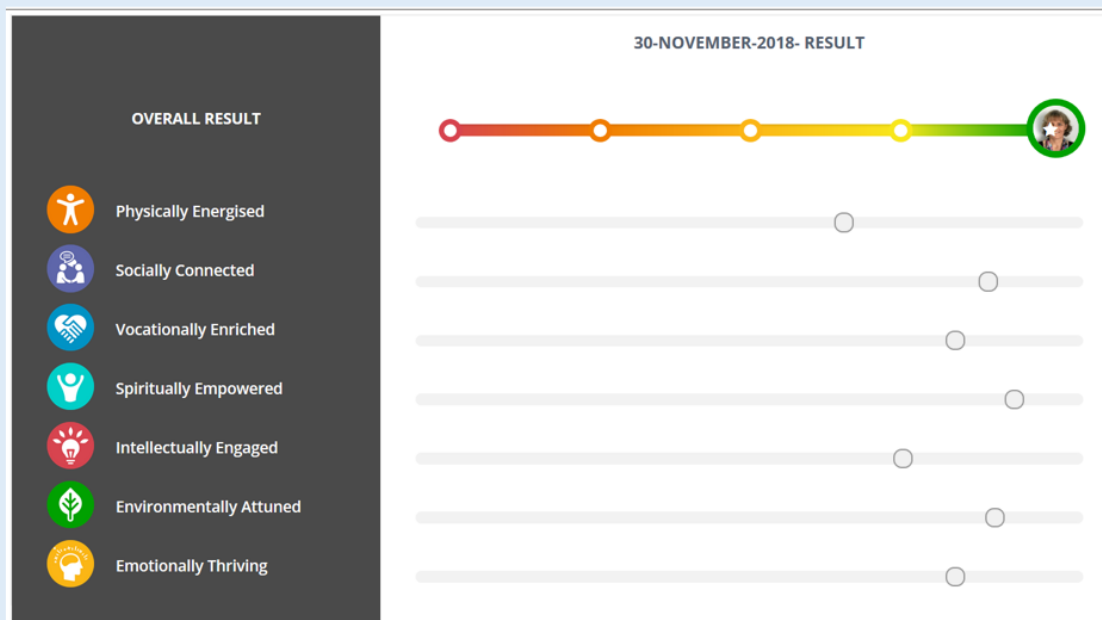
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Appendices

Appendix 1: Web and Mobile App Images of the LMP Intervention (as at 2018)



To Do List: An online “To Do” list (available on each personal dashboard) provided easily accessible links to complete the various components. Note: the “wellness snapshot” refers to the questionnaire administered at baseline and after completion of the program.



Overview of Wellness Snapshot Results: The “Wellness Snapshot” (i.e. questionnaire) provided a visual overview of where an individual was located on a continuum in seven different dimensions. A pie-chart view and percentage score out of 100 was also available.

1. Your Limbo Is Listening ✓
2. Motion Creates Emotion ✓
3. Blue & Green Should Often Be Seen ✓
4. Together Feels Better ✓
5. Feelings Follow Your Focus ✓
6. Food Feeds Your Mood ✓
7. Rest To Feel Your Best ✓
8. Stress Less ✓
9. Giving Is Living ✓
10. What Does It Take To Flourish? ✓



Food Feeds Your Mood

Learn how one of the most intriguing areas of medical research shows how certain types of foods that can keep the blues away.

- ▶ Introduction ✓
- ▶ Food Feeds Your Mood ✓
- ▶ Wrap ✓
- ▶ Masterchef Me Extra ✓

Sample View of Lesson 6 Content: Each lesson was divided into 3-4 short video presentations. Each new video segment was unlocked, on completion of the previous video. Segments were ticked off automatically as they were viewed.

F S S M T W T

19 20 21 22 23 24 25

Monday, 22 October 2018

DAILY CHALLENGES		WEEKLY CHALLENGES	
💡 Dispenser of Compliments	💡 Step It Up	💡 Etch Inspiration	💡 Lift It
💡 Uplifting Physical Environment	💡 Loving Act	💡 Enjoy a Sunrise	💡 Forgive
💡 What Went Well	💡 8 Fists Full of Fibre	💡 Gratitude Visit	💡 Masterchef Me

CLICK ON A CHALLENGE TO MARK IT COMPLETE.
 CLICK X TO UNMARK CHALLENGE.
 ? FOR MORE INFORMATION

View of challenge icons for lessons 1-6: After each lesson, participants are provided with daily and weekly challenges. For example, for Lesson 6, participants were challenged to eat 8 fists full of fibre daily, and were asked to make 1 high-fibre plant based meal for the weekly challenge - "Masterchef Me".

8 Fists Full of Fibre

Consume eight or more serves of high fibre whole foods the size of your fist. Now the best source of fibre are fruits, vegetables, beans and grains. Wholegrain bread counts, but not white bread.

10 POINTS

My Experience

1000 Characters left.

Add Photo

MARK AS COMPLETE

Masterchef Me

Prepare and share a high fibre plant based meal.

30 POINTS

I made a Lentil and Mushroom Stew and shared with my family

941 Characters left.

Update Photo

MARK AS COMPLETE

View of Lesson 6 Challenge Log Pages: When participants clicked on the challenge icon (previous screen) it opened up a screen to log daily challenges (possibility of 10 points scored daily) and weekly challenges (30 points scored per week). Name and photo ID has been obscured for privacy reasons

Leaderboard

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Statistics

Entire Program

820

POINTS

11

BADGES

58

CHALLENGES

Badges

Entire Program

Common Rookie

Memory Rookie

Sunrise Rookie

View of Leaderboard Names and photos have been blocked to protect privacy. Participants could compare their scores with others and earn badges for engagement

[←](#) HOME

Q Search By Title

RECENT ARTICLES



Sitting

Standing at work
Mrs Melody Tan

The standing desk phenomenon has gained traction in the workplace, but is it that good for your health?



Rejuvenation

The healing power of green time
Dr Darren Morton

Dr Darren Morton says that one way to lift your mood is simply to open your front door and step outside!



Nutrition

Best things to drink to help build immunity
Author Sanitarium Health

Do the old wives' tales like hot honey and lemon drinks really work?

PREVIOUS ARTICLES



Nutrition

Why choose a whole-food plant-based diet?



Sleep

Lifestyle medicine strategies to enhance...



Social Network

Connecting with others is powerful

Extra articles on various topics: Participants could read extra information on topics covered

Section 2:

The App

The following images are from the mobile app called “mywellness” – it was available on the “App Store” and “Google Play”

Telstra 4G 4:14 pm

Wellness Assessment



7 DIMENSIONS OF WELLNESS

Takes approximately 30 minutes to complete. You can save your progress and continue at a later time.

- About You ✓
- Emotionally Thriving ✓
- Physically Energised ✓
- Socially Connected >
- Vocationally Enriched >
- Intellectually Engaged >

Telstra 4G 4:15 pm

Save & Exit Socially Connected

I can talk about my problems with my friends.

12 of 17 questions

Strongly disagree

Disagree

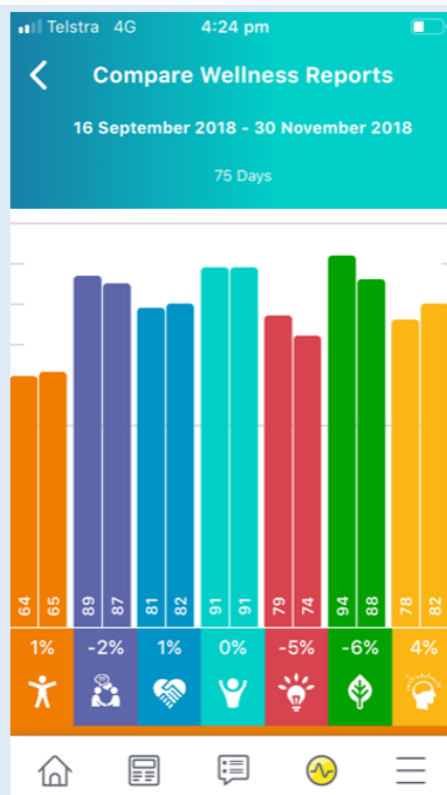
Slightly disagree

Neither agree or disagree

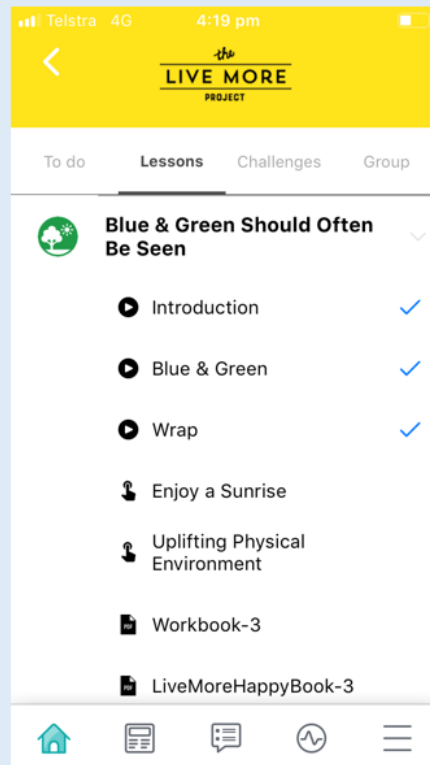
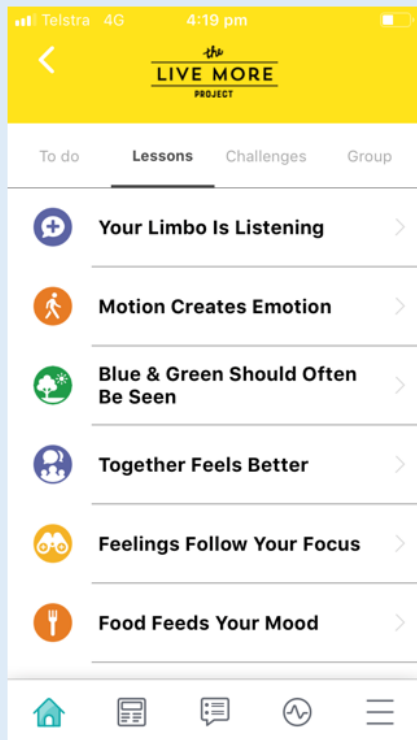
Slightly agree

Previous Next

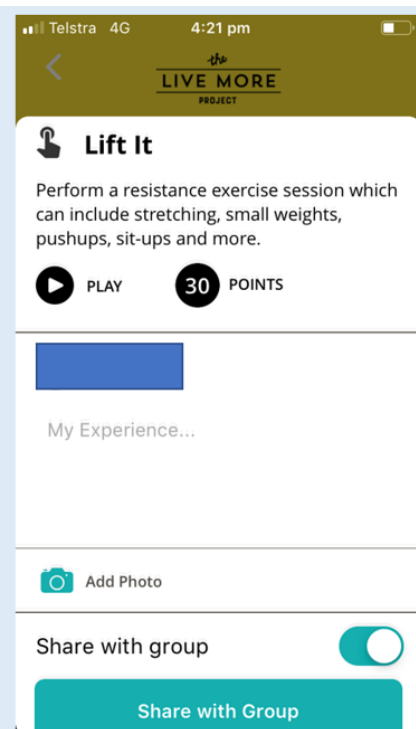
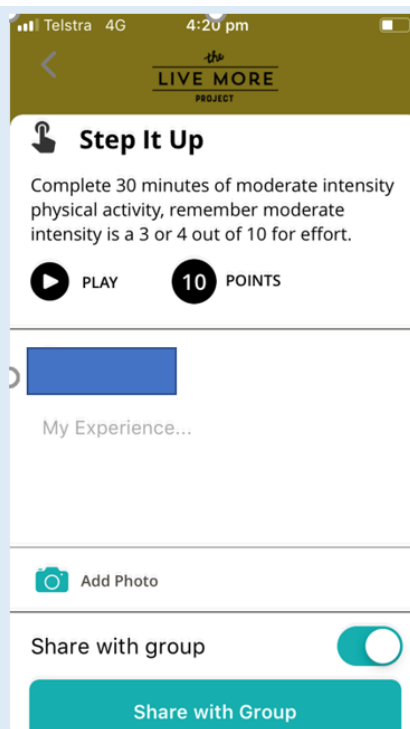
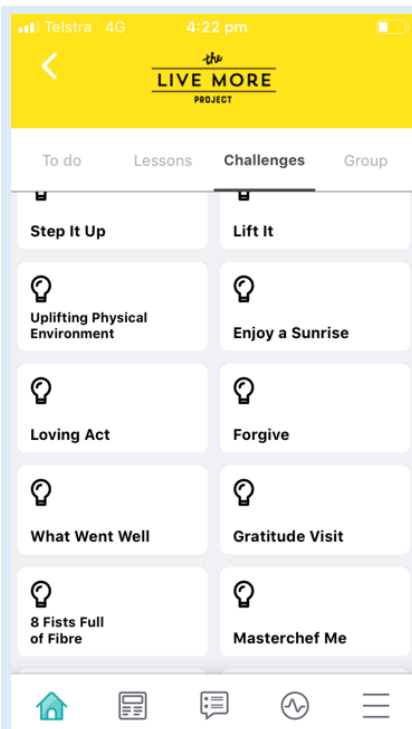
Questionnaire: Once a participant tapped the answer to the question on the screen, the screen automatically moved to the next question



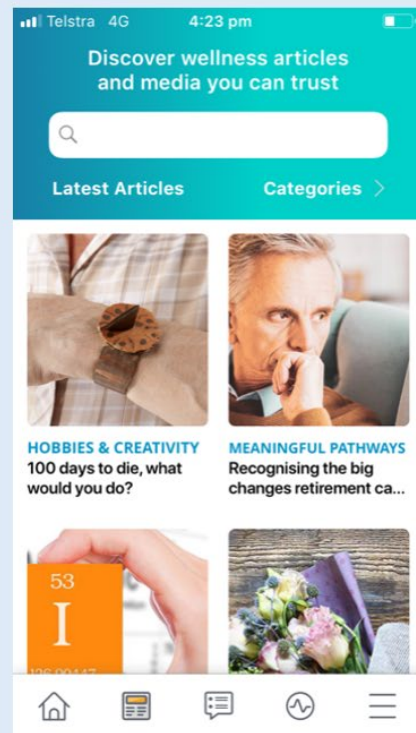
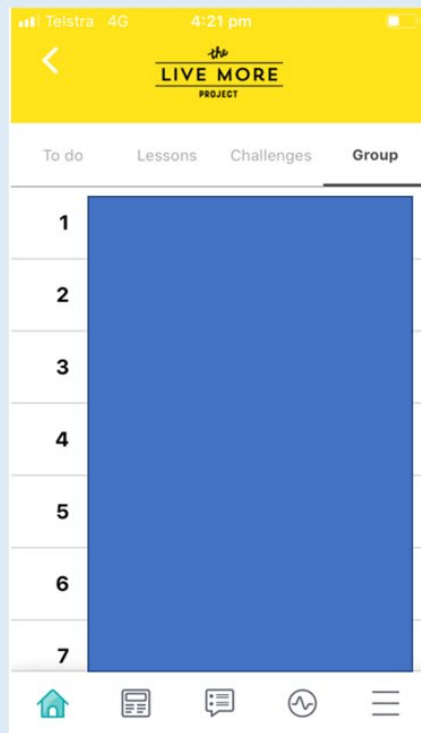
Comparison of Questionnaire Results – Pre & Post: Participants could compare their results before and after the intervention



Video content on the mobile app: Participants watched the video content and could download a workbook and a chapter of the accompanying text-book book “Live More Happy” (Morton, 2018) from the Lessons page on the app (or the website).



Challenges on the App: Participants could click on the icon and then record challenge activity while ‘on the go’.



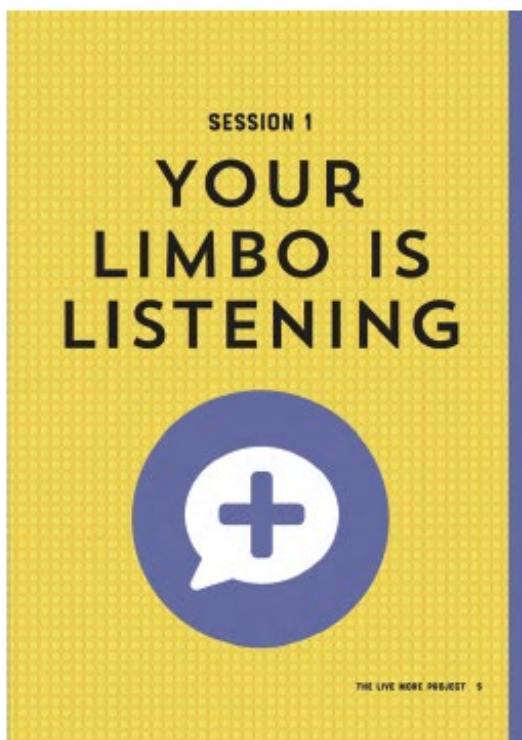
Leaderboard and extra articles: Names and photos have been removed for privacy. Participants could compare their progress with others on the leaderboard and read articles of interest related to the topics of the program.

Appendix 2: Sample of an LMP Session Workbook

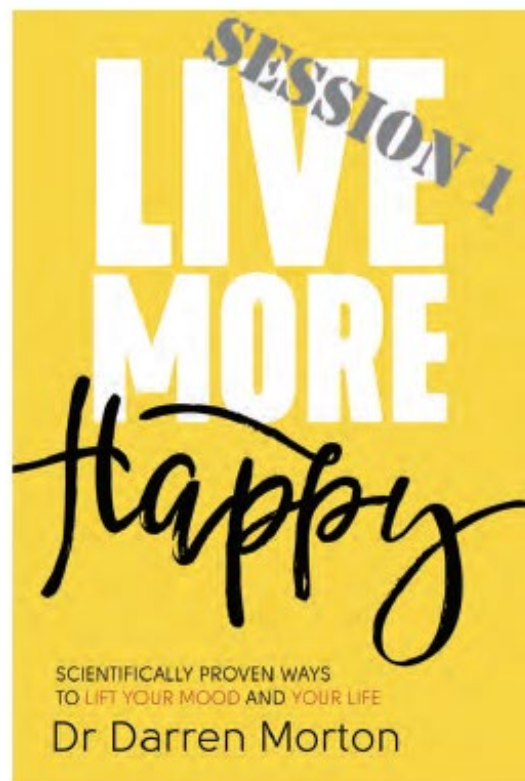
Note that several workbook pages have been omitted (e.g., pages with notebook lines only, a single image or a quote). The chapter from the book *Live More Happy* is not included.

the **LIVE MORE** PROJECT

This PDF contains the following



Live More Project
Course Workbook
Lesson One



Live More Happy
by Dr Darren Morton
Chapter 1 & 2

SESSION 1

YOUR LIMBO IS LISTENING



THE LIVE MORE PROJECT 5

S•M•I•L•E•R•S

**SPEAK
POSITIVELY**

▶ **SESSION 1 RECAP**

- ▶ Your Limbo is your “emotional brain” so it is responsible for how you feel—glad, bad, mad or sad. If you treat it right it can be your “Home of Happy”!
- ▶ While mood is your Limbo’s main function, it is also involved in:
 - Memory
 - Motivation
 - Many automatic processes in your body including heart function, gut function and even your immune system (that’s why how you feel affects how you heal!).
- ▶ To know how to make you feel your Limbo relies on what it is told from other parts of your brain and your body.
- ▶ One of the areas your Limbo is wired to is the language area of your thinking brain (the “Leader”) and so to give your Limbo a lift “Speak Positively”!
- ▶ Studies suggest that you should aim to say at least 5 positive things for every one negative.

LEADER

LIMBO



LEARN

Read chapters 1 & 2 of the book "Live More: Happy" where you will learn that:

- ▶ People who are optimistic about aging live an extra 7.5 years.
- ▶ Unscrambling words like "Bingo" and "Gray" can make you walk slower!



EXPERIENCE

YOUR DAILY CHALLENGE: GIVE COMPLIMENTS

To experience the power of speaking positively go out of your way each day to offer a genuine compliment to someone. We often think good things about others but we don't say them enough. So let's do it. Face-to-face is by far the preferred method of delivery but you can also send an email or text if you like.

Tips for activating the daily challenge:

- ▶ Notice and congratulate the success stories of others around you.
- ▶ Identify one person you work with who you really value and tell them.
- ▶ Identify a child or a young person in your life who has impressed you. Share this with both them and their parents.
- ▶ Tell a complete stranger such as the bus driver, cleaner, cashier or anyone, that you appreciate what they do.
- ▶ Identify skills and talents in others and bring it to their attention.
- ▶ Publicly affirm someone (this way your Limbo, their Limbo, and every Limbo in the room is uplifted).

DAY	1	2	3	4	5	6	7
Daily Challenge Completed							
(tick boxes)	10 points	10 points	10 points	10 points	10 points	10 points	10 points



YOUR WEEKLY CHALLENGE: ETCH INSPIRATION

This week “etch inspiration” by memorising an inspirational text or saying (or several). Practice reciting it until you know it by heart and every time you do remind yourself that your Limbo is listening. Let it become your response to negative self-talk. When you catch yourself engaging in negative self-talk, stop, and recite back the inspirational text or saying you’ve memorised.

Weekly
Challenge
Completed
(tick box)

--	--

Write your inspiration quote(s) here:

30 points

[illegible]

TOTAL POINTS
(Daily +
Weekly
Challenge
Points)



/100

THINK

WHAT'S THE BIG IDEA?

Imagine you are in an elevator and you have 30 seconds to explain to someone the big idea from this session. Write below what you would say and include the following words in your response:

Limbo (feeling brain) Leader (thinking brain) Highly impressionable Speak positively

THAT REMINDS ME...

Explain one time in your life where the Big Idea from this session has been very evident in your own experience.



THIS IS HOW IT WORKED THIS WEEK

What is the most noteworthy compliment you offered this week? Why did you choose this example? How did they respond and how did it make you feel?

SELF ASSESSMENT

Indicate below how this week's challenges affected your emotional wellbeing.

No effect	Small effect	Moderate effect	Large effect	Huge effect

(Tick the appropriate box)



Live More Project Research - Timetable

Log on to the website address below to access videos & record your challenge activity www.eliawellness.com/login		
Session Number	Week commencing	To Do
Orientation	September 9 - 15	Read "Invitation Email" (emailed 10/9/2018) Register to gain access to the website Log in & complete Questionnaire 1
Session 1	September 16 - 22	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 2	September 23 - 29	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 3	September 30 – October 6	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 4	October 7 - 13	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 5	October 14 - 20	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 6	October 21 - 27	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 7	October 28 – November 3	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 8	November 4 - 10	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 9	November 11 - 17	Watch video Complete Daily & Weekly Challenges Record challenges online
Session 10	November 18 - 24	Watch video Complete Daily & Weekly Challenges Record challenges online
Questionnaire 2	November 25 – December 9	Complete Questionnaire 2
Questionnaire 3	March 2019	Complete Questionnaire 3

Appendix 4: Study Information Statement

INFORMATION STATEMENT



PROJECT TITLE: The Human Touch: The Influence of Human Support on Adherence to, and Outcomes of, an Online, Lifestyle-based Mental Health Intervention.

Research team: Dr Darren Morton, Dr Lillian Kent, Dr Jason Morton, Dr Peter Beamish, Dr Jason Hinze, Melanie Renfrew

INVITATION

Thank you for registering your interest in the Live More Project study. We are pleased to invite you to participate in this study that is being conducted by researchers from Avondale College of Higher Education.

PURPOSE AND IMPORTANCE OF THIS RESEARCH

A randomised controlled trial in 2017 demonstrated that the Live More Project could improve the mental well-being of participants. Expanding on the encouraging 2017 results, the purpose of this study is to explore what influence different levels of human support provision have on outcomes for the Live More Project. The study will also explore what factors influence the participants' capacity to engage with the Live More Project online. Importantly, this study will contribute knowledge about the influence of human support in online programs and will inform the most effective methods for implementing the Live More Project in the future.

WHO IS BEING INVITED TO PARTICIPATE?

To participate in this study, you need to: be an adult (over 18 years old); live in Australia or New Zealand; possess a mobile phone with SMS capability; be able to access the internet; be fluent in English; be willing to allow your data to be used anonymously and confidentially for research; and provide informed consent.

Additionally, as an applicant you will need to agree that:

- (1) The Live More Project *will* include:
 - ✓ Being randomly assigned to one of three groups.
 - ✓ Participation in the 10-week program commencing September 2018.
 - ✓ Completion of an online wellness questionnaire on three occasions:
 - Prior to commencing the program.
 - At 12 weeks (after program completion).
 - 6 months after program commencement.
- (2) The Live More Project *may* include:
 - ✓ Receiving regular SMS messages (2-3 times per week).
 - ✓ Participation in a 30-minute weekly online group discussion (i.e., videoconference) using a freely accessible application called 'Zoom'.

WHAT DOES PARTICIPATION INVOLVE?

The Live More Project is a 10-week program that is accessed by logging onto a, password-protected, website dashboard. From your personal dashboard, watch a weekly, 35-minute video in which you will learn ways to improve your well-being. Each week you will be challenged to complete a daily and weekly activity arising from what you have learned. You are encouraged to keep track of challenges by logging your activity online. The challenge activities range from just a few minutes to 30 minutes in duration.

All participants complete an online well-being questionnaire that will take approximately 30 minutes which needs to be completed on three occasions (prior to commencement of the program, at 12 weeks, and 6 months after commencing the program). Participation *may* include receiving regular SMS messages or participation in a weekly 30-minute videoconference session to reflect on the related program session.

POSSIBLE RISKS OR INCONVENIENCES

The time commitment required is the only inconvenience associated with being part of this research study.

BENEFITS

During the Live More Project you will learn scientifically proven strategies for increasing your personal well-being, particularly your emotional well-being.

You will complete a questionnaire that measures seven dimensions of well-being: emotional, physical, social, vocational, intellectual, environmental, and spiritual. You will complete the questionnaire three times, and on each occasion, you will be able to view a summary score for each dimension. Your personal online access allows you to compare and contrast how your personal scores change across the three time periods. Please note, no other participants will see your questionnaire scores; the information is only viewable by you through your password-protected access.

On completion of the program, participants will receive ongoing access to the video presentations, where video content can be reviewed at leisure.

CONFIDENTIALITY, ANONYMITY AND DISCLOSURE OF INFORMATION

Your data will be treated confidentially. You will have access to a summary score for each dimension and the researchers will access the data for analysis. Your name will be removed so that your data is completely anonymous, and the data will be stored for five years on a password-protected computer. At the end of the five-year period, after the conclusion of the research, all electronic data will be erased.

USE OF INFORMATION COLLECTED

The information collected will be analysed and might be reported in a thesis, scientific papers, professional conferences, or media reports. The confidentiality of individual participants will be assured. In any publication, information will be provided in such a way that individuals cannot be identified.

FREEDOM OF CONSENT

Participation in this research is voluntary. It is completely up to you whether or not you participate. Only people who give their informed consent will be included in the study. Even if you agree to participate, you may withdraw at any time without giving a reason. If you decide not to participate or wish to withdraw from the project at any time, you will not be disadvantaged. If you choose to withdraw, and if it is possible to retrieve, your data will be returned to you.

FURTHER INFORMATION

If you would like to participate in the study or would like further information, please contact Melanie Renfrew at melanierenfrew@adventist.org.au

This research project has been approved by the Avondale College of Higher Education Human Research Ethics Committee (HREC). Avondale requires that all participants are informed that if they have any complaint concerning the manner in which a research project is conducted it may be given to the researcher, or if an independent person is preferred, to Avondale's HREC Secretary, Avondale College of Higher Education, PO Box 19, Cooranbong NSW 2265, or phone (02) 4980 2121 or fax (02) 4980 2117 or email: research.ethics@avondale.edu.au

Thank you for considering this invitation.

The research team.

Original Paper

A Web- and Mobile App–Based Mental Health Promotion Intervention Comparing Email, Short Message Service, and Videoconferencing Support for a Healthy Cohort: Randomized Comparative Study

Melanie Elise Renfrew, BEd, Grad Dip; Darren Peter Morton, MAppSci, PhD, FASLM; Jason Kyle Morton, BEd, BSci, PhD; Jason Scott Hinze, BEd, MLMed, PhD; Peter James Beamish, BEd, MEdSt, PhD; Geraldine Przybylko, BCom, MBA, MPH; Bevan Adrian Craig, BN, Grad Dip, PhD

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Abstract

Background: The rapid increase in mental health disorders has prompted a call for greater focus on mental health promotion and primary prevention. Web- and mobile app-based interventions present a scalable opportunity. Little is known about the influence of human support on the outcomes of these interventions.

Objective: This study aimed to compare the influence of 3 modes of human support on the outcomes (ie, mental health, vitality, depression, anxiety, stress, life satisfaction, and flourishing) of a 10-week, Web- and mobile app-based, lifestyle-focused mental health promotion intervention among a healthy adult cohort.

Methods: Participants were recruited voluntarily using a combination of online and offline advertising. They were randomized, unblinded into 3 groups differentiated by human support mode: Group 1 (n=201): standard—fully automated emails (S); Group 2 (n=202): standard plus personalized SMS (S+pSMS); and Group 3 (n=202): standard plus weekly videoconferencing support (S+VCS), hosted by 1 trained facilitator. Participants accessed the intervention, including the questionnaire, on a Web-based learning management system or through a mobile app. The questionnaire, administered at pre- and postintervention, contained self-reported measures of mental well-being, including the “mental health” and “vitality” subscales from the Short Form Health Survey-36, Depression Anxiety and Stress Scale-21, Diener Satisfaction With Life Scale (SWLS), and Diener Flourishing Scale.

Results: Of 605 potential participants, 458 (S: n=157, S+pSMS: n=163, and S+VCS: n=138) entered the study by completing registration and the preintervention questionnaire. At post intervention, 320 out of 458 participants (69.9%; S: n=103, S+pSMS: n=114, and S+VCS: n=103) completed the questionnaire. Significant within-group improvements were recorded from pre- to postintervention in all groups and in every outcome measure ($P \leq .001$). No significant between-group differences were observed for outcomes in any measure: mental health ($P=.77$), vitality ($P=.65$), depression ($P=.93$), anxiety ($P=.25$), stress ($P=.57$), SWLS ($P=.65$), and Flourishing Scale ($P=.99$). Adherence was not significantly different between groups for mean videos watched ($P=.42$) and practical activity engagement ($P=.71$). Participation in videoconference support sessions (VCSSs) was low; 37 out of 103 (35.9%) participants did not attend any VCSSs, and only 19 out of 103 (18.4%) attended 7 or more out of 10 sessions. Stratification within the S+VCS group revealed that those who attended 7 or more VCSSs experienced significantly greater improvements in the domains of mental health ($P=.006$; $d=0.71$), vitality ($P=.005$; $d=0.73$), depression ($P=.04$; $d=0.54$), and life satisfaction ($P=.046$; $d=0.50$) compared with participants who attended less than 7.

Conclusions: A Web- and mobile app-based mental health promotion intervention enhanced domains of mental well-being among a healthy cohort, irrespective of human support. Low attendance at VCSSs hindered the ability to make meaningful between-group comparisons. Supplementing the intervention with VCSSs might improve outcomes when attendance is optimized.

Trial Registration: Australian New Zealand Clinical Trials Registry (ANZCTR): 12619001009101; <http://www.anzctr.org.au/ACTRN12619001009101.aspx>

(*J Med Internet Res* 2020;22(1):e15592) doi: [10.2196/15592](https://doi.org/10.2196/15592)

KEYWORDS

guidance; health promotion; eHealth; short message service; videoconferencing

Introduction

Background

In 2012, the World Health Assembly requested the development of a plan to address escalating mental distress, resulting in the Mental Health Action Plan 2013–2020, which asserts that there is “no health without mental health” [1]. However, as we approach 2020, mental well-being continues to deteriorate. Depression is the leading cause of disability worldwide [2,3], and its prevalence is rising [4], evidenced by increasing antidepressant use [5] and the high rate of suicide—the second leading cause of death in the 15 to 29 years age group internationally [3]. Comorbidity is common [6], and those with major depression have a 40% to 60% risk of dying prematurely [1]. A 2018 review [7] of 12 countries revealed that depression and anxiety are the third most common reason for visits to a general practitioner in the developed world.

Mental well-being, even in the seemingly healthy population, is compromised by mounting stress and anxiety. In the 2015 Australian Psychological Society’s stress and well-being survey [8], 35% of those surveyed reported significant distress levels, 26% reported above normal anxiety, and 26% described themselves as having moderate to extreme depression levels. Therefore, provision of mental health promotion interventions (MHPIs) may be a vital approach to enhance mental well-being among healthy (ie, nonclinical), community-based cohorts.

There is a growing evidence base supporting the efficacy of MHPIs to improve the mental well-being of nonclinical population groups. These include interventions to alleviate stress [9–11], mindfulness training [12–15], lifestyle medicine strategies such as nutrition [16,17], and exercise [18,19] and an array of positive psychology interventions [20–22]. A recent analytic review [23] highlighted strategies from the fields of positive psychology and lifestyle medicine that have demonstrated effectiveness in enhancing mental well-being. Combining strategies from both fields, the same author devised a lifestyle-focused, multimodal intervention that has been piloted among university students on 2 occasions [24,25] and more recently as a Web-based randomized controlled trial (RCT) for a healthy community cohort [26]. The Web-based RCT demonstrated significantly greater improvements ($P<.001$) than the control group for all outcomes, with medium effect size improvements for the intervention arm in mental health ($d=0.52$), vitality ($d=0.56$), and stress ($d=0.45$). The same intervention was used for this study.

Web- and mobile app-based technology offers an unprecedented opportunity for disseminating MHPIs to healthy cohorts in community settings. Advantages, when compared with face-to-face interventions, include cost-effectiveness [27,28],

accessibility, and scalability [29,30]. Furthermore, up to 80% of potential users are “e-preferers” [31]. However, digital delivery also poses unique challenges (eg, quality control, data control, high dropout attrition, and low adherence) that require creative solutions [32,33]. Notably, provision of human support (ie, guidance) is recognized as a possible modulating influence on adherence and outcomes [33,34].

Human Support

Human support provision in Web-based interventions has generally been associated with improved adherence and outcomes in clinical cohorts [32,35–39]. A meta-analysis of 12 studies treating depression found effect sizes for studies that included human support were larger ($d=0.61$) in comparison with unsupported studies ($d=0.25$) [38]. Nevertheless, some studies have found that the level of human support does not significantly influence outcomes [40–44]. Furthermore, variability in the provision of human support (eg, mode, intensity, and synchronicity) results in high heterogeneity, which makes comparisons between studies problematic [33,39].

It is imperative to investigate the role of human support among nonclinical groups. Support requirements may be markedly different among healthy cohorts. Symptomatic factors (eg, apathy, weakened motivation, and general malaise) that could impede a clinical cohort from completing a program may be nonexistent or differ considerably for a nonclinical group. Conceivably, MHPIs may prove to be a credible pathway to enhance mental well-being and serve as a vital buffer to protect healthy populations against mental distress [45].

Studies comparing human support factors for healthy cohorts engaging in Web- or mobile app-based mental well-being interventions are scarce, and outcomes are mixed. Several primary prevention studies (all classified as “indicated” prevention) have reported no significant difference between supported and unsupported arms [46–48]. Zarski et al [49] examined 3 support approaches and compared the effects on adherence with a stress management intervention. Monitoring and written feedback improved adherence. However, administrative support (ie, access to a support team for technical assistance) had no positive effect [49]. Allexandre et al [50] compared no support, group support, and group support with added expert clinical support for a stress management intervention. Group support was beneficial, but added clinical care contributed no extra benefit. However, the program content was Web-based, and support was provided face-to-face in a work setting, making comparison problematic. Finally, a review and meta-analysis of 23 Web- and computer-based interventions to alleviate stress found that supported interventions demonstrated greater effects on outcomes ($d=0.64$) than unsupported ($d=0.33$) [51].

A confounder when drawing conclusions about the impact of human support on the effectiveness of Web- and computer-based programs is that there are many modes and delivery styles classified as human support, which differ markedly in their resource requirements (eg, time, cost, and intensity). For this study, we chose 3 support modes to compare, based on low (automated emails), medium (personalized SMS messaging), and high (facilitated videoconference) resource requirements.

Email Support

Emails are widely used [33] and easily incorporated into a Web-based intervention as an asynchronous, low intensity, low cost support method [52]. Notwithstanding, heterogeneity in the way emails are utilized makes comparison difficult, and results are mixed in clinical settings [46,53-55]. For instance, automated emails, often used as engagement prompts, may be built into the system design and require virtually no monitoring once set up. Conversely, personally tailored, individually written emails require effort and time on behalf of the support person and may be considered a more intense mode of support [52].

Short Message Service Support

SMS support varies in intensity depending on the method of dissemination (ie, automated or individualized), however, it is easily accessible and portable [56] through the widespread use of mobile phones. Researchers have used SMS support to aid adherence to medication [57,58], support asthma treatment [59], and promote adherence to healthy lifestyle practices [60] among other uses. A systematic review and meta-analysis of Web-based interventions, that used additional support modes demonstrated that SMS had large effects ($d=0.81$) compared with phone ($d=0.35$) and email ($d=0.18$) [61]. Nevertheless, users may ignore SMS prompts when they are perceived as impersonal, too frequent, or automated [62].

Videoconferencing Support

Videoconferencing most closely replicates the face-to-face setting; however, it requires a greater investment of time, cost, and human resources. Notwithstanding, it may provide a feasible, personal, and acceptable mode of support, similar to face-to-face settings, as long as technical assistance is available [63]. Participants value ease of accessibility and are still able

to bond as a group despite lack of various communication cues (eg, body language) [63]. Videoconferencing has been successfully used to support caregivers [64], patients with chronic disease [65], new parents [66], and bariatric surgery patients [67], among others.

Identifying the optimum input of human support resources to maximize program effectiveness is an important consideration for researchers designing MHPIs for nonclinical cohorts. This comparative study seeks to add to the evidence base by asking the question: "What is the influence of different modes of human support on the outcomes of a Web- and mobile app-based MHPI for a healthy, community-based cohort?"

Methods

Recruitment

Participants were recruited from an Australian and New Zealand faith-based cohort. Advertising, conducted from July to September 2018, included offline marketing through periodicals, magazines, and bulletins of the faith-based organization and online marketing using a combination of website, social media, and email strategies. Advertising material directed potential applicants to a Web page to examine the inclusion criteria (Textbox 1), acquaint themselves with participation expectations, and fill out an enrollment application.

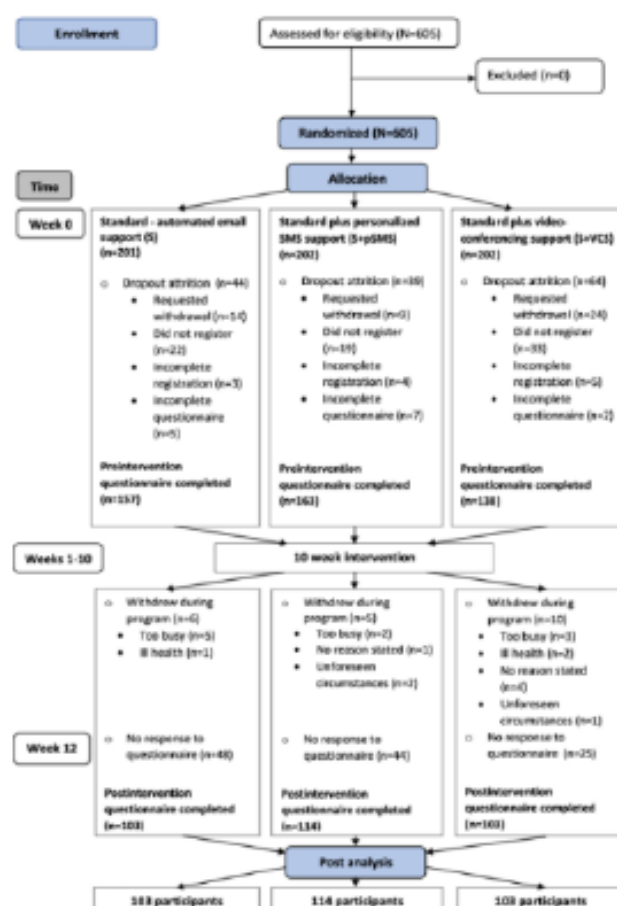
Approved applicants were randomized into 1 of 3 intervention groups (Figure 1) using computer-generating software. An email notified applicants of acceptance into the study, group allocation, instructions detailing the steps to complete registration on the Web-based electronic learning management system (eLMS), and a unique link to activate the registration process. Informed consent was gained as part of the registration procedure. Once registered, users could opt to download the mobile app and access all features of the intervention, including self-reported questionnaires, from either the eLMS or from the mobile app.

To provide anonymity, participants were permitted to use a pseudo name for the duration of the intervention, if desired. In the S+VCS group, which involved videoconferencing using the app "Zoom," the participants were given the option to choose a pseudo name and have the camera switched off.

Textbox 1. Inclusion criteria.

- Aged 18 years or older
- Mobile phone with SMS capability
- Internet access
- Australian or New Zealand resident
- Fluent in English
- Acceptance to provide informed consent
- Permission given for anonymous data to be used for research

Figure 1. Flow of participants.



Study Design

The study was a multiaim, randomized comparative design with 3 intervention groups that differed according to modes of human support:

1. Group 1: Standard—fully automated emails (S).
2. Group 2: Standard plus personalized SMS support (S+pSMS).
3. Group 3: Standard plus videoconferencing support (S+vVC).

Figure 1 shows that participants in each group accessed the intervention simultaneously, from September to December 2018.

Intervention

The 10-week intervention is presented in an audio-visual format and was initially administered in 2017 as a Web-based program on an eLMS. Version 2, released immediately before commencement of this study (August 2018), included an updated eLMS and a mobile app called “MyWellness.” See Multimedia Appendix 1 for screenshots. No new features were introduced during the study period.

The lifestyle-focused intervention is underpinned by the theory of planned behavior (TPB), which has demonstrated substantial health behavior change benefits [61]. The intervention actively seeks to change behavior through education and increase perceived control through easily attainable weekly challenges [24]. Using the pedagogical framework of Learn, Experience, Think, Share, the participants were introduced to basic neuroscience and explored 10 evidence-based strategies from lifestyle medicine and positive psychology for improving mental well-being. Table 1 outlines the weekly topics covered throughout the intervention [68–91].

Participants accessed the intervention free of charge by logging onto the eLMS or the mobile app. Each participant’s personal dashboard provided access to the weekly session, which included approximately 30 min of audio-visual content, a downloadable workbook, and extra reading materials relating to the topic [92]. The intervention emphasized experiential learning by encouraging participants to engage in daily and weekly challenges through which they could log their activity to earn challenge points. Participants were emailed a “timetable overview” (Multimedia Appendix 2), which outlined the recommended schedule to complete the intervention within the 10-week timeframe.

Table 1. Intervention overview.

Week	Topic	Overview	Daily challenge	Weekly challenge
1	Speak positively (your limbo is listening)	• Limbic system introduction—the “emotional brain” • Limbic system is “wired” to language area of brain [68,69]	Offer a genuine compliment.	Memorize an inspirational text or saying.
2	Move dynamically (motion creates emotion)	• Proprioceptors (nerve cells that detect movement) pass through the limbic system • Movement (even just 10 min) improves mood [70-73]	Complete 30 min of moderate-intensity activity.	Perform resistance exercises once during week (exercises demonstrated on video).
3	Immerse in an uplifting natural environment (blue and green should often be seen)	• The limbic system receives messages from all the senses • The limbic system likes blue and green spaces (ie, natural settings) • The limbic system needs about 30 min of 10,000 LUX of light daily [74-76]	Immerse in an uplifting natural environment for 30 min daily.	Watch a sunrise from an appealing blue or green location.
4	Immerse in a positive social environment (together feels better)	• Limbic systems communicate • Create positive social environments by making new friends or strengthening existing relationships • Forgiveness [77-79]	Daily, do something intentional to show a friend or family member they are loved (use their love language).	Give up your right to hurt someone who has hurt you (Act of forgiveness).
5	Look to the positive (feelings follow your focus)	• “Emotional brain” is wired to “Thinking brain” • What you focus on affects how you feel • Upward or downward spirals [21,45,80-82]	Write down 3 things that went well today “What Went Well?”	Gratitude visit—identify someone you are grateful to, write a gratitude letter to them, deliver and read in person, if possible.
6	Eat nutritiously (food feeds your mood)	• Gut bacteria linked to mood • Feed gut bacteria high fiber diet • Plant-based foods are high fiber • Eat a wide variety of fruit, vegetables, legumes, and grains [16,17,83,84]	Eat 8 fists full of fiber daily.	Prepare and share a high-fiber plant-based meal with one or more friends.
7	Rest—sleep (rest to feel your best)	• Sleep is fundamental for feeling upbeat (7-8 hours optimal) • Blue light vs yellow/orange light • Caffeine, lack of physical activity, and blue light—deprived sleep [85,86]	Spend 8 hours in bed every night.	Spend an evening by fire-light.
8	Rest—from stress (stress less)	• SMILERS strategies “open the valves” • Physical activity, practicing mindfulness, laughing, and rest day [13,51,87,88]	15-min “sit in silence” mindful activity.	Take a “guilt-free” day off.
9	Serve others (giving is living)	• Contributing/serving is emotionally uplifting • Serve sustainably using signature strengths [89-91]	Perform 1 or more random acts of kindness each day.	Use your significant strength to perform a significant act of service.
10	What does it take to flourish?	Five areas to flourish: PEARM—positive emotions, engagement, achievement, relationships, and meaning [90]	Spend time engaging in something you enjoy.	Create a list of goals and an action plan to achieve them.

Persuasive Systems Design Features

Features of Persuasive Systems Design (PSD) were key to the intervention, and numerous support principles were utilized on the Web platform and mobile app to encourage behavior change. The PSD model, developed by Oinas-Kukkonen and Harjuma [93], is largely based on earlier work by Fogg [94]. The model outlines a taxonomy of 28 principles, classified under 4 key areas of support, for designing completely digital, behavioral change interventions. "Primary Task Support" components of PSD included the use of "reduction" to simplify key learnings into practical strategies for implementation, along with "self-monitoring" and "rehearsing" desired behaviors in the form of daily and weekly challenges that were recorded on the eLMS or app. An element of "Dialogue Support" [93] utilized was "rewards" in the form of badge icons. "Social Support" elements of PSD [93] provided opportunities for various forms of interaction. Participants could choose to post challenge activity to a public "feed" (viewable by other group members) providing "social learning" and "social facilitation" opportunities. Furthermore, challenges posted as "public" provided opportunity for interaction between group members. "Competition" and "social comparison" were aroused through a challenge points leader board.

Human Support

Human support was crafted to reflect values of the Supportive Accountability Model (SAM), developed by Mohr et al [34]. They propose a range of support measures to improve adherence, including focusing on process expectations rather than outcome expectations, positive feedback provision, avoidance of controlling behavior, timely communication, being trustworthy, facilitating engaging discussions, and avoidance of pressure tactics [34].

Advertising Period

During the advertising period, the mobile app "Hitemup" was used to send enrollees (ie, those who had registered interest in joining the study) weekly, personalized SMS communication to remind them of the upcoming program.

Orientation and Registration Period

During orientation week, all enrollees were sent an email link to register onto the eLMS to finalize registration and complete the preintervention questionnaire. A total of 2 SMS reminders were sent, several days apart, as reminders to register.

On the intervention start date, a "welcome" email and SMS were sent to all registered participants outlining the steps to access the first session. In addition, within the first 2 weeks of the intervention, those who had not yet completed registration were sent 4 reminder SMSs and email messages inviting them to access the provided link to complete registration. Once participants completed registration, human support reverted to the constraints outlined for each group, and the eLMS was used to send SMS and automated email messages to registered participants.

Group 1 Support: Automated Emails—Standard

Automated emails, which are the routine communication mode outside the research setting, were set up as part of the eLMS.

All participants received a weekly email on the day before the next session commencing. The email included a link to a 20 to 25 second video by the presenter, inviting them to engage with the next presentation. A total of 3 days after a lesson was released, the system checked to see if the participant had logged any challenges: if "yes," participants were sent an email validating their participation, if "no," an email prompted the participant to complete the relevant challenge. A total of 8 days after a new lesson was released, participants who had not watched the video were sent an email reminder.

Group 2 Support: Standard Plus Personalized SMS Messages

The S+pSMS group received automated emails plus SMS messages that were sent 3 times weekly for the first 3 weeks and then 2 times weekly for the remaining 7 weeks. The reduction from 3 messages per week to 2 messages per week recognized the notion that support may have a threshold [34]; too many messages may be seen as controlling and undermine the commitment of individuals, therefore impairing engagement [34]. The messages focused on process accountability (ie, completing target behaviors such as viewing content and engaging in experiential learning) as opposed to outcome accountability, which may be detrimental and beyond an individual's control [34].

Each SMS included the participant's first name, a predetermined message to prompt engagement, and was signed by the research team member (MR) who also provided technical assistance. Specific message content included different combinations of the following: a brief hook sentence (eg, Lesson 2—Learn 3 practical tips to calm your nerves, Lesson 3—Have you had your dose of lux today?), the link to log into the eLMS, an inspiring quote, tips for implementing challenge activity, and a phone number for technical assistance.

Group 3 Support: Standard Plus Videoconference Support

As well as automated email support, participants in the S+VCS group were invited to attend a synchronous, videoconference session using the app "Zoom." A weekly timetable (Multimedia Appendix 3) provided 9 different time possibilities, and participants were invited to attend any one of these. During orientation week, participants were encouraged to attend 1 of 9 available "tech check" sessions. Each week, participants were sent 1 reminder SMS and an email with a link to the online meeting. Discussion sessions lasted 20 to 30 min and were led by an experienced educator who holds a post-graduate degree in lifestyle medicine. The facilitator had previously hosted many preventative health videoconferences for participant groups doing the renowned Complete Health Improvement Program. Prior training included 6 mentoring sessions on how to facilitate successful videoconferences in a Web-based setting. The videoconference support sessions included a recap of the weekly content by the facilitator, sharing new learnings and challenge experiences, plus dialogue on ways to incorporate strategies learned into everyday life.

Measurement—Outcomes

Participants completed a self-report questionnaire, the “7 Dimensions of Wellness Index” (7DWI), at preintervention (week 0) and postintervention (week 12). The 7DWI combines demographic- and lifestyle-related questions with various, freely available, validated instruments that measure 7 well-being domains (emotional, physical, social, spiritual, vocational, intellectual, and environmental). For the purpose of this study, the following instruments were utilized from the 7DWI to measure aspects of mental well-being:

36-Item Short Form Survey

The 36-item Short Form Health Survey (SF-36) is suitable for use in general population surveys [95], and 2 subscales of the SF-36 were used for this study: mental health (5 items) and vitality (4 items) [96]. Good internal consistency and reliability across the whole survey and subscales have been reported [97]. Cronbach alpha scores of .90 for the mental health subscale and .87 for the vitality subscale are well above the minimum reliability standard (.50–.70) [98].

21-Item Depression Anxiety and Stress Scale

The 21-item Depression Anxiety and Stress Scale (DASS-21) is widely used to measure depression, anxiety, and stress (7 items per factor), and satisfactory reliability has been demonstrated for both clinical and nonclinical samples [99–101]. The DASS has demonstrated adequate internal consistency as a total scale (Cronbach alpha > .90) [102] and for the 3 subscales, with Cronbach alpha scores ranging from .76 to .91 [99,101].

Satisfaction With Life Scale

Diener 5-item Satisfaction With Life Scale (SWLS) measures global life satisfaction and was initially tested on a nonclinical group of university students [103]. Good internal consistency was found (Cronbach alpha .87) [103], and the SWLS was deemed suitable for a wide range of age groups and settings [104]. Data from 6 studies indicated that the scale has high internal consistency (Cronbach alpha ranged from .79–.89) [105]. Furthermore, a meta-analysis of 62 articles provided 76 reliability coefficients testing the SWLS. The mean Cronbach alpha was .78—signifying good internal consistency [106].

Flourishing Scale (Diener)

Diener brief 8-item Flourishing Scale, designed to measure “social-psychological prosperity,” is suitable for nonclinical cohorts, correlates highly with other measures of well-being, and demonstrates good internal consistency under initial analysis (Cronbach alpha .87) [107]. The Flourishing Scale has a unidimensional factor structure, and more recent analysis, across 2 samples, also showed good consistency (.78 and .83) [108].

Measurement—Adherence

Primary adherence was measured as the total number of weekly videos viewed out of a possible ten presentations. Challenge adherence was also measured, with participants able to accumulate points through practical daily and weekly challenge activities. Each daily challenge was worth 10 points, and weekly challenges were worth 30 points. Participants could score a maximum of 100 points each week throughout the 10-week

intervention, thereby accumulating a total of 1000 points to be considered fully adherent. In addition, for the S+VCS group, videoconference attendance was recorded as a score out of 10.

Sample Size

The a priori power analysis indicated a required sample size of 148 participants in each arm of the study. This calculation was based on the following assumptions or requirements and relied on data from previous studies [24,26]: (1) participants were to be allocated equally between the 3 arms; (2) an ability to detect a 15% improvement in the mental health and vitality scales, as this was considered a clinically significant outcome [24]; (3) a 30% attrition rate, based on attrition rates observed in a prior similar study [26]; (4) a power level of ≥80%; (5) significance level of 0.05 (95% CI); and (6) a distribution SD of 16.1 in the mental health subscale, based on a prior study [24].

Randomization

Participants were randomized by a person not on the research team using computer random number generation. Equitable distribution of age and gender was tested and confirmed, negating the need for further stratification. The 3 randomized groups were allocated to a study arm by the person who conducted randomization. Researchers and participants were unblinded, and participants were notified of the mode of support they would receive during registration. As there was no control group, all groups were comparators of interest.

Statistical Analysis

Data were analyzed using the IBM SPSS Statistics Software (version 25). Within-group changes from baseline to post intervention were calculated using paired *t* tests, and repeated measures generalized linear models were used to measure analysis of variance between groups, taking into account time and group effects. Cohen *d* was used to measure effect size, and Fisher Exact test was used to test for relationships between the categorical variables. The 458 participants who completed the preintervention questionnaire were included in the analysis of baseline characteristics. All remaining analyses included only the participants who completed both preintervention and postintervention measures (*n*=320). This manuscript was prepared according to Consolidated Standards of Reporting Trials (CONSORT) guidelines [109] and utilized the CONSORT-EHEALTH checklist (Multimedia Appendix 4).

Ethics and Informed Consent

Ethics approval was granted from the Avondale Human Research Ethics Committee (Approval No. 2018.09). Prospective participants were emailed an “information statement” outlining the details of the study and an “informed consent statement” notifying them that choosing to register onto the eLMS would signify informed consent.

Results

Participants

Figure 1 records the flow of participants throughout the intervention period. Potential participants (*n*=605) were enrolled through the information Web page and were randomized into

3 groups: S (n=202), S+pSMS (n=202), and S+VCS (n=201). A total of 458 participants registered on the eLMS, completed the preintervention questionnaire, and were analyzed for baseline characteristics (S=157, S+pSMS=163, and S+VCS=138). At 12 weeks, 320 out of 458 (69.9%) participants had completed both the pre- and postintervention questionnaire required for postanalysis (S=103, S+pSMS=114, and S+VCS=103).

Baseline Characteristics

Table 2 describes the demographic and mental health characteristics of the study group at baseline. Fisher Exact tests demonstrated no significant between-group differences in any of the categorical characteristics of the study population. With a mean age of 45.5 (SD 13.7) years, participants were predominantly female (77.7%, 356/458), white (76.9%, 352/458), and had a tertiary education (78.0%, 357/458). There were no significant differences between the groups in any of the psychometric measures at baseline (Table 2).

Table 2. Baseline characteristics of the study population.

Factor	Standard automated email group (S; n=157)	Standard plus SMS message group (S+pSMS; n=163)	Standard plus videoconferencing support group (S+VCS; n=138)	Combined groups (N=458)	Analysis of variance or Fisher Exact test, P value
Age (years), mean (SD)	45.6 (13.9)	46.5 (13.4)	44.3 (13.9)	45.5 (13.7)	.19
Gender, n (%)					.82
Female	124 (79.0)	126 (77.3)	106 (76.8)	356 (77.7)	
Male	33 (21.0)	37 (22.7)	31 (22.5)	101 (22.1)	
Other	0 (0)	0 (0)	1 (0.7)	1 (0.2)	
Education, n (%)					.16
Primary or elementary	0 (0)	2 (1.2)	0 (0)	2 (0.4)	
Secondary or high school	36 (22.9)	39 (23.9)	24 (17.4)	99 (21.6)	
Tertiary undergraduate	74 (47.2)	65 (39.9)	75 (54.3)	214 (46.7)	
Tertiary postgraduate	47 (29.9)	57 (35.0)	39 (28.3)	143 (31.3)	
Ethnicity, n (%)					.34
White	124 (79.0)	118 (72.4)	110 (79.7)	352 (76.9)	
Maori/Pacific Islander	12 (7.6)	16 (9.8)	7 (5.1)	35 (7.6)	
Asian	5 (3.2)	11 (6.7)	2 (1.4)	18 (3.9)	
Black African/American	4 (2.5)	3 (1.8)	3 (2.2)	10 (2.2)	
Indigenous	0 (0)	0 (0)	1 (0.7)	1 (0.2)	
Spanish, Hispanic, Latino	5 (3.2)	3 (1.8)	4 (2.9)	12 (2.6)	
Other	7 (4.5)	12 (7.5)	11 (8.0)	30 (6.6)	
Outcome measures, mean (SD)					
Mental Health	64.4 (17.3)	65.7 (17.5)	64.6 (16.5)	64.9 (17.1)	>.99
Vitality	58.5 (17.4)	60.2 (17.4)	58.6 (17.2)	59.1 (17.3)	.59
Depression	3.8 (3.7)	4.0 (4.1)	3.9 (3.5)	3.9 (3.8)	.50
Anxiety	2.8 (2.9)	2.5 (2.6)	2.5 (2.8)	2.6 (2.7)	.83
Stress	5.7 (3.6)	5.7 (3.6)	5.9 (3.4)	5.7 (3.5)	.67
Flourishing	45.2 (7.1)	45.1 (6.8)	44.5 (6.3)	45.0 (6.7)	.10
Satisfaction With Life	23.4 (6.9)	22.5 (7.3)	22.5 (7.0)	22.8 (7.1)	.73

Measurement—Outcomes

Significant within-group improvements were recorded from pre- to postintervention in all groups and across all domains of mental well-being measured (Table 3). Within-group

improvements ranged from medium to large effect sizes (Cohen *d*), with flourishing ($d=0.64$), mental health ($d=0.67$), and vitality ($d=0.74$) demonstrating the largest effect. No significant between-group differences were observed for any of the outcome measures (Table 3).

Table 3. Pre- to postchanges in outcome measures of participants and between-group differences.

Outcome Measure	N	Pre, mean (SD)	Post, mean (SD)	Mean change	Change (%)	Within-group change, <i>P</i> value	Within-group change, Cohen <i>d</i>	Between-group difference, <i>P</i> value
Mental health								.77
Gr 1 standard—Emails	103	65.2 (16.4)	74.8 (15.2)	9.6	14.7	<.001	0.72	
Gr 2 Standard plus pSMS ^a	114	67.3 (16.7)	76.1 (13.3)	8.8	13.1	<.001	0.69	
Gr 3 Standard plus VCS ^b	103	66.0 (15.3)	74.2 (14.9)	8.2	12.4	<.001	0.61	
Combined	320	66.2 (16.1)	75.1 (14.4)	8.9	13.4	<.001	0.67	
Vitality								.65
Gr 1 Standard—Emails	103	58.7 (16.8)	69.6 (15.8)	10.9	18.6	<.001	0.78	
Gr 2 Standard plus pSMS	114	61.8 (16.5)	71.9 (13.7)	10.1	16.3	<.001	0.81	
Gr 3 Standard plus VCS	103	60.1 (16.1)	69.2 (15.4)	9.1	15.1	<.001	0.63	
Combined	320	60.3 (16.5)	70.3 (15.0)	10.0	16.6	<.001	0.74	
Depression								.93
Gr 1 Standard—Emails	103	3.5 (3.4)	2.2 (2.6)	-1.3	-37.1	<.001	0.44	
Gr 2 Standard plus pSMS	114	3.5 (3.5)	2.1 (2.7)	-1.4	-40.0	<.001	0.51	
Gr 3 Standard plus VCS	103	3.6 (3.3)	2.2 (2.7)	-1.4	-38.9	<.001	0.50	
Combined	320	3.5 (3.4)	2.2 (2.7)	-1.3	-37.1	<.001	0.48	
Anxiety								.25
Gr 1 Standard—Emails	103	2.7 (2.6)	1.5 (1.8)	-1.2	-44.4	<.001	0.52	
Gr 2 Standard plus pSMS	114	2.1 (2.1)	1.4 (1.8)	-0.7	-33.3	<.001	0.35	
Gr 3 Standard plus VCS	103	2.2 (2.5)	1.3 (1.6)	-0.9	-40.9	<.001	0.43	
Combined	320	2.3 (2.4)	1.4 (1.7)	-0.9	-39.1	<.001	0.43	
Stress								.57
Gr 1 Standard—Emails	103	5.8 (3.5)	4.3 (3.1)	-1.5	-25.9	<.001	0.46	
Gr 2 Standard plus pSMS	114	5.5 (3.4)	4.1 (3.0)	-1.4	-25.5	<.001	0.47	
Gr 3 Standard plus VCS	103	6.0 (3.2)	4.2 (3.0)	-1.8	-30.0	<.001	0.60	
Combined	320	5.7 (3.4)	4.2 (3.0)	-1.5	-26.3	<.001	0.51	
Satisfaction With Life								.65
Gr 1 Standard—Emails	103	23.2 (6.8)	25.6 (6.3)	2.4	10.3	<.001	0.50	
Gr 2 Standard plus pSMS	114	23.1 (7.2)	26.0 (6.6)	2.9	12.6	<.001	0.64	
Gr 3 Standard plus VCS	103	22.9 (6.9)	25.5 (6.5)	2.6	11.4	<.001	0.57	
Combined	320	23.1 (6.9)	25.7 (6.5)	2.6	11.3	<.001	0.58	
Flourishing								.99
Gr 1 Standard—Emails	103	45.2 (6.7)	48.1 (5.0)	2.9	6.4	<.001	0.61	
Gr 2 Standard plus pSMS	114	45.1 (7.0)	48.1 (6.1)	3.0	6.7	<.001	0.65	
Gr 3 Standard plus VCS	103	44.8 (6.2)	47.8 (5.9)	3.0	6.7	<.001	0.64	
Combined	320	45.0 (6.6)	48.0 (5.7)	3.0	6.7	<.001	0.64	

^apSMS: personalized SMS.^bVCS: videoconferencing support.**Measurement—Adherence**

Adherence was not significantly different between groups for mean videos watched ($P=.42$) or mean total challenge points

scored ($P=.71$). However, there was notable variability in responses as indicated by the large SDs: videos watched out of 10 ($S=6.05$ (SD 4.0), $S+pSMS=6.48$ (SD 3.9), $S+VCS=6.75$

(SD 3.8); challenge scores out of 1000 ($S=369$ (SD 362), $S+pSMS=340$ (SD 339), $S+VCS=377$ (SD 354)).

In the $S+VCS$ group, mean VCSS attendance was 2.8 out of 10, and 37 out of 103 participants (35.9%) had zero attendance. Just 19 out of 103 participants (18.4%) attended 7 or more VCSSs. Secondary analysis revealed participants who attended more than 7 VCSSs, compared with those who attended 6 or less, demonstrated significantly greater improvements in the measures of mental health ($P=.006$; $d=0.71$), vitality ($P=.005$; $d=0.73$) depression ($P=.04$; $d=0.54$), and satisfaction with life ($P=.046$; $d=0.50$).

Discussion

Principal Findings

This study compared the influence of 3 modes of human support on the outcomes of a Web- and mobile app-based, lifestyle-focused mental health intervention for a healthy adult cohort. Significant improvements in all domains of mental well-being were recorded in all groups, but the mode of human support had no effect. However, attendance at the VCSSs was low, hindering the ability to draw comparisons.

The study population could be classified as healthy (ie, normal), as evidenced by baseline DASS scores that were within the normal range: depression, mean=3.5 (normal 0-4); anxiety, mean=2.1 (normal 0-3); stress, mean=5.7 (normal 0-7). Notably, despite the "healthy" starting point, medium to large effect size improvements were observed. The results of this study are similar to 2 pilot trials [24,25] and an RCT [26] using the same intervention. Medium to large effects may be due, at least in part, to the multimodal nature of the intervention producing a compounding effect [24]. As the intervention embeds a combination of evidence-based strategies from lifestyle medicine and positive psychology for improving mental well-being, the overall effect of the intervention could be expected to exceed that of a single modality approach.

Videoconferencing has been successfully used as a form of support in various settings, but the sessions were not well attended in this study. Previous research highlights the benefits of videoconferencing as a feasible and acceptable mode of support as long as technology assistance is provided [63]. Benefits include enhanced group bonding, peer observation, personal sharing, and a higher social presence when compared with other forms of digital support [63]. However, although videoconferencing has been used as an effective method to support caregivers [64], chronic disease patients [65], new mothers [66], and postsurgical patients [67], it was underutilized in this intervention.

Several factors may have contributed to the underutilization of the VCSSs. First, Web-based interventions are essentially "pull" technologies, relying on the participant to initiate access to the intervention [110]. Conversely, human support features generally "push" participants to engage with a digital intervention [110]. Within this study, automated emails and SMS messages served as "push" strategies, requiring no effort on the part of the participant. However, videoconferencing support is a "pull" device that required participants to actively

seek engagement by attending the scheduled session, and this may have been a contributing factor in low engagement. Second, to overcome potential scheduling barriers, 9 sessions were offered within a week, but this did not translate into higher levels of participation and may have negatively impacted development of group dynamics and peer interaction. Participants could choose to attend any of the 9 sessions offered, which meant group bonding, a known videoconference advantage [63], may have been impeded by a lack of continuity in attendance within each time slot. Notwithstanding, a myriad of other factors may have negatively impacted VCSS engagement, such as time constraints, confidence to use technology, privacy or exposure concerns, and perceptions about effectiveness [63,111]. Undoubtedly, adherence is dynamic in nature [56], and many interindividual variations are still unexplained [49]. The low attendance at the VCSSs highlights the need to investigate engagement facilitators and barriers more thoroughly. Given that the majority of the $S+VCS$ group participants (82%) did not engage regularly with the support provided, this group, in effect, received a comparable level of support with the S group (automated emails), hampering between-group comparability.

Stratified within-group analysis in the $S+VCS$ group showed significantly greater improvement in depression, mental health, vitality, and satisfaction with life metrics for those who attended 7 or more VCSSs. Nevertheless, the results need to be treated with caution because the stratified subgroup is self-selected, no longer randomized, and therefore subject to bias. In addition, the small number of participants and unknown contributing factors (eg, motivation) make drawing conclusions problematic. Elucidating the reasons why participants chose to engage, or not, with videoconferencing support would be an important topic for further research.

Despite the lack of influence of human support in this study, the multimodal intervention demonstrated statistically significant improvement across all groups in all outcome measures, with medium to large effect sizes. Strengthened by results of previous pilot studies [24,25] and the RCT in 2017 [26], it may be feasible to trial the lifestyle-based intervention in primary prevention or clinical settings in the future to attenuate symptoms for those who are at high risk or already suffering from a disorder.

Strengths and Limitations

The intervention, Web design, and additional human support used in this study were underpinned by theoretical models, including the TPB [112], a framework for PSD [93], and key principles of the SAM [34]. Consistency in the VCSSs was enhanced by using 1 experienced, online group facilitator rather than multiple facilitators of varying skill levels. In addition, the study population included a large homogenous cohort, and this was further strengthened by a wide range of age groups from 18 to 81 years.

Limitations included low attendance at VCSSs, which meant that many $S+VCS$ group members probably experienced the intervention similarly to the S group (automated emails), negatively impacting the ability to make meaningful between-group comparisons. Notably, the previous RCT in

2017 [26] demonstrated similar statistically significant improvements within the intervention group to what was seen within the 3 groups of this study. Both the RCT and this study commenced with cohorts who were considered “normal” (indicated by the DASS scores). Conceivably, in adding human support, a ceiling effect was observed, and gauging further improvements above and beyond the benefits of the intervention itself were not realistically measurable.

The cohort were predominantly Seventh-day Adventist church members, which diminishes generalizability to other population groups because of commonly held lifestyle practices (eg, no alcohol or tobacco). Furthermore, participants were skewed toward white females and those who held a tertiary qualification. Although such demographics are commonly portrayed in digital interventions [113,114], these factors limit the generalizability of findings to the broader population. Participants were unblinded, and the study relied on self-reporting for all instruments, which comes with risk of reporting biases (eg, poor recall), and participants are sometimes unaware of their own personal motives and behavior [56].

Other limitations include the failure to measure how participants engaged with automated emails or SMS messages. In addition, we did not gather data regarding the proportion of participants

who accessed the program using the mobile app as an alternative to the Web-based platform, which would have been a useful comparison. In future applications, a postintervention survey should include questions regarding the use and preferences for the delivery systems (ie, computer or mobile app), plus participant perceptions regarding the influence of and personal engagement with email and SMS messaging. It would also be important to administer the intervention to a broader population sample to improve generalizability.

Conclusions

The findings of this study strengthen the rationale for Web- and mobile app-based interventions as easily accessible and scalable mental health promotion initiatives. The study demonstrated that a lifestyle-focused intervention improved the mental well-being of a healthy cohort, irrespective of human support. Low VCSS attendance reduced the ability to draw meaningful between-group comparisons, and hence, the influence of different human support modes, although SMS messages provided no significant benefit over automated email support. Stratified analysis demonstrated that regular attendance at a VCSS might be a possible method to enhance outcomes; however, more research is needed regarding factors that influence engagement with that mode of support.

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Conflicts of Interest

GP is employed by the South Pacific Division of the Seventh-day Adventist Church, which promotes and directs the intervention among members and the wider community. DM administers a “profit-for-purpose” Trust using a version of the intervention; he receives no personal financial remuneration. No authors have a financial interest in the intervention and no other authors have conflicts of interest to declare.

Multimedia Appendix 1

Website and app screenshots.

[PPTX File, 4354 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Timetable overview.

[DOCX File, 14 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Videoconference meeting schedule.

[PDF File (Adobe PDF File), 178 KB-Multimedia Appendix 3]

Multimedia Appendix 4

CONSORT-EHEALTH checklist (V1.6.1).

[PDF File (Adobe PDF File), 283 KB-Multimedia Appendix 4]

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Abbreviations

7DWI: 7 Dimensions of Well-Being Index

CONSORT: Consolidated Standards of Reporting Trials
DASS: Depression, Anxiety and Stress Scale
eLMS: electronic learning management system
MHPI: mental health promotion intervention
PSD: persuasive systems design
RCT: randomized controlled trial
S: standard group
S+pSMS: standard plus personalized short message service group
S+VCS: standard plus videoconferencing support group
SAM: supportive accountability model
SF-36: Short Form Health Survey
SWLS: Satisfaction With Life Scale
TPB: theory of planned behavior

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Original Paper

The Influence of Three Modes of Human Support on Attrition and Adherence to a Web- and Mobile App-Based Mental Health Promotion Intervention in a Nonclinical Cohort: Randomized Comparative Study

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Abstract

Background: The escalating prevalence of mental health disorders necessitates a greater focus on web- and mobile app-based mental health promotion initiatives for nonclinical groups. However, knowledge is scant regarding the influence of human support on attrition and adherence and participant preferences for support in nonclinical settings.

Objective: This study aimed to compare the influence of 3 modes of human support on attrition and adherence to a digital mental health intervention for a nonclinical cohort. It evaluated user preferences for support and assessed whether adherence and outcomes were enhanced when participants received their preferred support mode.

Methods: Subjects participated in a 10-week digital mental health promotion intervention and were randomized into 3 comparative groups: standard group with automated emails (S), standard plus personalized SMS (S+pSMS), and standard plus weekly videoconferencing support (S+VCS). Adherence was measured by the number of video lessons viewed, points achieved for weekly experiential challenge activities, and the total number of weeks that participants recorded a score for challenges. In the postquestionnaire, participants ranked their preferred human support mode from 1 to 4 (S, S+pSMS, S+VCS, S+pSMS & VCS combined). Stratified analysis was conducted for those who received their first preference. Preintervention and postintervention questionnaires assessed well-being measures (ie, mental health, vitality, depression, anxiety, stress, life satisfaction, and flourishing).

Results: Interested individuals (N=605) enrolled on a website and were randomized into 3 groups (S, n=201; S+pSMS, n=202; S+VCS, n=201). Prior to completing the prequestionnaire, a total of 24.3% (147/605) dropped out. Dropout attrition between groups was significantly different ($P=.009$): 21.9% (44/201) withdrew from the S group, 19.3% (39/202) from the S+pSMS group, and 31.6% (64/202) from the S+VCS group. The remaining 75.7% (458/605) registered and completed the prequestionnaire (S, n=157; S+pSMS, n=163; S+VCS, n=138). Of the registered participants, 30.1% (138/458) failed to complete the postquestionnaire (S, n=54; S+pSMS, n=49; S+VCS, n=35), but there were no between-group differences ($P=.24$). For the 69.9% (320/458; S, n=103; S+pSMS, n=114; S+VCS, n=103) who completed the postquestionnaire, no between-group differences in adherence were observed for mean number of videos watched ($P=.42$); mean challenge scores recorded ($P=.71$); or the number of weeks that challenge scores were logged ($P=.66$). A total of 56 participants (17.5%, 56/320) received their first preference in human support (S, n=22; S+pSMS, n=26; S+VCS, n=8). No differences were observed between those who received their first preference and those who did not with regard to video adherence ($P=.91$); challenge score adherence ($P=.27$); or any of the well-being measures including, mental health ($P=.86$), vitality ($P=.98$), depression ($P=.09$), anxiety ($P=.64$), stress ($P=.55$), life satisfaction ($P=.50$), and flourishing ($P=.47$).

Conclusions: Early dropout attrition may have been influenced by dissatisfaction with the allocated support mode. Human support mode did not impact adherence to the intervention, and receiving the preferred support style did not result in greater adherence or better outcomes.

Trial Registration: Australian New Zealand Clinical Trials Registry (ANZCTR): 12619001009101; <http://www.anzctr.org.au/ACTRN12619001009101.aspx>

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KEYWORDS

human support; adherence; attrition; engagement; web-based mental health; health promotion; eHealth; SMS; videoconferencing

Introduction

The burden of mental distress is pervasive globally and includes common mental health disorders such as depression and anxiety. Approximately 300 million people worldwide are affected by depression—the principal cause of global disability [1]. Depression is frequently comorbid with other diseases and severely compromises effective functioning for individuals, negatively impacting family and work environments [1]. Furthermore, indicators suggest that even the general population is increasingly experiencing mental distress, including severe stress, anxiety, depressive symptoms, a sense of isolation, and feeling overwhelmed [2,3].

While a growing repertoire of digital interventions is improving accessibility to treatment options for people with common mental health disorders, there is also an urgent need for easily accessible mental health promotion interventions (MHPIs) to improve the mental well-being of nonclinical population groups. MHPIs that focus on enhancing psychological well-being may provide an important buffer against mental distress, potentially attenuating the mental health burden. Furthermore, lifestyle-focused MHPIs might also ameliorate symptoms for those who have already been diagnosed with a common mental health disorder [4].

Innovative web- and mobile app-based technologies allow MHPIs to be disseminated widely and cost effectively to maximize accessibility. However, despite the many advantages of digital interventions, both high dropout attrition (ie, participants who drop out early or who are lost to follow-up) and nonusage attrition (ie, nonadherence) are persistent problems [5-7].

In his formative publication titled “The Law of Attrition,” Eysenbach [8] called for the methodical study of attrition in eHealth interventions because, unlike drug trials, it is usually easy for participants to both join and withdraw from a digital intervention, especially when they are not critical to life—sometimes described as “easy-in” and “easy-out” [9]. Maximizing adherence, defined as “the degree to which the user followed the program as it was designed” [10], is a complex challenge for researchers and health care providers. Additionally, definition differences and measurement heterogeneity between studies are problematic [11-13]. Nevertheless, many factors affecting adherence have been identified.

Influences on adherence are multifactorial, and consistency in adherence patterns have been elusive [12,14]. A 2018 review of theoretical perspectives on adherence suggested the need for

interdisciplinary collaboration to better understand patterns of adherence due to a diverse range of technological, environmental, and individual influences [12]. For instance, technological factors may include website design, persuasive systems design [15,16], behavior change techniques [17], human support factors [6,8,13,18,19], personalized content (ie, tailoring) [13], frequent updates and dialogue support (ie, praise, rewards, and reminders) [18], and gamification techniques [20]. Environmental influences consist of factors such as socioeconomic status, employment status, education level [21], internet or computer accessibility [22], literacy [21,23], culture, the health care system, family and community support [24], and time availability [13,22]. Examples of individual factors include whether a person self-selects into a study and invests effort [25], planning and self-efficacy [21,26], compatibility with personal values [8], motivation factors [6,22], focus on immediate benefit rather than long-term goals, perceived treatment credibility [13,27], receiving preferences [28], health status, psychological vulnerability [21-23], user expectations [6,13,23], gender [13,21], and age [17,21].

Human Support and Adherence

Clinical Settings

Despite the broad range of factors listed, adherence has frequently been positively associated with human support (ie, guidance) in clinical settings. A qualitative systematic review of 64 studies reported that adherence was improved by support of counselors, peers, and phone and email contact [24]. A 2012 systematic review and meta-analysis concluded that supported interventions yielded better retention and outcomes [29]. Other randomized controlled trials (RCTs) have also reported similar links between human support and adherence [14,30], though greater adherence does not always translate to better outcomes; and adherence may be problematic for individuals with depression, irrespective of the support received [30].

A 2017 scoping review [31] analyzed 19 RCTs from 2000 to 2016 that considered human support factors in internet-based interventions for depression and anxiety. The review identified 7 different human support factors (guided vs unguided, therapist expertise, human vs automated, scheduled vs unscheduled, support mode, synchronicity, and support intensity) and analyzed them for improvement in clinical outcomes and adherence. While just one human support factor (scheduled support) was associated with significantly improved outcomes, results were mixed in relation to adherence, with human support improving adherence in only 4 out of 9 studies [31].

Recent web-based interventions for common mental health disorders, comparing supported and unsupported arms, have found that well-designed self-guided interventions achieve significant improvements in outcomes and maintain high adherence rates irrespective of support provided [32-34]. Notably, in some cases, treatment satisfaction was higher in supported arms [34,35] and some participants perceived support as necessary to success [36].

Human support requirements to encourage adherence may be vastly different in nonclinical populations compared to clinical cohorts who experience symptoms that may preclude them from engaging with an intervention. Therefore, it is vital to determine if human support adds value to an intervention for a nonclinical cohort because unsupported interventions can be administered at a lower cost and be more easily distributed in a scalable manner.

Nonclinical Settings

Studies evaluating the influence of human support on adherence to MHPIs among nonclinical populations are scant in comparison to clinical cohorts. A study involving a mindfulness intervention, targeting college students and young working adults, found that despite telephone or email support, adherence was poor and nonadherers had poorer mental well-being and lower energy and treatment expectancy [37]. The researchers suggested a greater need for collaboration between health professionals and information technology experts to improve the "personalization" of digital interventions to enhance adherence [37]. A Swedish study that implemented an internet-based relaxation program found that human support did not affect treatment outcomes or adherence [27,35]. Outcomes were positively associated with completing the homework (ie, behavioral tasks) but not engagement with the online aspect of the program. Early attrition was predicted by low belief in the treatment; and nonadherence was associated with increased stress symptoms, lower levels of intrinsic motivation, and a greater focus on immediate consequences of behavior as opposed to long-term gains. Conversely, adherence was predicted (positively) by education level and treatment credibility.

In a pooled analysis of 3 web-based studies [14], researchers investigated the influence of 3 types of support: content-focused (ie, personalized email feedback), adherence-focused (ie, monitoring adherence and sending reminders), and administrative support (ie, access to contact details to ask for technical assistance). Those who received content- and adherence-focused support completed more modules than those who received only administrative support. However, the

researchers concluded that even after taking human support and other demographic variables into consideration, most interindividual variations in nonadherence remained largely unsolved [14]. A web-based mindfulness and stress management RCT [38] compared the effects of no support, group support only, and group support with added clinician support on engagement and outcomes. Group support improved outcomes and adherence, but extra clinician support added no benefit. Notably, although the program was web-based, support was provided face-to-face in the workplace.

We have previously reported the mental health outcomes of this study and found that no difference was observed between groups; improvements in outcomes were obtained irrespective of the differing modes of human support offered [39]. This study focused on examining attrition and adherence patterns between the groups. We also evaluated user preferences for human support and assessed whether adherence and mental health outcomes were enhanced when participants received their preferred mode of human support. The outcomes of the study contribute toward understanding the value of human support on adherence to a web- and mobile app-based MHPI targeting a nonclinical cohort. This is vital information for researchers and clinicians in order to inform the optimal delivery of digital MHPIs in a cost-effective, accessible, and scalable manner.

Methods

This section provides a brief summary of methods used. For a detailed explanation of the methods, refer to our previous article that reported the influence of human support mode on mental well-being outcomes [39].

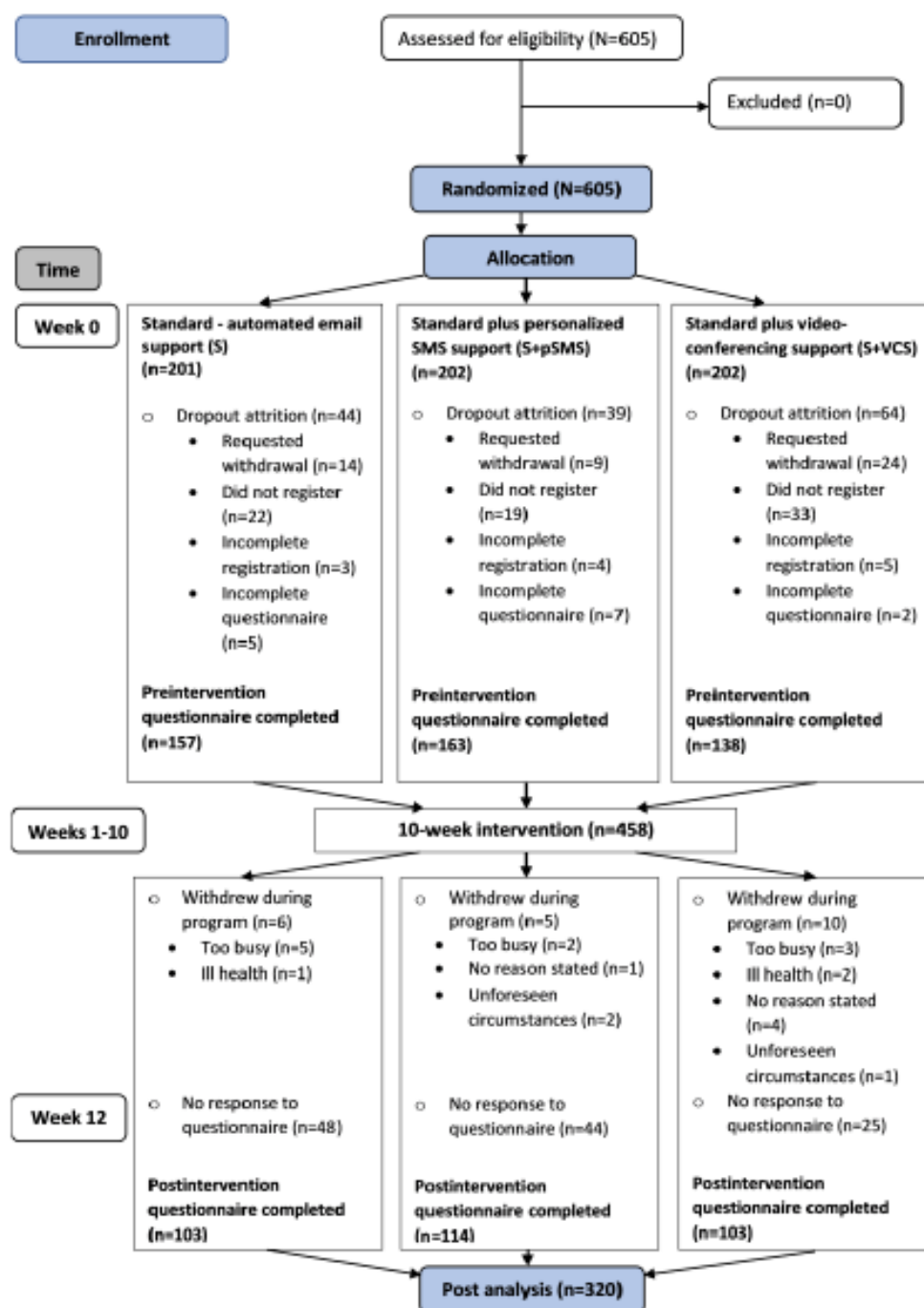
Study Design

The multiarm randomized comparative study design included 3 intervention groups that varied by human support mode: standard (S), comprising fully automated emails only; standard plus personalized SMS text messaging support (S+pSMS); standard plus videoconferencing support (S+VCS).

Recruitment and Randomization

The study was advertised to members of a faith-based organization using a combination of methods (eg, email, social media, bulletins, and magazines), and interested individuals were directed to a website to apply. After randomization, eligible participants were emailed their group allocation, a participant information document, and instructions on how to complete registration onto the electronic learning management system (eLMS), signaling consent. Figure 1 demonstrates the flow of participants through the study.

Figure 1. Flow of participants.



Intervention

The 10-week interdisciplinary intervention introduced participants to a range of evidence-based strategies for enhancing mental well-being, from the disciplines of lifestyle medicine and positive psychology. Participants logged onto the eLMS or mobile app to access the intervention, which included video content and a place to log daily and weekly experiential challenges (see screenshots in [Multimedia Appendix 1](#)). The

website and mobile app were designed using a range of persuasive system design principles to increase engagement [15]. Each week, participants were encouraged to view one lesson, perform small daily challenges, and complete 1 larger weekly challenge. A detailed week-by-week summary of the content and experiential challenge activities can be found in [Multimedia Appendix 2](#).

Human Support

The study was structured to compare the value of increasingly greater levels of human support on adherence. Principles of the adherence-focused supportive accountability model [6] underpinned interactions between the support coach and participants. As the lowest form of support, one automated email was sent to the participants each week, consisting of the following: their first name as a salutation, a couple of sentences to encourage them to view the content, and a link to an introductory video by the presenter. A reminder email was sent if a participant had not logged experiential activity for 3 days, or viewed video content for 8 days. The second level of support involved SMS messages that were written and sent from a support coach who focused on ensuring content was process-focused; messages were sent regularly, and tone exuded positivity. Messages addressed the recipient by first name and were signed by the support coach. They were sent 3 times weekly for the first 3 weeks, and twice weekly for the remaining 7 weeks. In the highest level of support, the opportunity to develop key tenets of the supportive accountability model (eg, bond and legitimacy) was provided through weekly videoconferencing sessions (9 weekly time slots). Focus was given to facilitating a supportive, respectful environment where participants could share experiences safely. The facilitator sought to build trust through benevolent engagement with participants.

Measurements

Dropout Attrition

Dropout attrition was measured as the total number of randomized participants who did not complete either the preintervention (ie, early dropout) or the postintervention (ie, lost to follow-up) questionnaire.

Adherence Measures

Primary Adherence—Videos Viewed

Primary adherence was measured as the total number of weekly videos viewed, out of a total of 10. A video was considered “viewed” when at least 80% of the presentation had been played.

Secondary Adherence—Experiential Challenge Activities

Participants were encouraged to accumulate points through daily and weekly challenge activities that involved putting the new learning into practice. Engagement with challenges was measured in 2 ways—the total weekly challenge score and the total number of weeks out of 10 in which an engagement with a challenge was recorded. Each daily challenge was worth 10 points (ie, a total of 70 points weekly), and weekly challenges were worth 30 points. Therefore, participants could score a maximum of 100 points each week throughout the 10-week intervention, thereby accumulating a total of 1000 points to be considered fully adherent for the experiential challenge activities.

Videoconference Adherence

Attendance records were kept for the videoconference support sessions for those in the S+VCS group. Each participant was invited to attend 1 session each week, out of a possible 9

available time slots. Participants were able to receive a maximum adherence score of 10 over the 10-week intervention.

Well-Being Measures

A self-report questionnaire termed the “7 Dimensions of Wellness Index” was completed by all participants on the web-based eLMS or on the mobile app, at preintervention (Week 0) and postintervention (Week 12) (Figure 1). Demographic and lifestyle-associated questions were combined with freely accessible validated instruments to measure the participant’s well-being in several domains: physical, emotional, social, vocational, intellectual, spiritual, and environmental. Validated instruments utilized for this study on mental well-being included 2 subdomains from the 36-item Short Form Health Survey (SF-36) (ie, mental health and vitality) [40]; the 21-question Depression Anxiety and Stress Scales (DASS-21) to measure depression, anxiety, and stress [41]; the Diener flourishing scale [42]; and the Diener Satisfaction With Life Scale (SWLS) [43,44]. Well-being measures are reported on in detail in the aforementioned article [39].

Preferences

Participants rated 4 different human support options from most preferred to least preferred (1=most preferred, 4=least preferred) as part of the postintervention questionnaire. Support options were as follows: standard (automated email only), standard plus SMS only, standard plus VCS only, and standard plus SMS and VCS combined (not offered in the study). Stratified analyses were conducted to measure adherence and outcomes for participants who received their desired human support preference.

Statistical Analysis

Analyses were conducted using SPSS, version 25 (IBM Corp). Preintervention-to-postintervention changes were calculated using paired *t* tests. Descriptive statistics, involving means and standard deviations, measured patterns of adherence. Analysis of variance (ANOVA) was used to compare adherence between groups. Fisher exact test was utilized to analyze relationships between categorical variables, and Cohen *d* measured effect size.

Ethics and Informed Consent

Avondale Human Research Ethics Committee granted ethics approval for the study (Approval No. 2018.09), and it was registered with the Australian and New Zealand Clinical Trial Registry (ANZCTR12619001009101). An email containing an “Information Statement” and a “Participant Consent Form” was sent to all prospective participants. The email explained that choosing to register on the eLMS would signify informed consent.

Results

Participants

Potential participants (*N*=605) enrolled on the information website and agreed to participate in the study irrespective of randomization allocation. Subjects were randomized into 3 arms (S, *n*=201; S+pSMS, *n*=202; and S+VCS, *n*=202) (Figure 1).

During a 1-week period, after being notified of group allocation, and before the intervention commenced, 24.3% (147/605) of participants dropped out. Early dropout attrition between groups was significantly different ($P=.009$). A total of 21.9% (44/201) withdrew from the S group, 19.3% (39/202) from the S+pSMS group, and 31.6% (64/202) from the S+VCS group. Table 1 shows that dropout was significantly different between groups when the S+VCS group was compared; differences were not significant between the S and S+pSMS groups.

A total of 75.7% (458/605) of randomized participants registered on the eLMS and completed the initial questionnaire (S, $n=157$; S+pSMS, $n=163$; S+VCS, $n=138$). Notably, there were no significant differences between the groups in age ($P=.19$), gender ($P=.82$), education ($P=.16$), or ethnicity ($P=.34$). Of the registered participants, 69.9% (320/458) completed the postintervention questionnaire (S, $n=103$; S+pSMS, $n=114$; S+VCS, $n=103$), resulting in 30.1% (138/458) being lost to follow-up; there was no difference between groups ($P=.24$).

Table 1. Dropout attrition between groups.

Group comparison	P value
All groups	.009
S ^a and S+VCS ^b	.03
S+pSMS ^c and S+VCS	.004
S and S+pSMS	.52

^aS: standard (automated emails only).

^bS+VCS: standard plus videoconferencing support.

^cS+pSMS: standard plus personalized SMS.

Adherence

Primary Adherence—Videos Viewed

As shown in Table 2, the number of videos viewed was not significantly different between the groups ($P=.42$). Almost half

of all participants in each group were fully adherent (ie, watched all 10 video sessions), with less than 10% of individuals in each group viewing no videos. Furthermore, the percentage of participants at any level of adherence did not differ significantly between groups.

Table 2. Primary adherence percentages and between-group comparisons.

Videos viewed	S ^a ($n=103$)	S+pSMS ^b ($n=114$)	S+VCS ^c ($n=103$)	Between-group difference P value
Number of videos viewed, n (%)				
10	47 (44.6)	54 (47.4)	50 (48.5)	.58
8-9	4 (3.8)	6 (5.3)	5 (4.9)	.38
5-7	12 (11.6)	15 (13.2)	18 (17.5)	.54
1-4	33 (32.0)	31 (27.2)	21 (20.4)	.55
0	7 (6.8)	8 (7.0)	9 (8.7)	.95
Videos viewed, mean (SD)	6.0 (4.04)	6.5 (3.87)	6.8 (3.75)	.42

^aS: standard (automated emails only).

^bS+pSMS: standard plus personalized SMS.

^cS+VCS: standard plus videoconferencing support.

Secondary Adherence—Challenges

No significant differences were recorded between the groups in the mean challenge points scored ($P=.71$) or in the mean number of weeks in which challenge scores were recorded ($P=.66$) (Table 3). There was an overall lack of adherence to experiential challenges, as indicated by mean challenge scores less than 400 out of a possible 1000 points. Additionally, challenge scores were logged in fewer than half of the weeks for the 10-week intervention.

Figure 2 shows weekly mean challenge scores by group, and Figure 3 portrays what percentage of participants were logging

challenges each week over the 10-week intervention. The mean number of challenge points scored was greatest in the first 3 weeks for the 3 groups. Additionally, scores declined in a graded manner from weeks 3 to 10 in each group, as illustrated in Figure 2. During the first 3 weeks of the intervention, between 59%–72% (67 to 74) participants in each group were logging challenges. The number of participants logging challenges was greatest in week 1 for the S group, highest in week 2 for the S+VCS group, and highest in week 3 for the S+pSMS group, although between-group differences were not significant. Figure 3 illustrates the steady decline in participants logging challenges from lessons 3 to 10 for all groups.

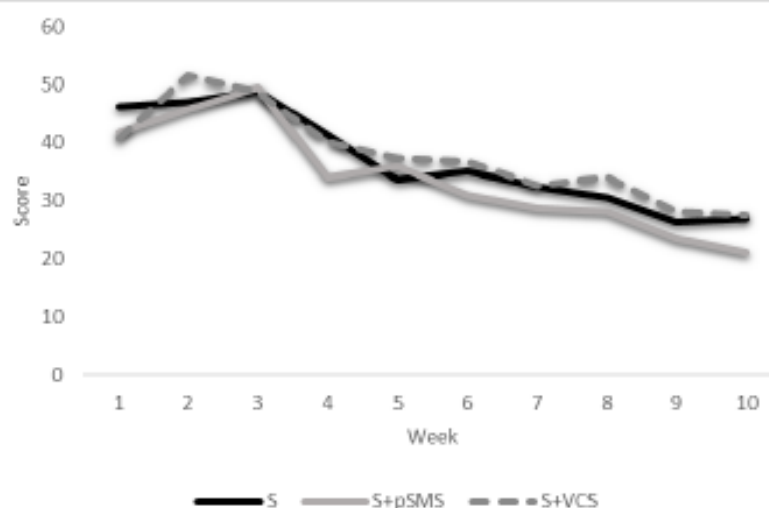
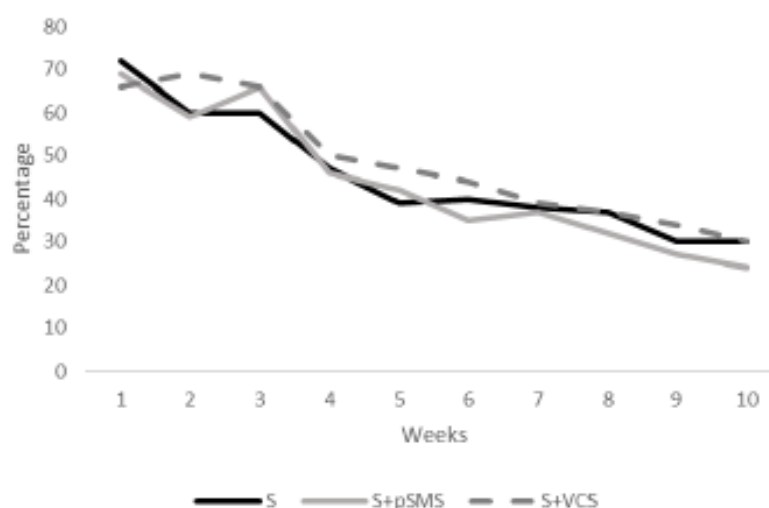
Table 3. Secondary adherence scores for experiential challenge activities.

Challenge activities	S ^a (n=103)	S+pSMS ^b (n=114)	S+VCS ^c (n=103)	P value
Challenge points (out of 1000), mean (SD)	368.7 (361.6)	340.2 (339.0)	377.5 (354.0)	.71
Number of weeks in which challenge scores were logged (out of 10), mean (SD)	4.5 (3.7)	4.4 (3.4)	4.8 (3.6)	.66

^aS: standard (automated emails only).

^bS+pSMS: standard plus personalized SMS.

^cS+VCS: standard plus videoconferencing support.

Figure 2. Group-based mean challenge scores over 10 weeks. S: standard—automated emails; S+pSMS: standard plus personalized SMS; S+VCS: standard plus videoconferencing support.**Figure 3.** Percentage of participants who logged challenges over 10 weeks. S: standard—automated emails; S+pSMS: standard plus personalized SMS; S+VCS: standard plus videoconferencing support.

Videoconference Adherence

Participation in videoconferencing support was low, with 35.9% (37/103) of participants (in the S+VCS group) not attending

any support sessions and only 18.4% (19/103) attending 7 or more out of 10 sessions.

Preferences

Table 4 specifies the preferred mode of human support by group. A total of 88.7% (284/320) of participants indicated a valid human support preference. Almost half of participants within each group indicated a preference for combined support (ie, automated emails, personalized SMS, and VCS); however, the combined support alternative was not offered as part of the study. In comparison, the preference for solely S+VCS support was low across all the groups, with only between 7% to 8% choosing it from each group. Table 4 also indicates that 24% (22/91) in the S group, 27% (20/96) in the S+pSMS group, and 8% (8/97) in the S+VCS group received their preferred mode of support.

Table 4. Preferences for modes of human support.

Support mode preference	S ^a (n=91)	S+pSMS ^b (n=96)	S+VCS ^c (n=97)
Standard, n (%)	22 (24)	21 (22)	18 (19)
Standard plus SMS support, n (%)	25 (27)	26 (27)	23 (24)
Standard plus VCS ^d support, n (%)	6 (6)	7 (7)	8 (8)
Standard plus SMS & VCS support, n (%)	38 (42)	42 (44)	48 (49)

^aS: standard (automated emails only).

^bS+pSMS: standard plus personalized SMS.

^cS+VCS: standard plus videoconferencing support.

^dVCS: videoconferencing support.

Table 5. The preferred human support mode's effect on adherence and outcomes.

Variables	Preference		Between-group difference	
	No (n=1000), mean (SD)	Yes (n=56), mean (SD)	P value	Cohen d
Adherence				
Videos watched (out of 10)	6.1 (3.9)	6.5 (4.0)	.91	0.09
Challenge points (out of 100)	339.9 (352.2)	388.6 (385.9)	.27	0.13
Outcomes				
Mental health	8.4 (14.4)	9.8 (13.3)	.86	0.10
Vitality	9.5 (15.2)	10.6 (13.8)	.98	0.08
Depression	-1.3 (3.4)	-1.6 (2.5)	.09	0.10
Anxiety	-0.6 (1.9)	-1.2 (2.6)	.64	0.26
Stress	-1.0 (3.5)	-1.6 (2.8)	.55	0.19
Life satisfaction	2.2 (4.6)	1.9 (4.8)	.50	0.06
Flourishing	0.14 (.53)	0.21 (.53)	.47	0.13

Discussion

Principal Results

Higher early dropout attrition occurred in the group which was allocated videoconferencing as a mode of human support. However, the mode of human support made no impact on attrition or adherence after the commencement of the intervention. Moreover, for participants who received their first

Secondary analysis was conducted to determine whether those who received their first preference for support mode scored better adherence or outcomes than those who did not receive their first choice. Participants (n=128) who chose the combined support as their first preference (an option not included in the comparative study) were excluded from the analysis, and the remaining participant data (n=156) were analyzed. Table 5 outlines the results between those who did not receive their first preference in human support mode and those who did. There was no significant difference between the 2 groups in either adherence or well-being measures.

preference in human support, compared to those who did not, no differences were observed in adherence. Preference for VCS support was low, yet almost half of the participants indicated they would prefer all forms of human support, though this was not an option in this study.

In this study, after the initial email notified participants of their group allocation, a disproportionate number of participants allocated to the S+VCS group withdrew from the study, with a

significant between-group difference ($P=.009$). The early dropout attrition may have been influenced by dissatisfaction with the assigned support mode. Figure 1 shows that, in the S+VCS group, 57 participants either requested withdrawal or failed to register compared to 36 in the email group (S), and 28 in the S+pSMS group. Of the 24 participants who requested withdrawal from the S+VCS group, 10 stated that time was a factor, 8 provided no specific reason, 4 stated personal illness, 1 mentioned work commitments, and 1 participant stated they did not want to be involved in videoconferencing.

No differences in adherence between the groups were detected; and as documented in a previous report [39], we observed no differences between the groups in the well-being measures either. However, in observing that almost half (150/320, 46.9%) of the entire cohort were 100% adherent (ie, viewed all 10 videos), we conducted stratified analysis to compare well-being measures of those who were fully adherent ($n=150$) with those who were not ($n=170$). Significantly greater improvements were observed in the fully adherent group for life satisfaction ($P=.011$; $d=0.15$) and flourishing scores ($P=.012$; $d=0.15$), yet effect sizes were small.

While the primary aim of human support is usually to foster greater adherence [14,45,46], support did not influence adherence behavior for the participants in this study. While earlier research among clinical cohorts have indicated that supported interventions yielded better adherence and outcomes [29,47,48], numerous studies have also shown that human support made no difference [31,32,34,49–53]. Considering the extensive repertoire of previously identified factors affecting adherence, it is plausible that, in this nonclinical group, a wide range of variants may have influenced adherence at the individual level [14], reducing the potential impact of human support as a single factor. Therefore, exploring participants' perceptions regarding influences on adherence is an important topic for further investigation.

The S+VCS was the least preferred support mode (7%), and low VCS attendance reflected the low preference for this type of support. Exploring reasons for the disinterest in videoconferencing as a mode of support may be a topic for further research, as videoconferencing has been used successfully in other group contexts [54–58] and has proven to be useful so long as technical support was provided [54]. Albeit, in a recent German study, 64% of patients were resistant to videoconferencing as a method of communication with health professionals. Notably, less than 1% reported previous experience with its use [59].

The S+VCS group allocation required an extra time commitment on behalf of participants compared to the other groups. Both email and SMS support required no effort by the participant—support was “pushed” to devices [7]. Conversely, videoconference support attempted to “pull” participants to an extra event, requiring effort and time to gain benefit from the support offered. Conceivably, the time and energy required to engage with that mode of support, loss of anonymity, technological barriers, unfamiliarity with videoconferencing software, or concerns about the group interaction may have been a barrier that facilitated significantly greater dropout.

Additionally, further research should investigate if the preference for S+VCS would have been higher if support had been provided on an individual rather than a group basis.

For participants remaining in the S+VCS group, many demonstrated low engagement with the videoconferencing support. Consequently, by not engaging in the VCS support, they experienced a similar level of support to those in the S group (ie, automated emails only). This hindered the ability to draw meaningful between-group comparisons regarding the influence of human support offered through video conferencing on adherence.

Receiving their first preference in human support mode did not translate to participants reporting better adherence or outcomes in this study. We were unable to locate comparable studies for nonclinical groups. However, previous research among clinical cohorts has demonstrated that receiving support preferences may impact patient perceptions about the usefulness of an intervention [60] and improve adherence [28,61]. While a meta-analysis revealed that patients receiving their preferences demonstrated improved treatment satisfaction, adherence, and outcomes with moderate effect sizes [28], other research found that receiving the preferred option does not always impact outcomes [61,62]. A 2019 study of patients with anxiety and depression compared adherence and outcomes when patients chose their preferred support [63]. Interestingly, 78% chose the maximal support option, regular weekly support, and just 22% chose optional support (ie, support by request only). Yet, both groups achieved similar improvements in anxiety and depression scores and there were no differences in adherence. Contact between participants and therapist was much less for those who chose optional support, suggesting that similar results can be achieved with less time and cost investment.

Although combined human support (ie, access to automated emails, SMS, and videoconferencing) was not offered in the study, it is interesting that almost half of the participants in every group chose this as their preferred support option. While the reasons for this are unclear, it is hypothesized that it is a common trait of human nature to want access to everything possible, even though the available options are not necessarily utilized or needed. Further research exploring participant perceptions regarding human support modes and preferences is warranted.

Strengths and Limitations

The intervention and its implementation were supported by established theory. While the intervention itself was underpinned by the theory of planned behavior [64], the design components of the intervention for the web- and mobile app-based platforms were informed by the persuasive design model [15] and human support elements reflected principles of the supportive accountability model [6]. The use of a sole facilitator as a support person provided consistency in the participant's experience with regards to technical assistance, messaging, and videoconference facilitation. The study attracted a large cohort with a broad range of ages (18–81 years); and adherence data was easily collected through the eLMS and mobile app, avoiding the possibility of human error. Despite the addition of human support elements, the administration of the intervention using

the eLMS and the mobile app provided acceptable scalability, portability, and accessibility, demonstrating the potential for broad-based mental health promotion.

Several limitations should be noted. The study attracted mainly White, well-educated women. While this is often seen in digital health interventions [65,66], it limits the ability to generalize more widely. Data gathering relied on self-reporting, which may be subject to bias, and self-selection into the study may have resulted in a cohort skewed by factors such as technological ability and motivation to achieve better mental health. Bias may have been introduced by the disproportionate number of participants who withdrew from the S+VCS group after being notified of their group allocation, reducing the validity of the randomization process. In asking participants to rank human support preferences, analyses were limited by including a preference option in the questionnaire that was not included in the study (ie, combined support involving email, SMS, and VCS). Almost half of the participants ranked combined support as their first preference and were consequently excluded from further investigation, reducing the power of the analyses. Additionally, some factors that would have been useful for

group comparison were not measured. For example, asking participants to indicate their level of engagement with SMS and emails, and collecting data regarding preference for use of the mobile app compared to the web-based experience, would have provided an indication of engagement with the human support offered.

Conclusions

The findings of this study indicate that a web- and mobile app-based MHPI for a nonclinical cohort can be designed and implemented to maximize accessibility, scalability, and adherence without the additional cost of human support. While early dropout attrition may have been influenced by displeasure with allocated support, adherence to a 10-week MHPI for a healthy cohort was not impacted by differing modes of human support. Engagement with videoconference support was suboptimal, hindering the ability to draw meaningful between-group comparisons. However, SMS support demonstrated no added value compared to automated email support. Adherence was not impacted by participants receiving their first preference for support. Future research should explore participant perspectives on adherence behaviors.

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Conflicts of Interest

DM operates a "profit-for-purpose" trust that administers the delivery of a version of the intervention; no personal remuneration is received. GP is employed by the South Pacific Division of the Seventh-day Adventist Church, which administers the intervention among members of the organization, including the participants of this study. No authors have a financial interest in the initiative, and there are no other conflicts of interest to declare.

Multimedia Appendix 1

Website and app screenshots.

[PDF File (Adobe PDF File), 1454 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Detailed intervention overview.

[PDF File (Adobe PDF File), 208 KB-Multimedia Appendix 2]

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Abbreviations

ANZCTR: Australian New Zealand Clinical Trials Registry

DASS: Depression, Anxiety and Stress Scales
eLMS: electronic learning management system
MHPI: mental health promotion intervention
RCT: randomized controlled trial
S: standard (automated emails only)
S+VCS: standard plus videoconferencing support
S+pSMS: standard plus personalized SMS
SF-36: Short Form Health Survey
SWLS: Satisfaction With Life Scale
VCS: videoconference support session

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Original Paper

Participant Perceptions of Facilitators and Barriers to Adherence in a Digital Mental Health Intervention for a Nonclinical Cohort: Content Analysis

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Abstract

Background: Digital mental health promotion interventions (MHPIs) present a scalable opportunity to attenuate the risk of mental health distress among nonclinical cohorts. However, adherence is frequently suboptimal, and little is known about participants' perspectives concerning facilitators and barriers to adherence in community-based settings.

Objective: This study aimed to examine participants' perceptions of facilitators and barriers to adherence in a web- and mobile app-based MHPI for a nonclinical cohort.

Methods: This qualitative study used inductive, reflexive thematic analysis to explore free-text responses in a postintervention evaluation of a 10-week digital MHPI. The intervention was administered using a web and mobile app from September to December 2018. Participants (N=320) were Australian and New Zealand members of a faith-based organization who self-selected into the study, owned a mobile phone with messaging capability, had an email address and internet access, were fluent in English, provided informed consent, and gave permission for their data to be used for research. The postintervention questionnaire elicited participants' perceptions of facilitators and barriers to adherence during the intervention period.

Results: Key factors that facilitated adherence were engaging content, time availability and management, ease of accessibility, easy or enjoyable practical challenges, high perceived value, and personal motivation to complete the intervention. The primary perceived barrier to adherence was the participants' lack of time. Other barriers included completing and recording practical activities, length of video content, technical difficulties, and a combination of personal factors.

Conclusions: Time scarcity was the foremost issue for the nonclinical cohort engaged in this digital MHPI. Program developers should streamline digital interventions to minimize the time investment for participants. This may include condensed content, optimization of intuitive web and app design, simplified recording of activities, and greater participant autonomy in choosing optional features. Nonetheless, participants identified a multiplicity of other interindividual factors that facilitated or inhibited adherence.

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KEYWORDS

web-based mental health; health promotion; eHealth; adherence; participant perceptions; mobile phone

Introduction

Background

Mental distress and disorders are increasingly prevalent [1], and mental health promotion interventions (MHPIs) present opportunities to enhance the well-being of nonclinical groups, decreasing the risk of mental health distress. The widespread availability of digital technology offers unprecedented accessibility, portability, and cost-effectiveness for implementing such interventions on a wide scale. However, adherence, defined by Kelders et al [2] as “the extent to which individuals should experience the content (of the intervention) to derive maximum benefit from the intervention, as defined or implied by its creators,” is often suboptimal [3], and little is known about participants’ perceptions of facilitators of and barriers to adherence for nonclinical cohorts in community-based settings.

Considerable research has been undertaken by researchers and program developers to facilitate optimum adherence to digital health initiatives. Methods used to promote participant adherence include the adoption of a robust set of persuasive system design principles [2,4,5], provision of rewards and incentives, positive feedback [6], implementation of gamification techniques [7,8], and various forms of human support [9]. However, adherence to digital interventions remains to be problematic [3], and there is a paucity of research elucidating participant perspectives on the factors that impact adherence [10] in community-based, nonclinical groups. Importantly, factors that may hamper adherence in a clinical population (eg, disease and disorder symptoms) [11,12] may be dissimilar to the influences on adherence in healthy nonclinical cohorts.

Several qualitative studies have addressed participant perspectives on perceived barriers to and facilitators of adherence in MHPIs for nonclinical cohorts in workplace settings. A stress management intervention, using mindfulness training, found that participants’ attitudes (eg, motivation, previous interest in mindfulness, and positivity toward change), awareness of treatment effectiveness, curiosity, and alignment with personal preferences for managing stress were facilitators of adherence [13]. Conversely, barriers included insufficient detail or evidence provided as a rationale for the strategy used, length of time required for completing activities, and program intensity [13]. Carolan and de Visser [14] explored employee perspectives on workplace digital mental health interventions and found that lack of time was considered the core barrier to adherence. Notably, anonymity, convenience, and flexibility were deemed to have dual impacts (ie, considered both a facilitator and barrier). Employees described their ideal workplace intervention as one that was short, that was easily accessible, that was available for an indefinite period, updated regularly, and that provided some form of e-coaching support [14]. Research by Blankenhagel et al [15], which focused on the perspectives of various stakeholders in digital stress management programs, found that certain requirements of interventions were needed for nonclinical users who often have substantial work responsibilities. These intervention

requirements were prioritizing time efficiency (5- to 15-minute sessions), splitting larger goals into smaller goals, providing flexibility for users to design their own personal notification or reminder schedule, featuring an intuitive and simple web or app design, prioritizing individualization (ie, tailoring), providing high autonomy, fostering some degree of human interaction, facilitating comparability to peers, and offering high mobility [15]. The aforementioned requirements related to a work-based setting for a nonclinical cohort; however, although there may be similarities, variant influences on adherence may be present in a community-based context.

This study sought to broaden the understanding of factors that both facilitate and hinder adherence in a nonclinical cohort participating in a digital MHPI within a community-based situation. This study builds on quantitative data collected during a randomized comparative study that examined the impact of different levels of human support on well-being outcomes [16] and attrition and adherence [17] in a digital MHPI for a nonclinical cohort. Quantitative data revealed improvements in mental well-being irrespective of the level of human support offered, and adherence did not differ significantly between groups. Notably, using the aforementioned definition of adherence by Kelders et al [2], participants were advised to view one video weekly and complete daily and weekly experiential activities over a 10-week period to gain optimal benefit from the intervention. Overall, attrition and adherence were suboptimal [17]. A total of 605 subjects indicated an interest in the intervention by filling out a preliminary web-based enrollment form, with 24.3% (147/605) of these subjects not fully registering by failing to complete the prequestionnaire. Of those who completed the prequestionnaire ($n=458$), a further 30.1% (138/458) did not complete the postquestionnaire, resulting in a completion rate of 69.9% (320/458). Primary adherence was measured by the number of videos viewed, with 34% (109/320) of the cohort watching less than half of the videos, 18.9% (60/320) viewing 5 to 9 videos, and 47.1% (151/320) viewing all 10 videos. Secondary adherence was measured by the points scored for completing assigned daily and weekly activities. Participants could score a total of 1000 points (ie, 100 points weekly throughout the 10-week intervention) to be considered fully adherent. The mean score for the cohort was 362, indicating low adherence to challenge activities [17].

Objectives

This study aims to increase knowledge regarding participant adherence in digital MHPIs by revealing participant perceptions about the facilitators and barriers to watching the videos and their completion of daily and weekly experiential activities. The findings will assist researchers and developers to refine and improve the design and implementation of interventions to optimize the adherence of participants in future MHPIs in nonclinical settings.

Methods

Overview

This qualitative study stems from the aforementioned study, which reported the quantitative results of the intervention

[16,17]. These qualitative responses were recorded as part of the postquestionnaire administered at the conclusion of the intervention. Participants were allocated a 2-week period, immediately after the intervention period, to complete the postquestionnaire on either the provided app or the web platform. Therefore, the following section of this paper is a summary of the methods used in the aforementioned study, with details only provided for those areas related to the qualitative components of this study.

Setting and Participants

Advertising was used to direct potential participants (Australian and New Zealand members of the Seventh-day Adventist Church) to a website that explained the intervention, outlined the inclusion criteria, and provided an opportunity to self-enroll as a potential participant. To be included in the study, subjects were required to be aged above 18 years, own a mobile phone with SMS text messaging capability, have internet access, be an Australian or New Zealand resident, be fluent in English, provide informed consent, and give permission for their data to be used for research [16]. Participants who completed the MHPI were invited to provide free-text responses to 2 statements within the postquestionnaire.

Intervention

The intervention program, known as the *Live More Project* or *Lift Project*, introduced participants to aspects of neuroscience and a combination of evidence-based strategies to enhance mental well-being from the disciplines of lifestyle medicine and positive psychology. Designed to be implemented as a weekly session for 10 weeks, the content of the program was shared in a 30-minute audiovisual presentation followed by participation in daily and weekly practical activities to consolidate learning. Video sessions were released weekly with a lock/unlock system so that participants watched the presentations in sequential order. An intervention and activity overview is provided in [Multimedia Appendix 1](#).

Subjects chose to access the program on a web-based learning management system (eLMS) or a mobile app. Along with the audiovisual content, the eLMS or mobile app included a place to complete the pre- and postquestionnaire, a section to log experiential activity and earn points, an opportunity to interact with other participants through a public feed, and gamification strategies (eg, points on a leaderboard or badges) to induce adherence. As an optional extra, previously introduced experiential activities could be repeated and logged in forthcoming weeks to earn extra points. This resulted in an increasingly longer list of activities to complete as the intervention progressed. Screenshots of the web- and mobile app design are shown in [Multimedia Appendix 2](#).

Participants were divided into 3 groups that differed according to the mode of human support allocation. The first group received automated email support only, the second group received automated email support along with text messages (2-3 times weekly), and the third group received weekly videoconference support along with email support [16].

Data Collection

After completing the intervention, each participant was asked to complete the postquestionnaire within a 2-week period on either the web or mobile app. As part of the postquestionnaire, participants responded to 2 adherence-related statements in an expanding text box with no imposed word limits. These statements were as follows:

- *Statement 1:* thinking about your personal experience as a participant in the Live More Project over the last 10 weeks, if it was *easy* for you to watch the video presentations and complete the daily and weekly challenges, please describe/list all the factors that contributed to this.
- *Statement 2:* thinking about your personal experience as a participant in the Live More Project over the last 10 weeks, if it was *difficult* for you to watch the video presentations and complete the daily and weekly challenges, please describe/list all the factors that contributed to this.

Data Analysis

An inductive, reflexive thematic analysis (RTA) approach [18-20] was used to extract meaning from the data set. The inductive approach is sometimes described as *bottom-up*, or data-driven, as the themes are generated from within the data [20]. The RTA method suited one researcher (MR) performing the initial coding, followed by 2 additional coders reviewing the progress. MR had multiple roles in the study and functioned as the technical support person; therefore, this approach, in which multiple coders reviewed the data (as recommended by O'Brien et al [21]), reduced the possibility of personal bias.

The coding researcher adopted the 6 phases of thematic analysis by Braun and Clarke [20] as a structured approach and used a spreadsheet (Microsoft Excel) and a qualitative analysis program (NVivo software) to assist in collation, analysis, and coding of the deidentified data. All identifying information was removed before coding, and participant identification numbers were used instead. In phase 1, the researcher read through the data set twice to maximize familiarity with the data. During phase 2, all comments were systematically analyzed by constructing and labeling codes in a descriptive and interpretive manner until all data were coded. In an additional immersion stage, coding was reviewed and code names were edited. In phase 3, the researcher scrutinized the codes for patterns, relationships, and similarities. The codes were clustered together based on broad themes. During phase 4, after repeated scrutiny to ensure that the code names accurately matched the data and that the developing themes represented the participants' descriptions of their most typical experiences, clusters were formed into broad themes and several subthemes to develop a thematic map, as recommended by Braun and Clarke [18]. To ensure that the themes and subthemes accurately reflected the original data set as a whole, and the coded data, a final revision of the themes and codes was undertaken by the original coding researcher in consultation with 2 other researchers. During this process, the coders analyzed the themes and subthemes in relation to the original intention of the study. This procedure enabled the coders to identify any mismatches between the theme and subtheme names and the original data. Furthermore, the coders identified any themes, subthemes, codes, or data within codes that were

deemed of low relevance to the overall themes or this study's intention. This relevance-based scrutiny was followed by analysis of any codes that were characterized by very few participant quotes. This way, we were able to determine the *weightiness* or key ideas across the entire data set. In cases where relevance and the number of participant responses were considered to be low, the subtheme or code was discarded from the overall thematic map.

In the final phase of coding, the original coder and consulting coders collaboratively identified the main focus and extent of each theme. Some names of the main themes and subthemes were also modified to increase the alignment between the documented theme and subtheme labels and the data they each contained. This refinement of the theme and subtheme definitions informed the final write-up phase.

The Standards for Reporting Qualitative Research checklist was used as a guide for reporting (Multimedia Appendix 3) [21], and ethics approval was granted by the Avondale Human Research Ethics Committee (approval 2018.09).

Results

Overview

Most participants were female (262/320, 81.9%), and 50.3% (161/320) of the participants were aged 40 to 60 years. Almost one-third of the cohort (91/320, 28.4%) were aged 25 to 39 years, 15.6% (50/320) were aged 61 to 81 years, and 5.6% (18/320) were aged 18-24 years. Two-thirds of the cohort

(212/320, 66.2%) worked either full or part time, 6.2% (20/320) identified as students, and the remaining 27.6% (88/320) identified as being unemployed or doing *home duties*. The majority of the cohort (240/320, 75%) provided a codable response describing facilitators of adherence, and almost all participants (314/320, 98.1%) provided codable responses related to barriers.

As the participants were asked to respond to 2 separate statements (one focusing on facilitators and the other focusing on barriers), responses to these 2 statements were analyzed separately. However, in some cases, participant responses overlapped and issues were reported as both a facilitator and a barrier. Broad themes that emerged were time, program components, personal factors, system design, technology, and human support. Notably, comment frequency regarding barriers to adherence were more than double the comments specifying facilitators of adherence. Table 1 (facilitators of adherence) and Table 2 (barriers to adherence) outline the thematic framework of responses.

During the development of the thematic map, it became evident that there was strong alignment between themes and subthemes in both sets of responses, that is, the thematic map illustrates the two-fold nature of most themes, with the order of reporting of the themes reflecting the most important themes first, as assessed by the coding researcher, according to relevance and volume of comments received. The issue of time emerged as a dominant theme in the data, with the vast majority of participants mentioning *time* across their responses.

Table 1. Perceived facilitators of adherence—themes, subthemes, and codes.

Themes, subthemes, and codes or category	Comments, n
Time	
Availability	
Opportune circumstances	20
Weekend	12
Efficiency	
Priority and planning	14
Multitasking	10
Program components	
Videos	
Highly engaging	70
Length	5
Challenge or experiential factors	
Achievable	18
Enjoyable	12
Part of normal lifestyle	6
Accountability	5
Overall program	
Easy or engaging	8
Quality	5
Personal factors	
Motivation	
High interest in personal health	9
Commitment to complete	5
Perceived value	
Personally beneficial	11
Reinforcement of positive habits	5
System design	
Convenience	
Accessibility	16
App	14
Usability	
Extra features	7
Ease of use	7

Table 2. Perceived barriers to adherence—themes, subthemes, and codes.

Themes, subthemes, and codes or category	Comments, n
Time	
Daily life	
Lack of time in general	129
Work and study combination	58
Family responsibilities	40
Travel	16
Full schedule	8
Work and family combination	6
Life event	
Death	9
Medical	6
Relocation	5
Other major change	5
Period	
Christmas	15
Holiday travel	6
Program components	
Challenge or experiential factors	
Perceived as difficult	33
Time consuming	22
Too many activities	19
Disliked recording or logging activity	18
Forgot to implement or record	10
Confusion	5
Video factors	
Length	17
Unappealing content or style	10
Extra segments	7
Personal factors	
Well-being	
Illness	16
Fatigue	10
Mental health distress or disorder	7
Stress	5
Capacity	
Lack of motivation	18
Lagging behind	17
Not a priority, so forgot	16
System design	
Lock restrictions	10
Features missing	9
Gamification	8

Themes, subthemes, and codes or category	Comments, n
Login and navigation	8
Video playback	5
Recording activity	5
Technology	
Internet	
Internet and data access	28
Personal device	
Faulty	18
Interrupted viewing	6
Human support	
Videoconferencing difficulties ^a	11
Lack of prompts	8
Lack of accountability	6
Preference for face-to-face	5

^aVideoconferencing support was provided to 1 subgroup during the intervention (n=103).

Facilitators of Adherence

Time

Time was perceived as a facilitator of adherence when participants believed that they had time available and efficiency was optimized. Each weekly lesson was released on a Sunday, and this timing was viewed positively. Expediency afforded by being retired, living alone, or not working also facilitated adherence:

I liked that the videos were released on Sunday, even if some Sundays were busy and we couldn't make time to watch them that day. Sunday is a day it's easier to make time to watch the full set of lesson videos. [ID 2614]

Some participants prioritized, scheduled, and multitasked to ensure that the program components were completed each week. Specific factors that permitted time availability or efficiency included being at home, not traveling, completion of usual duties, incorporation of tasks into daily activities, a high level of organization or planning, and having children in a regular sleep routine:

When I made specific time to sit down and watch the program it made it easier to participate and plan how I can incorporate the challenges. [ID 2278]

Program Components

This theme refers specifically to video content and the completion of practical activities. A total of 3 subthemes related to the program's components emerged from the analysis: the overall program, video presentations, and experiential activity.

Although some participants perceived that the overall program was of high quality, easy to understand, and engaging, the key program components perceived as facilitators of adherence were the video presentations and the experiential challenges.

Engaging video content has been frequently reported as a facilitator of adherence. The terms used to describe the videos included *humorous, entertaining, interesting, motivating, and easy to understand*. Participants appreciated the lighthearted presentation style, which included just enough information and interesting facts, to avoid information overload:

The videos were funny and engaging. Had enough info to be interesting but not overly filled with over-your-head stuff. [ID 2380]

The daily and weekly experiential challenges that participants completed and recorded were perceived as fostering adherence because they were relevant, easy to accomplish, enjoyable, simple to log or record, and readily incorporated into daily life. Some challenges could be easily doubled up and, for some participants, recording their challenge activity provided a sense of accomplishment:

The small daily challenges were able to be absorbed into the day without having to find extra time and it felt like many could become habits. [ID 2302]

I found a lot of the challenges crossed into another which made it easier such as being in the green and blue and going for a walk covered two challenges. [ID 2550]

Personal Factors

There are numerous personal reasons that may influence adherence, including beliefs, motivation, personal well-being, and a broad array of diverse circumstances. During coding, several key personal subthemes were developed that included motivational factors, beliefs about the value or relevance of the program, level of personal well-being, and individual capacity.

Motivation and perceived value were identified as subthemes that positively influenced adherence at a personal level. Participants reported positive motivation through a high level of readiness, commitment to the intervention, and a personal

desire to improve their health. Some participants were motivated to maintain their adherence to the program based on their belief that the intervention would be personally beneficial to them. They recognized a number of enabling aspects of the program, including the way it reinforced positive lifestyle choices; recognized that even small changes would be worthwhile; and identified the value of immediate effects. Participants also benefited from the multifactorial approach:

I looked forward to the video presentations because they were so relevant to my life, very interesting and well presented. I have been experiencing problems with sleep issues for many years and even taking herbal sleeping supplements, but after applying the information I received from the Live More sessions, I've been a good 7 to 8 hours sleep every night. This has been mainly the result of all the walking I've been doing - between 1 to 2 hours a day and more. I'm now taking more notice of nature and enjoying more green and blue. Having recently moved from [name of Country], I had no friends and felt lonely. So I went to the local Library and Community Centre and got a booklet with the different activities for retired people. I joined a group of like-minded people and enjoyed the activities they provided. [ID 2419]

System Design

This theme relates to the various design and accessibility features of the web or mobile app and primarily includes the methods used to disseminate weekly video content and record experiential activities in the digital setting. Additional features such as gamification (ie, earning points), the ability to view what others were doing, and accessibility to extra resources were also included. Similar to other themes, the system design facilitated adherence for some participants and was perceived as a barrier for an almost equal number.

Two key design concepts were reported by users as positive influences on adherence: accessibility and convenience of the mobile app. Participants appreciated flexible access to view and review the content. This was amplified with easy portability through a mobile app:

I could do it when it was suitable for me. Whether 10pm or 6am. The flexibility made it possible. [ID 2195]

Barriers to Adherence

Time

Participants overwhelmingly perceived lack of time as problematic to adherence, with noticeably more comments referencing time as a barrier to adherence rather than a facilitator. Furthermore, time was mentioned substantially more often than any other factor recognized as a barrier. The 3 subthemes generated in relation to lack of time were daily life, life events, and the intervention period.

The demands of daily life were the foremost barriers and predominantly included work, study, and family commitments and the various combinations of all three:

Small child needing attention, lack of help from spouse due to work commitments; other extra-curricular activity; helping my elderly parents with household tasks and other daily activities. [ID 2538]

Major life events were perceived as hindering adherence and included the death of a loved one, relocation, major illness, or a combination of trials that consumed major amounts of time:

The timing of this project was the one of the busiest 10 weeks in my life! Moved house. Solo parented for 4 weeks. My sister's wedding. School holidays. The sickest our family has been in 10 years. Term 4 after-school events as part of my work responsibilities. We moved house the week the program started and then went straight into school holidays of which we were away the whole time. Then we were really sick for three weeks whilst I was solo parenting. So I just never got the chance to get started. [ID 2214]

The intervention was conducted from September to early December 2018. The lead up to Christmas and the added pressures that often accompany the Christmas period in the work and social environment were deemed barriers. In addition, for this cohort (ie, a faith-based population), church activities were perceived as adding further to the time pressures already experienced at this time of year:

Making a commitment at this time of year was more difficult than I thought; this time of year is hectic for my job which also probably means my answers at the end could actually be worse than at the start, because of how tired I have been. [ID 2630]

If it was at another time of year I probably would have completed it. This time of year is crazy for me at work, I'm a preschool assistant, and I am involved with helping with Road to Bethlehem [Christmas program]. The last few weeks I just found it difficult to think much about what I was doing. [ID 2417]

Program Components

Some users deemed the overall program too intense and too long. Video segments were perceived as lengthy, and some users found the content unappealing and disliked the presentation style, describing it as cliché, corny, and over the top:

The videos were too long. I'd prefer 2-3 shorter ones per topic. That would be easier to watch while in train or fitting between other things I had to do. [ID 2318]

While the actual science was interesting, much of the video content felt patronising and the jokes fell flat. [ID 2142]

Most perceptions about the program components were directly related to difficulties with experiential activities. Time was viewed as a hindrance for both completing and logging the activity, and some participants perceived the activities as being too hard. Although some participants completed the daily and weekly experiential challenges, they disliked recording their

activities, felt overwhelmed by the increasingly growing list of activities to record, or simply forgot to log their activities:

Having the challenges compound each week to record them meant that it was too overwhelming and I gave up logging on to record. I think having reminders about the previous weeks challenges is great, but filling in that many challenges every day is too hard! [ID 2287]

Personal Factors

Numerous personal factors hindering adherence were grouped under 2 subthemes: personal well-being and capacity. Personal illness was the dominant factor affecting well-being. Other factors influencing well-being included the presence of a mental disorder, stress, and fatigue, with several respondents specifically identifying screen fatigue. Comments regarding capacity were equally divided among 3 key areas: a reported lack of motivation, discouragement at lagging behind in viewing content or completing experiential activities, and simply not prioritizing the intervention:

When I had downtime I didn't have the motivation to intently watch the videos & do the thinking & work required so it was easy to fall behind. [ID 2204]

Also, with working full time (looking at a screen) all day, I really didn't want to sit in my home office to look at another screen, so I failed to keep on top of the weekly presentations. [ID 2563]

System Design

Several design features and difficulty navigating the website were perceived as negative influences on adherence. Most comments were made in relation to the lock restrictions, the lack of some desirable features, dissatisfaction with the gamification setup, and the perceived tedious system for logging experiential activity. Although participants were provided with a recommended 10-week schedule for engaging with the intervention content, some participants emphatically opposed the lack of autonomy in how and when they consumed the information:

I don't mind having to unlock videos - just please don't constrict it to a week at a time!!! And let me do any or all of the challenges at the start or when I unlock things in my own time - don't make me wait 7 days / a fortnight / 3 weeks etc to engage in all the challenges just because! Let me unlock them at my pace. [ID 2142]

Desirable features that were noted as missing included an audio-only option, the ability to predownload the video content, and the option to read the material instead of viewing a video. A readable script was actually provided, although it was not explicitly recommended as an alternative to viewing video content. Although gamification was included as a way to enhance adherence, for some participants it was perceived negatively and a deterrent to further adherence:

It's very demotivating having a leaderboard for someone who's not near the top. [ID 2549]

The system setup for recording experiential activity was seen as a barrier because it was perceived as difficult to use, with one participant describing it as "glitchy and not particularly intuitive" with "long and chunky lists" [ID 2142]:

Prompts on challenge input boxes were too vague about what the user needs to write. Should the user explain anything or just state that the challenge was completed? It was not clear whether the user's statement in the challenge input box would be shared with others (user had to just try it and see what happens during the first session). I could not log more than one challenge on the interface at a time (I had to change to another page and then come back to the challenges to log another one). [ID 2391]

Technology

Technology (ie, data availability, internet access, and device suitability) was deemed a barrier, mainly because of poor internet accessibility or personal device problems.

Internet access problems included slow download speeds, internet outages, and no internet access at home. Personal device problems included old or faulty smartphones that could not download the mobile app, small screen size, sound problems, and perceived inability to correctly operate the device:

We had some difficulty watching the videos on my tablet, the volume is not loud enough, we really need a PC or to data project to a bigger screen for optimal viewing/listening. [ID 1767]

Human Support

Human support offered to participants varied depending on the group allocation they received. All participants received automated email reminders to engage with video content and record their practical activities. One group received regular text messages, and the other group was offered weekly videoconference sessions as an extra measure of support. Despite human support being the focus of the original study [16], perceptions about the support offered did not feature strongly. However, some participants reported that adherence was impeded because of human support factors or lack thereof. A lack of prompting and accountability were stated as reasons for difficulty in adherence. In the group that received videoconferencing support, some of the group members reported that videoconferencing support was problematic for a range of reasons, most commonly that the meetings were held at an unsuitable time:

Timing of online groups sessions didn't work for me with my responsibilities during that time period. I needed a later evening session. 9pm! Or a 5:30am session. The timing of the first 5 weeks would have been difficult for me regardless. [ID 2214]

Discussion

Principal Findings

This study provides novel insights into participants' perspectives regarding facilitators and barriers to adherence in a digital MHPI

for a community-based nonclinical population. Themes often had dual impacts, deemed as both facilitators and barriers. Facilitators of adherence included engaging in video content, achievable experiential activities, time availability, user-friendly web and mobile app design, and high personal interest or motivation. Conversely, a perceived lack of time was the main barrier to adherence. Completing and logging practical activities, a range of personal influences, problematic design features, technological issues, and a lack of support or prompting were also identified as barriers.

As barriers were the predominant focus of participants' perspectives, it is clear that an MHPI is a difficult endeavor for a nonclinical group and that time is the foremost issue in relation to adherence. Similarly, other qualitative studies in workplace settings [14,15] have concluded that time scarcity is a major inhibitor of adherence and that participants need interventions requiring only small time commitments. It is evident that certain features or problems (eg, difficult website navigation and restrictions on video viewing) consumed inordinate amounts of the participants' time, thereby negatively impacting their adherence. Similarly, such issues have previously been exposed as barriers to the success of web-based learners in educational settings [22,23]. Therefore, time efficiency must be a core consideration by researchers in every aspect of the intervention design. It is vital to design interventions to minimize time and energy investment for participants while concurrently optimizing outcomes.

An important element that underpinned the data was the participants' desire to easily incorporate core components of the program (ie, videos and challenge activities) into their everyday lives. A key priority in the design and development of future interventions should be to collaborate with potential users in designing interventions that enable autonomous, optimal integration of the essential intervention elements into daily life. Practical examples may include the provision of multiple options to access the content (eg, video, print, or audio), choice of methods to log activities, and recommendations on combining some activities to make optimal use of time.

The preponderance of dual themes in this study sheds more light on an important element that has been identified previously [24], that is, individual differences have a substantial influence on adherence to MHPIs. Although previous research by Banerjee et al [13] identified several twofold themes in a qualitative study focusing on engagement with a mindfulness intervention, a study by Zarski et al [24] on adherence to a digital stress management intervention noted that, even after accounting for socioeconomic demographics, personal well-being status, and human support, many individual variances in nonadherence were inexplicable. This study highlights some of these differences.

Understandably, the high prevalence of individual variance confounds efforts to crystallize a precise set of factors influencing adherence to digital interventions. Plausibly, future research should embrace individual differences by examining ways to prioritize participant autonomy in tailoring interventions according to personal preferences. This could be achieved by offering an eclectic, self-directed approach that encourages

participant choice in activating or deactivating a range of optional features (eg, gamification or type and frequency of human support) as desired. This constructivist-style approach, commonly used in educational settings, is well supported by research as an efficacious method [25,26].

The original study, from which this qualitative study was derived, focused on the influence of varying levels of human support on outcomes and adherence to an MHPI [16,17]. However, in this qualitative analysis, human support did not have a strong influence on adherence. Considering that the quantitative analysis revealed that adherence was not impacted by different levels of support and that participants achieved improvements in outcomes irrespective of the human support provided, this is not surprising. Although numerous studies have demonstrated that human support may improve outcomes [9,27,28], there is substantial evidence that well-designed, self-guided interventions can be successful without added human support [9,29-32] and their associated costs.

Strengths and Limitations

The large cohort and inclusive age range (18-81 years) of participants were strengths of this study. Furthermore, participants were not restricted to the length of their responses and could write as little or as much as desired. All comments were coded, and participants received no guidance on what topics to comment on, eliminating preconceptions by researchers.

Recruitment bias could be seen as a potential limitation to this study as participants were self-selected into the study, and the target group were Seventh-day Adventist Church members who typically share common health practices (eg, abstinence from alcohol or smoking) and may be more inclined to take a greater interest in health than the general population. In addition, recruits were largely tertiary educated (262/320, 81.9%), White (280/320, 87.5%), and female (262/320, 81.9%). Although a high female proportion is the characteristic of an internet intervention [33,34], it limits transferability to the wider population. In addition, participants were not given the opportunity to indicate whether they used the web-based platform, the mobile app, or a combination of both, which prohibited a comparison of data based on the different delivery methods.

By allowing participants to comment freely on an open-ended statement, the assumption must be made that participants only reported on factors most relevant to their personal experiences. Therefore, the study does not contain all the views of the participants. As researchers, we adopt the position that the predominant issues are exposed and that the volume of comments depicts saturation on crucial issues.

Notably, 2 other factors may have inadvertently influenced participants' perceptions. First, barriers, particularly *time*, may have been augmented by the period that the intervention was conducted (mid-September to early December 2018). Avoiding administering an intervention that ends in December is a learning for future implementation. Second, the website and mobile app design, in permitting recording of an increasing array of experiential activities as the weeks progressed (rather than just

the activities for the current week), may have augmented dissatisfaction with the logging or recording component, introducing an element that went beyond the intentions of the original intervention design.

Conclusions

Although there are a diversity of factors influencing adherence, highly engaging content encourages adherence and time efficiency is a principal consideration for a nonclinical, community-based cohort. Therefore, intervention designers should place a concerted focus on streamlining interventions to reduce the time required by participants and simplify all program

elements. Other considerations to increase adherence include allowing participants to create their own experience by choosing what optional features to include or exclude, enhancement of the website and mobile app to facilitate a more intuitive experience, shorter video presentations that are easily accessible and provide high autonomy in the way they are consumed, simplified and limited recording of experiential activities, and options for personal choice in accountability. In future research, it will be important to consider the views of users in relation to adherence and respond with an adequate level of agility that assures an ever-improving experience for participants to ensure optimal adherence and sustainability.

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Authors' Contributions

MR and DM conceptualized this study. MR completed the data analysis in consultation with DM and MN. All authors contributed to the revision and editing of the manuscript.

Conflicts of Interest

DM manages a *profit-for-purpose* trust that uses a version of the intervention without receiving personal remuneration. GP is employed with the South Pacific Division of the Seventh-day Adventist Church (administrator of the intervention). No other authors have any financial interests or conflicts of interest to declare.

Multimedia Appendix 1

Program overview.

[PDF File (Adobe PDF File), 110 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Web or app screenshots.

[PDF File (Adobe PDF File), 1141 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Checklist—standards for reporting qualitative research.

[PDF File (Adobe PDF File), 566 KB-Multimedia Appendix 3]

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Abbreviations

eLMS: web-based learning management system

MHPI: mental health promotion intervention

RTA: reflexive thematic analysis

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The Influence of Human Support on the Effectiveness of Digital Mental Health Promotion Interventions for the General Population

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Mental wellbeing amongst the general population is languishing—exacerbated by the Coronavirus Disease 2019 (COVID-19) pandemic. Digital mental health promotion interventions, that improve mental health literacy and encourage adoption of evidence-informed practical strategies are essential. However, attrition and non-adherence are problematic in digital interventions. Human support is often applied as an antidote; yet, there is a paucity of randomized trials that compare different human support conditions amongst general population cohorts. Limited trials generally indicate that human support has little influence on adherence or outcomes in DMHPs. However, providing participants autonomy to self-select automated support options may enhance motivation and adherence.

Keywords: digital mental health promotion, human support, human guidance, adherence, mental wellbeing, general population, interdisciplinary

INTRODUCTION

As the world deals with the Coronavirus Disease 2019 (COVID-19) pandemic, a parallel crisis in mental wellbeing is emerging. Prior to the pandemic, depression was a leading cause of global disability (World Health Organization, 2019) and, in high income countries, depression and anxiety were the third and fourth highest reasons, respectively, for visiting a primary care physician (Finley et al., 2018). Furthermore, treatment coverage for mental health disorders was already extremely low, particularly in low income nations (World Health Organization, 2019). Alarming, extensive deterioration in mental wellbeing has been detected globally since the pandemic began (Ammar et al., 2020; Pera, 2020) across all sectors (e.g., general public, health workers, and those with pre-existing psychological conditions) (Vindegard and Benros, 2020), with one study reporting that mental distress had doubled since the pandemic (Fisher et al., 2020).

The ensuing mental health crisis requires urgent, evidence-based, and interdisciplinary action (Campion et al., 2020; Holmes et al., 2020), and the use of digital technologies such as computers, tablets, and smartphones offers opportunities for the delivery of digital (i.e., Web- and app-based) interventions that are highly portable, accessible, and scalable. With primary care services urgently required to assist patients in clinical settings, evidence-informed digital mental health promotion interventions (DMHPs) provide a pathway to enhance the mental health of the general population (Campion et al., 2020; Holmes et al., 2020; Marshall et al., 2020; Renfrew et al., 2020a; Przybylko et al., 2021a).

DMHPs may improve the mental/emotional wellbeing of general population groups through a range of diverse approaches that enhance resilience and relieve stress, anxiety, and depressive symptoms. Suitable interventions may incorporate strategies from the fields of psychology (e.g., cognitive behavior therapy) (Lau et al., 2017; Cuijpers et al., 2019; Karyotaki et al., 2021), positive psychology (e.g., practicing gratitude, writing positive experiences, kindness) (Bolier et al., 2013; Drozd et al., 2014; Galante et al., 2014; Dickens, 2017; Hendriks et al., 2020; Koydemir et al., 2020), lifestyle medicine (e.g., physical activity, nutrition, access to green space) (Penedo and Dahn, 2005; Quirk et al., 2013; Cooney et al., 2014; Dale et al., 2014; Sarris et al., 2014, 2015; Cohen-Cline et al., 2015; Conner et al., 2015; Jacka et al., 2017) and various other practices which cross over several of the abovementioned fields (e.g., mindfulness, meditation) (Spijkerman et al., 2016; Galante et al., 2021).

Despite the advantages of digital delivery, high attrition (i.e., dropout) and low adherence (i.e., participants not engaging with the intervention as intended by designers) often compromise the outcomes of digitally-delivered interventions (Couper et al., 2010; Mohr et al., 2011, 2013b; Kelders et al., 2012; Richards and Richardson, 2012; Kohl et al., 2013; Short et al., 2014; Spijkerman et al., 2016; Linardon and Fuller-Tyszkiewicz, 2020). While there are numerous theoretical perspectives on factors that improve attrition and adherence (Ryan et al., 2018), a commonly purported facilitator is human support, often referred to as "guidance" (Mohr et al., 2011; Baumeister et al., 2014; Alkhaldi et al., 2016; Ebert et al., 2018; Ryan et al., 2018; Linardon and Fuller-Tyszkiewicz, 2020). It is important to evaluate the evidence regarding human support as a modifying factor in attrition and adherence to DMHPs, as the addition of human support has cost implications (Mohr et al., 2013a; Morledge et al., 2013; Drozd et al., 2014; Michie et al., 2017), limits scalability, and requires the time of scarce human personnel (Mohr et al., 2013a). On the other hand, human support may improve adherence through prompting participants to engage, fostering participant accountability, strengthening motivation, and therefore optimizing outcomes (Mohr et al., 2011; Schueller et al., 2016).

This mini review evaluated the effectiveness of adding human support to DMHPs for employees and general community groups. A search (using PubMed, reviews and other sources) revealed a paucity of randomized trials that directly compared supported with unsupported conditions for non-clinical groups in work and community settings. Hence, the search was widened to include suitable meta-analytic reviews to evaluate trends between guided and unguided conditions in the workplace and general community. This review also appraised the findings from recent studies conducted by the authors that compared different human support conditions amongst a general community cohort.

HUMAN SUPPORT

While early studies among clinical cohorts suggested that adding human support to digital interventions improved outcomes (Richards and Richardson, 2012; Baumeister et al., 2014), more

recent studies have demonstrated mixed results (Shim et al., 2017). For example, some clinical studies have shown no difference in the outcomes of self-guided vs. supported digital interventions (Titov et al., 2015, 2016; Ivanova et al., 2016; Mira et al., 2017; Dear et al., 2018a,b; Eimontas et al., 2018; Zagorscak et al., 2018). Moreover, it is feasible that the requirement for added human support elements in DMHPs for healthy non-clinical population groups may be different to unwell clinical population cohorts where symptoms of disease or disorder (e.g., general malaise, compromised motivation) may impede adherence (Mohr et al., 2013b; Deady et al., 2017; Karekla et al., 2019; Karyotaki et al., 2021).

Workplace Settings

Meta-Analytical Reviews

Systematic reviews and meta-analyses, regarding the effectiveness of workplace DMHPs, present mixed evidence with regards to the influence of the addition of human support (Stratton et al., 2017; Phillips et al., 2019). For example, in a systematic review and meta-analysis, by Phillips et al. (2019), guided interventions consistently demonstrated higher effect sizes than unguided in all the areas of measurement: stress (Hedges $g = 0.76$ for guided and $g = 0.27$ for unguided), depression ($g = 0.48$ and $g = 0.23$), anxiety ($g = 0.48$ and $g = 0.26$), burnout ($g = 0.69$ and $g = 0.33$), insomnia ($g = 1.00$ and $g = 0.53$), mindfulness ($g = 0.57$ and $g = 0.36$) and wellbeing (no guided studies, unguided $g = 0.35$). However, the authors recommended caution as heterogeneity was high in the pooled analysis of 22 RCTs and subgroup analyses were underpowered. Conversely, Stratton et al. (2017) demonstrated that supported conditions ($g = 0.27$) were similar in effects to unsupported ($g = 0.22$). However, different types of approaches revealed heterogeneous effects in regard to human support. Cognitive behavior therapy demonstrated low effects in both conditions, stress management showed small effects for supported, but negative effects in unsupported conditions. Mindfulness, which was only administered in unsupported conditions, demonstrated moderate effects (Hedges $g = 0.59$).

Carolan et al. (2017) conducted a systematic review of 21 digital psychological interventions for employees and reported similar outcomes for both supported and unsupported interventions (guided $g = 0.39$, self-guided $g = 0.34$). Notably, in further examination of 7 studies that reported the highest adherence and lowest attrition, human support was only one of four common elements: human support (used in 5/7 studies); use of persuasive system design principles (all studies); 6- or 7-week program length (a mean of 6.6 week length compared to a mean of 8.1 weeks in the other 14 studies); and, the use of "secondary modalities" (e.g., emails, text messaging) in intervention delivery (6/7 studies).

Randomized Trials

Two randomized trials compared human support conditions in workplace settings. Allexandre et al. (2016), compared three support conditions (i.e., no support, group support, and group support plus therapist support) in a workplace digital mindfulness and stress management intervention. The addition of therapist support added no benefit, but general group

support improved both outcomes and adherence compared to those who received no support. Albeit, overall, adherence was low—50% of participants never logged on to the intervention. Additionally, the intervention was digitally-delivered but support was provided face-to-face.

A pooled analysis of three RCTs (Zarski et al., 2016) compared human support in a digital stress management workplace intervention. Researchers identified that “content” support (i.e., personalized written feedback for tasks completed) and “adherence” support (i.e., monitoring module completion and sending reminders) did improve adherence behavior in comparison to only “administrative” support (i.e., provision of contact details for technical support). Although there were no significant differences in adherence between the “content” and “adherence” focused support, the time investment required by support personnel for the adherence-focused support was considerably lower, which highlights substantial cost implications dependent on different support variables (e.g., mode, intensity, and frequency).

Community-Based Settings Meta-Analytical Reviews

Meta-analytical reviews of studies in community settings generally demonstrated improved effects in supported conditions; although, authors of one meta-analytical review (Deady et al., 2017) refrained from evaluating differences between supported and unsupported conditions due to high heterogeneity. In a meta-analysis (Koydemir et al., 2020), which included 68 RCTs of positive psychology interventions for community cohorts, some delivered digitally and some delivered face-to-face, significant differences were found between self-guided interventions and those facilitated face-to-face. The effect size for the face-to-face condition ($d = 0.32$) was almost twice the self-guided condition ($d = 0.17$), although effect sizes were in the lower range for both conditions. A meta-analysis by Heber et al. (2017) evaluated the efficacy of Web- and computer-based studies for stress management amongst generally healthy adults. Sub-group analysis showed that supported and unsupported conditions demonstrated positive effects, though supported conditions (Cohen $d = 0.64$) were almost double the effect size of unsupported ($d = 0.33$).

Randomized Trials

While access to human support is often desired by non-clinical DMHPI users (Carolan and de Visser, 2018; Renfrew et al., 2020b), its effectiveness in improving adherence or outcomes is less convincing, based on three randomized studies that compared human support variables and targeted general community cohorts. In a three-pronged RCT (Morledge et al., 2013), participants from the general population were recruited to assess the effectiveness of a digital mindfulness intervention. Participants in one intervention group completed the activities with no added human support, while those in a second intervention group were encouraged to interact through an online message board that was hosted by a facilitator. Both groups demonstrated significant improvements compared to the control group; yet, no significant differences in measurement outcomes were observed between the two intervention groups. Notably,

85% of those in the message board group reported that the message board was of little or no value (Morledge et al., 2013). Mira et al. (2017), in an RCT designed to assist participants to cope with difficulties and depressive symptoms, compared an automated human support condition with the same condition plus weekly phone calls. Both groups improved significantly compared to control and no differences in attrition, adherence or outcomes were observed. Furthermore, participant satisfaction was high in both intervention groups.

In a digital relaxation training intervention (Alfonsson et al., 2016), self-selected participants from the general population were randomized to either “normal” treatment (i.e., black/white text files, weekly support from a trained therapist) or “enhanced” treatment (i.e., color text, video format, daily therapist support). Participants in both treatments improved significantly, irrespective of differing levels of support. The participant relationship with the support therapist did not predict adherence; rather, attrition, and non-adherence were predicted by low intrinsic motivation, low perceived treatment credibility, baseline stress symptoms, and focus on immediate behavior consequences rather than long term goals. Conversely, adherence was positively correlated with intrinsic motivation, education level, and treatment credibility, including belief in the effectiveness of the online format.

Recent Research by the Authors

We have previously reported the results of a 10-week DMHPI that was implemented in a general population setting. The interdisciplinary intervention, that integrated strategies from the fields of positive psychology and lifestyle medicine, compared the influence of three different modes of human support on outcomes (Renfrew et al., 2020a) and adherence (Renfrew et al., 2020b). Participants were randomized into groups that received differing levels of human support: automated email support only, automated email support with added personalized text messaging, and automated email support plus a weekly, facilitated, group videoconference session. Significant pre- to post-intervention improvements in outcomes were recorded in every group irrespective of the human support condition. Similarly, adherence (i.e., viewing weekly video content, and completing daily and weekly experiential activities) was not significantly different between the groups. Further, no differences in either adherence or improvements in wellbeing metrics were observed between those participants who were randomized to their first preference for human support and those who were not (Renfrew et al., 2020b). Nonetheless, despite the apparent lack of effect of human support, 45% of the entire study cohort indicated they would prefer to have *all* forms of human support available to them (Renfrew et al., 2020b). The reasons for this are unclear, it may be that participants like the autonomy to choose from a broad range of choices, even when they have no interest in accessing all options.

We reported low attendance at videoconference support sessions, with 36% of the participants allocated to this group never attending a session and only 18% attending seven or more of the 10 sessions (Renfrew et al., 2020b). Consequently, the human support experience for many participants in this group was effectually the same as for those in the automated

emails only group. Nevertheless, secondary analysis revealed that participants who attended seven or more videoconference sessions did experience significantly greater improvements in overall mental health, vitality, depression and life satisfaction compared to those who attended less than seven sessions; although, numerous variables (e.g., motivation level) may have contributed to this difference (Renfrew et al., 2020a).

We also examined the influence of a DMHPI on the experience of “flourishing” (Przybylko et al., 2021b), which is a construct used to express a high level of human functioning. We found that the inclusion of text messaging support, or weekly videoconferencing support, had no additional benefit in the enhancement of flourishing. Notably, in our research we have observed highest attrition rates among participants who were randomized to a treatment group that involved the greatest level of human support. Participants in the aforementioned human support comparative study had agreed to take part regardless of which arm of the study they were allocated to, however, 32% of those assigned to the videoconferencing group—the highest level of human support offered—withdrew upon receiving notification of their allocation (Renfrew et al., 2020a). The dropout attrition was significantly greater ($P = .009$) than attrition in the other two arms of the study that involved mostly automated support. Furthermore, videoconferencing was the least desired form of support by participants—just 7% indicated it as their preferred support method. Interestingly, 22% of participants preferred email support, 26% preferred emails plus text messaging, and the remaining 45% desired access to all support forms.

To gain further insight into participant perspectives, we conducted a qualitative study (Renfrew et al., 2021) using inductive thematic analysis to examine user perceptions regarding facilitators of, and barriers to, adherence. The provision of human support did not feature as a perceived facilitator of adherence. Rather, perceived facilitators were engaging presentations, time availability, ease of accessibility, easy or interesting experiential activities, and personal motivation augmented by the perception that the intervention would be highly valuable. Overwhelmingly, the largest perceived barrier to adherence was lack of time, which is similar to that reported by other recent studies in workplace settings (Carolan and de Visser, 2018; Blankenhagel et al., 2019). Other barriers, some of them also time related, were presentation length, time consuming system design elements, technical issues, and a wide array of interpersonal factors that generally related to wellbeing (e.g., illness) or capacity (e.g., motivation). Notably, the addition of human support is not likely to assist in overcoming the abovementioned barriers, or further enhance the perceived facilitators of adherence.

The emerging, but limited body of evidence indicates that human support is not the panacea for attrition, adherence and outcomes in DMHPIs for a general community cohort; rather, the influences on adherence are multifactorial and complex. In a scoping review, Ryan et al. (2018) concluded that adherence to digital interventions is impacted by a range of technological, environmental and individual influences that require interdisciplinary cooperation (Ryan et al., 2018).

Zarski et al. (2016) likewise concluded that many interindividual differences related to adherence remain unknown.

DISCUSSION

The evidence in this mini review indicates that DMHPIs may be implemented among work-based and general community cohorts without the need for added human support. While the meta-analytical reviews generally demonstrated that human support improved adherence and augmented positive effects, the few randomized trials indicated that self-guided conditions were comparable, in adherence, and outcomes, to conditions that included human support. Notwithstanding, the indication that general population cohorts often desire access to human support signifies that it is a desirable element that should be considered as an automated component in intervention design.

One possible option to incorporating automated human support, is a flexible, elective approach in which intervention creators provide participants with substantial autonomy to customize support along with other discretionary features (e.g., gamification). For instance, self-tailoring or personalizing an intervention might include choosing human support options from a range of automated modes (e.g., text message reminders, email notifications), and choosing the intensity and frequency of support, based on individual preference.

Identified in Self-determination Theory as one of three core basic needs for humans—*autonomy*, along with *relatedness* (i.e., connection) and *competence*—when fostered well, create the supportive conditions for intrinsic motivation to be optimized (Ryan and Deci, 2000), and greater intrinsic motivation has been linked to greater adherence (Mohr et al., 2011; Alfvén et al., 2016). Importantly, the autonomy to choose from different automated support options, along with providing choice in other discretionary features may assist in stimulating intrinsic motivation to adhere to a program (Yardley et al., 2016), resulting in improved outcomes.

Finally, evidence that adding human support improves attrition, adherence, and outcomes of DMHPIs for general population groups is limited and mixed. Furthermore, it is evident that well designed, self-guided interventions can be effective in enhancing mental wellbeing. Nevertheless, human support is generally desired by intervention participants. Providing autonomy for participants to individualize or self-tailor an intervention, by selecting personal preferences for automated support and other discretionary features, might enhance participant experience and also bolster intrinsic motivation to adhere to a program—an area for further research. Carefully designed DMHPIs, that include automated forms of human support, should be urgently implemented in community settings to alleviate the COVID-19 pandemic-related decline in mental wellbeing.

AUTHOR CONTRIBUTIONS

MR and DM conceptualized the study and outlined the review structure. MR wrote the initial manuscript and all authors were involved in the revising and editing process.

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