The effectiveness of a digital multicomponent interdisciplinary intervention on the mental health and wellbeing of a nonclinical Australasian cohort

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B.Comm (WSU), MBA(DU), MPH (USYD)

Thesis submitted in fulfillment of the requirements for the degree

Doctor of Philosophy

Principal Supervisor: Associate Professor Darren Morton
Associate Supervisor: Dr Jason Morton



December 2021

Declarations

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Thesis by Publication

I hereby certify that this thesis is in the form of a series of four publications. The thesis is by publication, supplemented by narrative, as per Avondale University guidelines. I have included as part of the thesis a written statement endorsed in writing 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 the thesis

This thesis is presented as a series of four papers that were published in peer-reviewed journals. The first paper was published in Frontiers of Psychology, a Q2 ranked journal with an impact factor of 2.99. The second paper was published in BMC Psychology, a Q2 ranked journal with an impact factor of 2.54. The third paper was published in the Journal of Positive Psychology, a Q1 ranked journal with an impact factor of 4.20. The fourth paper was published in JMIR Mental Health, a Q1 ranked journal with an impact factor of 4.39.

Publication 1:

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Przybylko, G., Morton, D. P., Kent, L., Morton, J., Beamish, P., Hinze, J., Renfrew, M. (2020). The effectiveness of an online multimodal intervention for mental health promotion: A randomized controlled trial. [Original Paper]. *BMC Psychology, 9:77*. https://doi.org/10.1186/s40359-021-00577-8

Publication 3:

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

Publication 4:

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Other scholarly activities related to the dissertation

Publications, scientific abstracts and presentations, and awards that have been undertaken and contributed to during the PhD candidature are outlined below.

Publications

Morton, D., 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/10.1177/1559827617733941

Renfrew, M. E., Morton, D. P., Morton, J. K., Hinze, J. S., Beamish, P. J., Przybylko, G., & Craig, B. A. (2020). 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. *Journal of Medical Internet Research*, *22(*1), e15592. https://doi.org/10.2196/15592

Renfrew, M. E., Morton, D. P., Morton, J. K., Hinze, J. S., Przybylko, G., & Craig, B. A. (2020). 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. *Journal of Medical Internet Research, 22*(9), e19945. https://doi.org/10.2196/19945

Renfrew, M. E., Morton, D. P., Northcote, M., Morton, J. K., Hinze, J. S., & Przybylko, G. (2021). Participant perceptions of facilitators and barriers to adherence in a digital mental health intervention for a nonclinical cohort: Content analysis. *Journal of Medical Internet Research, 23*(4), e25358. https://doi.org/10.2196/25358

Renfrew, M. E., Morton, D. P., Morton, J. K., & Przybylko, G. (2021). The influence of human support on the effectiveness of digital mental health promotion interventions for the general population. *Frontiers of Psychology, 12*, (3590). https://doi.org/10.3389/fpsyg.2021.716106

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List of Common Abbreviations

AIHW	Australian Institute of Health and Welfare
DASS-21	Depression, Anxiety and Stress Scale (21-Items)
LETS	Learn, Experience, Think and Share
GLM	General Linear Modelling
MHC-SF	Mental Health Continuum Short Form
MHPI	Mental Health Promotion Intervention
PERMA	Positive emotion, Engagement, Relationships, Meaning and Achievement
PPI	Positive Psychology Intervention
PSD	Persuasive System Design
RCT	Randomized Controlled Trial
SF-36	Short-Form 36 Health Survey
SWLS	Satisfaction With Life Scale
TPB	Theory of Planned Behaviour
WHO	World Health Organisation
X^2	Chi-square

Definition of Terms

Flourishing	The collective state of feeling good and functioning well to achieve high mental wellbeing levels (Huppert & So, 2013)
Lifestyle medicine	The application of therapeutic lifestyle interventions and motivational principles to influence chronic disease prevention and management in a clinical and public setting (Egger, 2019).
Live More Project	A ten-week intervention that integrates lifestyle medicine and positive psychology strategies to enhance mental health and wellbeing.
Mental health	“A state of wellbeing in which the individual realises his or her own abilities, can cope with the normal stress of life, can work productively and fruitfully, and is able to make a contribution to his or her community" (World Health Organization, 2018a).
Persuasive Systems Design	Digital software of information systems aimed to shape attitudes or behaviours without coercion or deception (Oinas-Kukkonen & Harjumaa, 2009).
Postive psychology	The scientific study of the strengths and virtues that empower individuals and communities to

	improve their quality of life and citizenship so they can flourish (Seligman & Csikszentmihalyi, 2000).
Universal or Population-level. based intervention	Non-clinical, primary prevention strategies focused on an entire population that address generic mental health risk and protective factors (Purtle et al., 2020).

Abstract

The prevalence of depression and anxiety before the COVID-19 pandemic was estimated at 586 million worldwide, and this figure has subsequently increased. The current paradigm for preventing and managing mental health is predicated primarily on pharmacotherapy. This approach is not working, and there are urgent calls to use integrated non-pharmacological strategies. Studies have demonstrated the effectiveness of lifestyle medicine and positive psychology interventions to enhance mental health and wellbeing. However, no randomized controlled trial (RCT) has examined the effectiveness of a digital multicomponent interdisciplinary intervention for improving mental health and wellbeing in a nonclinical setting. In addition, the literature is sparse in understanding the gender and age responsiveness to digital mental wellbeing interventions.

This thesis utilised two experimental studies (Study 1, randomized controlled trial, n=421; and Study 2, a randomized comparative study, n=458) to assess the effectiveness of a ten-week digital multicomponent interdisciplinary mental wellbeing intervention that used Persuasive System Design (PSD), principles and combined strategies from lifestyle medicine and positive psychology. The participants completed a questionnaire at baseline and post-intervention that assessed their mental health, vitality, depression, anxiety, stress, life satisfaction, and flourishing. Study 1 also included follow-up at 12 weeks post-intervention. Intervention adherence and engagement were also assessed.

This thesis presents the findings of the studies in a coherent series of publications in scholarly journals and highlights several significant findings. First, the digital multicomponent interdisciplinary mental wellbeing intervention

significantly improved all mental health and wellbeing measures amongst the Australasian nonclinical cohort. The outcomes measures remained significant at 12 weeks post-intervention for the intervention group.

Second, the studies observed larger effect sizes than previous studies that utilised single-modality interventions, suggesting that a multicomponent interdisciplinary approach may yield compounding benefits. Third, gender and age did not influence adherence to the intervention that employed PSD principles to improve mental health and wellbeing. Last, the studies reported low attrition rates compared to the existing literature, which typically finds adherence and attrition problematic for digital delivery.

In summary, a digital multicomponent interdisciplinary mental wellbeing intervention that uses a lifestyle medicine and positive psychology approach, and employs PSD principles, can significantly increase mental health and wellbeing across gender and age groups. Amid COVID-19 pandemic, there is an urgent need to implement interventions at a population-level–such as the one used in this thesis–that are cost-effective and easily disseminated. This thesis informs a potential way forward.

CHAPTER ONE: OVERVIEW

1.1 Background

Common mental health disorders have reached epidemic proportions, with a global annual economic burden of USD 1 trillion (United Nations, 2020). The current paradigm for the treatment of mental health disorders centres around treating risk factors and symptoms. In addition, the prescription of antidepressant medications is often the end of the therapy (Stubbs et al., 2016). Antidepressant usage has escalated worldwide, with a prevalence rate of 13.2% in the United States (Centers for Disease Control and Prevention, 2020), 16.6% in the United Kingdom (GOV.UK, 2020), 16.8% in Australia (Brett et al., 2017), and 12.6% in New Zealand (Wilkinson & Mulder, 2015). Despite the increase in antidepressant usage, the prevalence of depression continues to rise (Jorm et al., 2017; Mars et al., 2017). There is evidence supporting the benefits of early detection and prevention in poor mental health; however, there continues to be a lack of investment in this area (Arango et al., 2018; Le et al., 2021).

Treating mental disorders is predicated primarily on pharmacotherapy. This approach is not working; hence there are urgent calls to use an integrated system that provides non-pharmacological strategies such as lifestyle interventions, mental health promotion, education programs, and psychological therapies (Cuijpers, 2003; Ilyas et al., 2017; Jacka et al., 2012; Sarris et al., 2014). A greater emphasis on mental health promotion and prevention initiatives are needed to enhance mental health and wellbeing on a population-level. The benefits of mental health promotion and prevention initiatives include improving psychological resilience (Santarone et al., 2020; Sharma & Verma, 2020), providing a protective buffer against mental

disorders (Gloria & Steinhardt, 2016), and reducing the burden of mental health disorders (Boiler et al., 2013).

Two distinct and complementary disciplines advocate non-pharmacological strategies and therapies for enhancing the mental health and wellbeing of individuals. These emerging disciplines are lifestyle medicine, which applies environmental, behavioural, and motivational principles to prevent and manage chronic disease in a clinical setting (Egger, 2019), and positive psychology, which uses strengths and virtues that improve quality of life so people can flourish (Keyes et al., 2012). However, the disciplines are often used in isolation and as a single strategy (Kvam et al., 2016; Sin & Lyubomirsky, 2009).

Emerging literature has demonstrated that digital mental health and wellbeing interventions can improve mental health (Kalra et al., 2012; Koydemir et al., 2020; Naslund et al., 2019) and prevent the onset of mental health disorders (Deady et al., 2017; Sander et al., 2016). Digital mental health and wellbeing interventions provide the opportunity to disseminate the intervention cost-effectively at a population-level (Deady et al., 2017). However, these interventions tend to have higher dropout rates (Gander et al., 2016), and adherence is often problematic (Renfrew et al., 2020).

1.2 Research Aims

1.2.1 Aims

The aim of this thesis was two-fold: to determine the effectiveness of a digital multicomponent interdisciplinary intervention for improving the mental health and wellbeing of an Australasian nonclinical cohort, and to examine the influence of gender and age on the outcomes of and adherence to the intervention. Of particular interest was the integration of lifestyle medicine and the positive psychology approach.

1.2.2 Research questions

The thesis used two experimental studies to answer the following research questions:

Primary Research question:

1. Can a digital multicomponent interdisciplinary intervention improve the mental health and wellbeing of an Australasian nonclinical cohort?

Secondary Research question:

2. What is the influence of gender and age on the outcomes of and adherence to a digital multicomponent interdisciplinary mental wellbeing intervention amongst an Australasian nonclinical cohort?

1.3 Significance of the thesis

This thesis adds to the body of knowledge relating to the promotion of mental health and wellbeing in a nonclinical setting, and the publications arising from this thesis present novel insights. For example, Publication 2 was the first in the academic literature to employ a randomized controlled design to examine the effectiveness of a digital multicomponent interdisciplinary mental wellbeing intervention. Similarly, Publication 3 was the first to report that a digital multicomponent interdisciplinary mental wellbeing intervention can increase flourishing utilising the Huppert and So conceptual framework. Finally, Publication 4 was the first to document the influence of gender and age on the outcomes of and adherence to a digital multicomponent interdisciplinary mental wellbeing intervention that employed PSD principles.

1.4 Structure and Overview of the Thesis

This thesis utilises two experimental studies (Study 1, randomized controlled trial, n=421; and Study 2, a randomized comparative study, n=458) to assess the efficacy of a ten-week digital multicomponent interdisciplinary mental wellbeing intervention that combined strategies from lifestyle medicine and positive psychology. The findings of the thesis are presented in a coherent series of publications to address the research aims. The structure of the dissertation is as follows:

Chapter One: Introduction provides the contextual background of the study and outlines the research aims and the significance of this thesis.

Chapter Two: Literature Review firstly defines mental health and wellbeing, explores the Australasian mental health landscape, and overviews the conventional management model of addressing the mental health and wellbeing crisis. Secondly, the literature review examines the emerging disciplines of lifestyle medicine and positive psychology, highlighting strategies to improve mental health and wellbeing. Thirdly, the influence of variables such as gender, age and adherence on digital mental health and wellbeing interventions is explored in light of mental health and wellbeing interventions increasingly moving towards a digital mode of delivery. The literature review culminates with **Publication 1**, was published in *Frontiers of Psychology,* and is titled "Addressing the COVID-19 mental health crisis: A perspective on using interdisciplinary universal interventions", highlighting digital interdisciplinary mental health and wellbeing interventions as a potential strategy for improving the mental health of populations during the COVID-19 pandemic and beyond.

Chapter Three: Methodology outlines the study design and describes the intervention, including the theoretical framework and principles underpinning the intervention. Data analysis methods are also described.

Chapter Four: Publication 2 was published in *BMC Psychology* and is titled "The effectiveness of an online multimodal intervention for mental health promotion: A randomized controlled trial".

Chapter Five: Publication 3 was published in the *Journal of Positive Psychology* and is titled, "An interdisciplinary mental wellbeing intervention for increasing flourishing: Two experimental studies".

Chapter Six: Publication 4 was published in *JMIR Mental Health* and is titled "The influence of gender and age on the outcomes of and adherence to a digital interdisciplinary Mental Health Promotion Intervention in an Australasian Nonclinical Setting: A cohort study".

Chapter Seven: Discussion, Conclusion, and Future Directions synthesises the major findings and addresses the overall research aims. In addition, the chapter outlines the significance of the studies contained in the thesis and highlights their key strengths and limitations. Finally, the chapter explores directions for future research.

Chapter Two: Literature Review

2.1 Chapter Overview

There are six sections to the literature review. Section one outlines the approach taken in conducting the literature review. Section two defines the terms *mental health* and *wellbeing* and reviews the Australasian mental health and wellbeing crisis and the conventional management model of addressing the crisis. Sections three and four review the literature on the effectiveness of interventions using lifestyle medicine and positive psychology strategies to improve mental health and wellbeing. Section five reviews the literature on digital mental health and wellbeing interventions and the influence of gender, age, and adherence. Section six discusses the spread of Coronavirus 2019 (COVID-19) and the subsequent impact on mental health and wellbeing. The final section calls for digital multicomponent interdisciplinary interventions to improve mental health and wellbeing at a population-level.

2.2 Literature Review Search Strategy

A literature review was conducted on mental health and wellbeing using online database keyword searches, additional searches from references of peer-reviewed articles, and the review of abstracts and books. The following steps outline the literature search process: development of keywords and search strategies; review of the reference section of journal articles to identify additional valuable studies; online searches of databases for relevant articles; screening of abstracts and reviewing the relevance to the research questions; and review of government organisations and non-government websites. Critical databases included Cinahl, PubMed, Ovid Nursing, Cochrane, ABI Inform, PsycINFO, ProQuest Psychology, ProQuest Standard, APA PsycNet, Web of science, APA-FT, and Medline. The initial search strategy used the following key words: “lifestyle” OR “diet” OR “physical activity” OR “exercise” OR “sleep” OR “alcohol” OR “smoking”

combined with “positive psychology” OR “mental health” combined with “digital” OR “online” OR “internet” combined with “intervention” AND “adult”. The initial search strategy identified over 8,300 articles in the last ten years. The key word “COVID-19” was then combined with the initial search strategy and identified over 230 articles. More than 1,700 journal articles, books and websites were accessed and reviewed.

2.3 Mental Health and Wellbeing: Definitions

The World Health Organization (WHO) in 1946 defined health as "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity" (World Health Organization, 1946, p100). This definition highlights that mental health is an essential and integral component of health.

Jahoda (1958) provided one of the earliest conceptual definitions of mental health and identified six key components: an individual's attitudes toward self, self-actualisation, integration, autonomy, perceptions of reality, and environmental mastery. WHO later defined mental health as "…a state of wellbeing in which the individual realises his or her own abilities, can cope with the normal stress of life, can work productively and fruitfully, and is able to make a contribution to his or her community" (World Health Organization, 2018a).

Universal or population-based, mental health interventions are relatively new (Evans & Bufka, 2020) and are defined as non-clinical, primary prevention strategies focused on an entire population that address generic mental health risk and protective factors (Purtle et al., 2020; Rudd & Beidas, 2020). Mental health promotion is aimed at the general public or populational-level and promotes psychological wellbeing and strengthens abilities to build resilience and adapt to adversity (Arango et al., 2018).

Universal primary preventative interventions will often utilise mental health promotion strategies (Arango et al., 2018) to enhance mental health and wellbeing,

and hence the terms are used interchangeably. For example, Layard (2005) stated that wellbeing primarily focused on positive emotions, whereas Kahneman and Krueger (2006) defined wellbeing as the balance of positive and negative emotions. However, emotions or *hedonic* wellbeing is only a part of the construct of wellbeing. Wellbeing also incorporates a more sustainable, long-lasting experience referred to as *eudemonic* wellbeing (Huppert et al., 2008; Huppert & So, 2013; Joshanloo et al., 2020; Seligman, 2011). Eudemonic wellbeing tends to be a stronger predictor of overall wellbeing than subjective hedonic emotions (McMahan & Estes, 2011). Hunter et al. (2013) defined wellbeing as a broad and wholistic concept that describes the experience of functioning well and includes mental, physical, and social health.

McNaught (2011) expanded the wellbeing concept by providing a comprehensive framework. The framework consists of four key domains: individual wellbeing, family wellbeing, community wellbeing, and societal wellbeing, as seen in Figure 1. These domains incorporate various factors from environmental, geographic, socio-economic, social justice, and political forces. The comprehensive framework is adaptable to different cultures and communities. However, the framework omits the global domain and, hence, the effects of globalisation on wellbeing standards. Additionally, the model presented by McNaught has a potential bias towards a Western post-industrial society (La Placa et al., 2013).

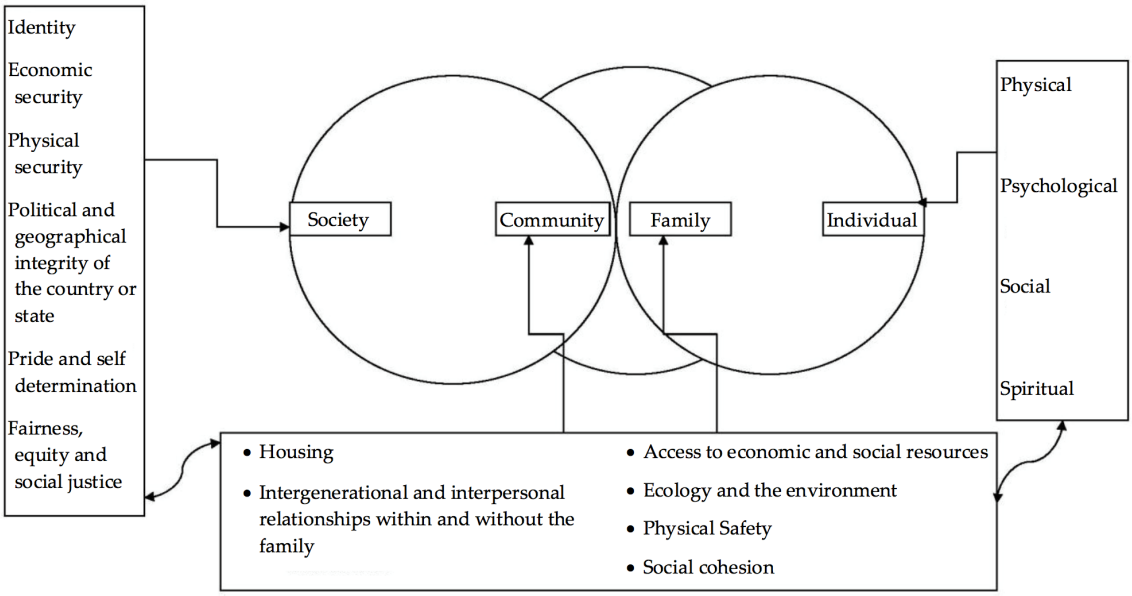


Figure 1. *A structured framework of wellbeing (McNaught, 2011, p. 11)*

In addition, Marks & Thompson (2006) assert a distinction between objective and subjective wellbeing. Objective wellbeing relates to wellbeing on a societal level, where the government or organisation conventionally regards it as their responsibility (Marks & Thompson, 2006). Objective wellbeing contrasts with subjective wellbeing, a multifaceted construct synonymous with happiness (Danna & Griffin, 1999) and is life experience from an individual's perspective (Huppert & Cooper, 2014). Subjective wellbeing is an individual's overall evaluation of the presence of positive affect, the absence of negative affect, and overall life satisfaction (Busseri & Sadava, 2011; Diener et al., 1999; Jebb et al., 2020). Huppert and Cooper (2014) argued that wellbeing involves positive notions; a sense of engagement and capability; being resilient in the face of setbacks; experiencing satisfying relationships; feeling a sense of belonging; and contributing to a community.

Flourishing is a positive construct of wellbeing that is often used in positive psychology literature to describe the collective state of feeling good and functioning well to achieve high mental wellbeing levels (Huppert & So, 2013). A more detailed description of flourishing is outlined in Section 2.7.1. of the literature review.

Wellbeing and *wellness* are concepts that are often used interchangeably (Miller & Foster, 2010; Reardon, 1998). However, according to the Global Wellness Institute's chairman, the definition is predicted to change, and wellness will be closely associated with health and prevention, and wellbeing will become more associated with happiness (Ellis, 2016). The delineation of wellbeing is due to organisations and governments focusing on indexes, such as the Gallup-Healthways *Well-Being Index* and the United Nation's *World Happiness Report*, and the realisation that happy countries do not necessarily mean healthy countries.

Over the past few decades, the mental health and wellbeing literature has increased due to the rise in common mental health disorders (Subramaniam et al., 2020), an upward trend in non-communicable diseases (Nugent & Fottrell, 2019; World Health Organization, 2021a), and people wanting to live healthier, happier, and longer lives (Seligman, 2013). Additionally, improving mental and physical health is an urgent priority due to the impact of the COVID-19 pandemic (Ammar et al., 2020; Holmes et al., 2020; Salari et al., 2020).

2.4 The Mental Health and Wellbeing crisis and the Australasian Landscape

The world is experiencing a mental health and wellbeing crisis. The prevalence of depression and anxiety is estimated at 586 million people worldwide (World Health Organization, 2017). Depression is the leading cause of disability and a significant contributor to the global burden of disease (World Health Organization, 2021a). Despite the global economic burden of USD 1 trillion annually, there is less than one mental health professional for every 10,000 people, resulting in the lack of treatment for mental health conditions and increasing pressure on health professionals (United Nations, 2020). This dire landscape preceded the COVID-19 pandemic, with over 245 million cases and 5 million deaths reported as of 31 October 2021 (World Health Organization, 2021b).

The 2017-2018 National Health Survey reported that 4.8 million people had a mental and behavioural condition in Australia, increasing 20% from 2014–2015 (Australian Bureau of Statistics, 2018). Additionally, 3.2 million Australians (13%) reported an anxiety-related condition and one in ten surveyed had depressive symptoms. Too et al. (2019) conducted a systematic review and meta-analysis and reported that individuals diagnosed with a mental health disorder had an eight-fold increased risk of suicide compared with those without a mental health disorder. In 2017-2019, suicide was the leading cause of death for those aged 15 to 44 years (Australian Institute of Health and Welfare, 2021a). In 2018, the prevalence of fatalities from suicide and self-inflicted injuries for males was almost three times higher than females (Australian Institute of Health and Welfare, 2020c).

In New Zealand, one in five adults over 15 years were diagnosed with a mood or anxiety disorder (Wilson & Nicolson, 2020). The New Zealand population is experiencing an upward trend in mental distress, with the highest prevalence among 15 to 24 year olds. Alarmingly, UNICEF Innocenti (2020) reported that New Zealand and Australian adolescents experienced the highest suicide rates amongst the 41 high-income nations of the Organisation for Economic Cooperation and Development or the European Union.

In Australia, expenditure on mental health-related services increased by 25% to $10.6 billion from 2014-2015 to 2018-2019 (Australian Institute of Health and Welfare, 2016, 2021b). Similarly, Pharmaceutical Benefits Scheme (PBS)/Repatriation Pharmaceutical Benefits Scheme (RPBS) prescriptions increased by 27% to $1.4 billion during the same period. The Australian government has substantially increased its expenditure over the past two decades on mental health services, as seen in Figure 2. However, the overall prevalence of poor mental health prevalence in the population is trending in the opposite direction, and Australia is now ranked number three across 36 countries for antidepressant consumption (Organisation for Economic Cooperation and Development, 2019).

The ‘big four’ (O'Neil et al., 2015) non-communicable diseases (i.e., cardiovascular disease, cancers, respiratory diseases, and type 2 diabetes) account for 85% of all premature deaths related to chronic conditions (World Health Organization, 2021a) and compound the mental health and wellbeing crisis. Deaths in Australia and New Zealand due to non-communicable diseases are higher at 89% compared to the global rate of 71% (World Health Organization, 2018b). The 2017-2018 National Health Survey revealed that 47% of Australians aged 15 years and

older had at least one chronic condition, up from 42% in 2007-2008 (Australian Bureau of Statistics, 2018).

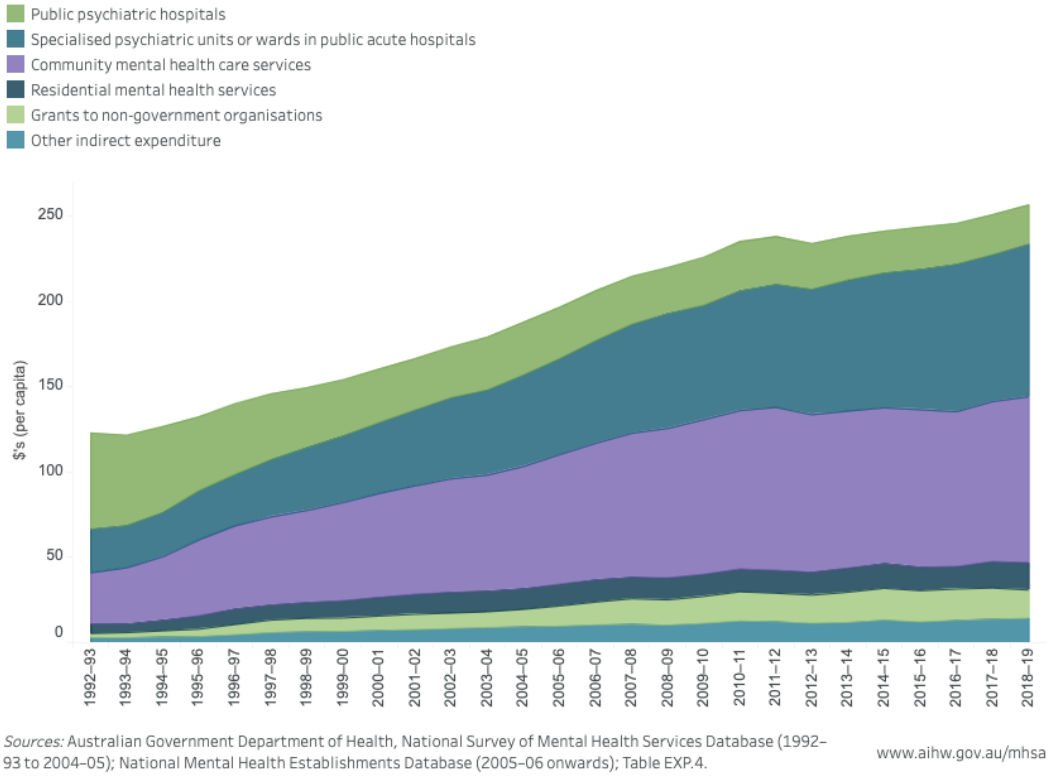


Figure 2. *Recurrent expenditure ($) per capita on state and territory specialised mental health services, 1992–93 to 2018–19 (Australian Institute of Health and Welfare, 2021b).*

The survey revealed that two-thirds of adults were overweight or obese. Other chronic diseases include heart disease, stroke, vascular disease, osteoporosis, chronic obstructive pulmonary disease, cancer, and kidney disease (Australian Bureau of Statistics, 2018). Similarly, the New Zealand population reported high rates of chronic diseases (Institute of Health Metrics and Evaluation, 2016).

The multimorbidity of chronic conditions has compounded the mental health and wellbeing crisis and resulted in more complex needs and poorer quality of life. In addition, there is strong evidence that depression is a risk factor for heart disease,

stroke, and diabetes (Carke & Currie, 2009). In 2017-2018, almost five million Australians had two or more chronic diseases (Australian Institute of Health and Welfare, 2020a). Notably, mental disorders such as depression are comorbidities with various chronic diseases, including coronary heart disease, diabetes, and cancer (Dare et al., 2019). Growing evidence indicates that negative emotions can lead to adverse social relationships and environments, affecting the psychophysiological pathways and resulting in coronary heart disease and diabetes, which can lead to depression (Chapman et al., 2005).

Rugulies (2002) conducted a meta-analysis of 11 studies and found that depression was an independent risk factor and predicted the development of coronary heart disease in healthy people. Furthermore, Chireh et al. (2019) conducted a systematic review and meta-analysis of 20 studies and reported that the pooled odds ratio between diabetes and depression was 1.33. The authors estimated that over 9.5 million global depression cases were potentially attributable to diabetes, and projected that a 10-25% reduction in diabetes could prevent 930,000 to 2.34 million global depression cases.

Indeed, chronic diseases are strongly related etiologically, sharing risk factors and critical pathways (O'Neil et al., 2015). In order to help address the mental health and wellbeing crisis, it is vital to recognise the comorbidity and multimorbidity implications of chronic disease. The implications can affect the severity of the disease and make patients less responsive to treatment, worsen prognosis, and increase recovery time.

2.5 Current Paradigm of Addressing the Mental Health and Wellbeing Crisis

The current paradigm of practising medicine is centred on a deficit model, which focuses on treating risk factors and symptoms. The management of common mental health disorders typically involves the prescription of antidepressant medications as the end of the treatment (Stubbs et al., 2016). Within this paradigm, the responsibility is carried by the health professional. The patient often takes on a passive role as a recipient of care in primary health care settings and typically is not required to make significant lifestyle changes.

Health professionals face increasing pressures on several fronts– economically, institutionally, and professionally, contributing to the current paradigm in healthcare. In addition, training systems that promote drug prescription have reduced recognition and reliance on other evidence-based strategies, such as psychotherapies for managing mental health conditions (Walsh, 2011). In Australia, antidepressant use increased by 352% (in terms of daily doses per 1,000 people) from 1990 to 2002; further increasing by 95% over the next ten years (Stephenson et al., 2013). However, from 2008 to 2017, an 11.6% decrease in the annual incidence of antidepressant usage resulted in a prevalence of 16.8%. In addition, there was a 7.4% increase in the median yearly duration of antidepressant use (Brett et al., 2017). In New Zealand, antidepressant use increased by 21% for individuals over 15 years of age in 2008 to a prevalence of 12.6% in 2015 (Wilkinson & Mulder, 2015).

The mental health and wellbeing crisis and the current paradigm of practising medicine are contribute to increased expenditure on health goods and services in Australia of AUD 195.7 billion in 2018-19, up 3.1% from the previous year (Australian Institute of Health and Welfare, 2020b). In 2018 to 2019, the Australian

Institute of Health and Welfare (AIHW) reported that primary care accounted for 33.5% (AUD 65.5 billion) and hospital services accounted for 31.7% (AUD 62 billion) of the health budget. In 2019 to 2020, the health budget for New Zealand was NZD 19.9 billion, equating to 25% of the government spending. The increasing and unsustainable health care costs are not unique to Australia and New Zealand. According to the World Health Organization (2020b), other countries face similar challenges, with global spending on health continuing to rise in 2018 to USD 8.3 trillion or 10% of gross domestic product.

Despite the evidence supporting the medical and economic benefits of prevention and early detection (Arango et al., 2018; Le et al., 2021), current disease-control efforts are underfunded and fragmented (Eyre, 2004). For example, in Australia, less than 1.5% of total health expenditure went to public health in 2018 to 2019, down from 1.7% in 2011 to 2012 (Australian Institute of Health and Welfare, 2014, 2020b). The expenditure included health prevention, protection, and promotion. Australia's prevention expenditure per capita is under 2%, which is below the 2.8% OECD average (Gmeinder et al., 2017). More funding is required to help combat the burgeoning mental health and wellbeing crisis (Shiell & Jackson, 2018) and to bring funding up to levels of the United Kingdom (4.3%), the United States (5.5%), and Canada (5.7%).

The lack of investment in early detection and prevention combined with the conventional health care model is ineffective in reducing mental health and chronic disease prevalence. Not only is there a mental health and wellbeing crisis, but there is also a burden imposed on the individual, taxpayer, health care system, and government (Alonso et al., 2011; Williams, 2021). Hence, there is an urgent need to reassess the medical model for preventing and managing the mental health and

wellbeing crisis. Two disparate but complementary disciplines advocate non-pharmacological strategies and therapies for enhancing the mental health and wellbeing of individuals. These two emerging disciplines are lifestyle medicine and positive psychology.

2.6 The Emergence of the Discipline of Lifestyle Medicine

Lifestyle medicine has gained recognition over the past two decades as a way forward for supporting conventional medicine in the prevention and management of chronic disease (Egger, 2018). However, lifestyle principles have been promoted since antiquity, through Levitical health laws that prescribed hygiene and avoidance of pathogenic substances and advocated through Hippocrates' infamous statement "let food be thy medicine" over 2,000 years ago (Morton et al., 2016)

Lifestyle medicine is the application of therapeutic lifestyle interventions– such as physical activity, healthy diet, smoking cessation, alcohol avoidance and stress management–and motivational principles to influence chronic disease prevention and management in a clinical and public setting (Egger, 2019; Nunan et al., 2021). Lifestyle medicine aims to modify behavioural and lifestyle causes of chronic conditions in primary prevention (Egger et al., 2011). In addition, secondary prevention aims to modify existing risk factors to prevent disease progression. Further, lifestyle medicine can rehabilitate the individual from a disease state or prevent the recurrence of the disease through tertiary prevention.

Lifestyle medicine is not an alternative to conventional medicine. Instead, it is a discipline that aims to use therapeutic lifestyle interventions to address the whole person rather than the symptoms of disease, focusing on the process of awareness, education and growth (Egger, 2018). In contrast to conventional medicine, lifestyle medicine takes a longer-term approach, requiring active participant engagement in

making lifestyle changes. Motivation and compliance are essential due to the greater emphasis on self-care and self-management, as seen in Table 1 below.

Table 1. *Differences between conventional and lifestyle medicine approaches in primary care (Egger, 2019)*

Conventional medicine	**Lifestyle medicine**
Focus on risk factors and proximal determinants of disease	Focus also on medial and distal determinants of disease
Patient more a passive recipient of care	Patient should be an active partner in care
Patient not required to make big changes	Treatment almost always long term
Emphasis on diagnosis and prescription	Emphasis on motivation and compliance
Less emphasis on the environment	Greater consideration of the environment
Involves predominant medical specialities	Includes greater allied health input
Doctor acts independently on 1:1 basis	Doctor is the coordinator of a health professional team

A number of key studies that have contributed to the evidence base for lifestyle medicine are outlined in Table 2.

Table 2. *Studies that have contributed to lifestyle medicine*

Study	**Reference**
Framingham Heart study	Dawber et al., (2015); Mahmood et al. (2014); Tsao and Vasan (2015); Wong and Levy (2013)
Lifestyle Heart Trial	Ornish et al. (1998)
Esselstyn's studies on coronary heart disease	Esselstyn (1999, 2010); Esselstyn et al. (2014); Esselstyn et al., (1995)
Nurses' Health study I and II	James et al. (2013)
Women's Health study	Mursu et al. (2013)
Health Professional's Follow-up study	Ardisson Korat et al. (2014); Dauchet et al., (2006)
Adventist Health study I and II	Fraser (2003); Kiani et al., (2006); Tonstad et al. (2009)
EPIC Northfolk Study	Khaw et al. (2008)
Diabetes Prevention Program	Katula et al. (2013)
Complete Health Intervention Program	Englert et al. (2004); (Kent et al., 2013); Morton et al. (2015); Morton et al. (2014); Rankin et al. (2012).

Studies estimate that 90% of type 2 diabetes and cardiovascular disease could be prevented (Ford et al., 2009; Yusuf et al., 2004), and 30-45% of all cancers may have been prevented had risk factors been altered to optimal levels or eliminated (Vineis & Wild, 2014; Wilson et al., 2018). The vast potential for lifestyle behaviour change on mortality and morbidity should give sufficient reason to motivate clinicians to prescribe lifestyle medicine as the first line of therapy (Lianov & Johnson, 2010). Lifestyle changes include increasing physical activity, consuming a healthy diet, eliminating tobacco use, avoiding alcoholic beverages, and getting adequate rest (Arena et al., 2015; World Health Organization, 2021a).

Despite the evidence for lifestyle medicine, studies indicate clinicians seldom recommend lifestyle changes, resulting in poor quality of health care (Bodai et al., 2018). New skills, tools and procedures in lifestyle medicine are continually adapted and developed, requiring clinicians' proof of concept testing and education to transform clinical practice (Egger et al., 2019). Some barriers to clinicians practising lifestyle medicine include inadequate funding, insufficient knowledge, lack of confidence (Manger, 2019), and limited counselling skills in the area of lifestyle medicine (Lianov & Johnson, 2010; Manger, 2019; Polak et al., 2015)

2.6.1 The Benefits of Lifestyle Medicine for Mental Health and Wellbeing

While there is a plethora of literature for the benefits of lifestyle medicine for physical conditions, lifestyle medicine for mental health and wellbeing is relatively new (Sarris et al., 2014). The influence of lifestyle practices such as regular physical activity, healthy diet, adequate sleep, smoking cessation, minimal or no alcohol use, and multicomponent lifestyle strategies on common mental health disorders (Boden & Fergusson, 2011; Firth, Solmi, et al., 2020) will now be discussed.

7.1.1 Physical Activity

The benefits of regular physical activity for improving mental health have been known for decades (Yeung, 1996). The decline in physical activity and the increase in lifestyle-related diseases has resulted in a renewed interest in the effectiveness of physical activity on improving mood, depressive symptoms and treating depression. Over the past decade, several meta-analyses and reviews have shown that physical activity is an effective intervention for depression (Cooney et al., 2013; Josefsson et al., 2014; Kvam et al., 2016; Silveira et al., 2013). Josefsson et al. (2014) reported

that 13 studies in a meta-analysis had a significantly large overall effect favouring physical activity interventions for improving depressive symptoms.

Kvam et al. (2016) found in a meta-analysis of 23 studies that physical activity was an effective intervention for depression for those willing and motivated to engage in the intervention. Additionally, the authors found that exercise therapy was comparable to pharmacotherapy for depression.

Studies have demonstrated that physical activity can improve wellbeing and be protective against depression. For example, Lathia et al. (2017) reported that among a cohort of over 12,000 adults, physically active individuals reported higher levels of happiness and increased positive affect while exercising. In addition, a meta-analysis of 49 prospective cohort studies found that higher physical activity levels resulted in decreased odds of developing future depression and was protective against depression regardless of age, sex, and geographical region (Schuch et al., 2018).

The evidence shows that physical activity benefits mental health, however, the mechanisms of accomplishing this are less known. Two decades ago, Hansen et al. (2001) conducted a study on 21 college students and found that 10-minute bouts of physical activity at an aerobic level of 60% is adequate to increase vigour, decrease fatigue, and total negative mood state. Eriksson and Gard (2013) conducted a systematic review of eight studies and found that higher intensive exercise, whether in the form of aerobic or resistance exercise, is more important for improving mood and depressive symptoms than the frequency at which exercise is performed. It was acknowledged in the review that an expectation bias might persist in the data due to the participants' potential belief in the efficacy of the physical activity.

7.1.2 Diet

Studies demonstrate a significant association between diet and mental health (Akbaraly et al., 2009; Beezhold et al., 2010; Firth et al., 2020; McMartin et al., 2013) that persists throughout the life course of a person (Jacka et al., 2015). Rather than single nutrients, dietary patterns are vital predictors of depression (Nanri et al., 2010). A meta-analysis of 21 epidemiological studies reported that the Western diet, characterised by a high intake of red and processed meat, refined grains, refined sugars, and high-fat dairy products, is associated with a higher risk of depression (Li et al., 2017). In contrast, a healthy diet consisting of high intakes of vegetables, fruits, whole grains, soy, fish, and low-fat dairy was associated with a lower risk of depression.

In the *SMILES* randomized controlled trial—which investigated the efficacy of a 12-week dietary improvement program on major depressive episodes—a Mediterranean-style diet high in fruits, vegetables, grains, and legumes reduced depression four times more effectively than the control group (Jacka et al., 2017). The intervention involved a clinical dietician delivering seven individual sessions while the control group only received social support. The results were independent of changes in weight, body mass index (BMI), smoking rates, and physical activity. Additionally, the new healthier diet was more affordable, with mean weekly food costs of $112 compared to $138 (Rachelle et al., 2015). While the results of the *SMILES* study were informative and completion rates were high for the intervention group (93%), the control group had a lower completion rate (74%), and the study did not meet the planned sample size, which may have affected the outcomes and conclusions. Further replication of the study with larger sample sizes is required.

Several studies have also demonstrated that diet quality has a bi-directional relationship with mental health disorders (Akbaraly et al., 2009; Sanchez-Villegas et al., 2006). For example, people experiencing mental health disorders often have poor dietary habits, impacting their depressive illness and self-care, resulting in a spiralling effect and a continuous cycle.

Studies also report that diet can affect wellbeing. In a longitudinal study of nearly 9,000 participants in the Adventist Health Study 2, increased amounts of n-6 polyunsaturated fatty acids, found in common vegetable oils, desserts, dressings, meats, and chips, led to cardiovascular disease and mental health problems (Ford et al., 2016). A meta-analysis of 15 randomized controlled trials of a nonclinical sample of depression reported that dietary interventions significantly reduced depressive symptoms (Firth et al., 2019), suggesting that a healthy diet can play a pivotal role in the treatment and self-management of depressive symptoms.

Several studies have reported increased fruit and vegetable consumption to improve mental health and wellbeing (Nanri et al., 2010; Södergren et al., 2012), even over a brief period (Conner et al., 2017). Furthermore, a dose-response relationship exists between fruit and vegetable consumption and positive emotion, with research indicating that eight servings daily promotes optimal outcomes in positive affect (White et al., 2013). Prescribing a healthy diet is crucial for improving mental health and wellbeing.

7.1.3 Sleep

Sufficient sleep requirements vary across a person's lifespan. The recommended sleep guidelines for healthy adults are between seven to nine hours sleep per night (Hirshkowitz et al., 2015). The prevalence of suboptimal sleep in Australia is estimated at double the rate for those with a mental health condition

(Metse et al., 2021). A Sleep Health Survey in Australia found that 33-45% of Australian adults were affected by inadequate sleep of either duration or quality (Adams et al., 2016). Short sleep of fewer than six hours per day versus the recommended sleep was associated with the highest number of comorbidities than other sleep combinations (Seow et al., 2020). In addition, approximately one in four respondents indicated that work or home duties prevented them from getting enough sleep. Further, 29% of respondents admitted they made errors at work due to sleepiness or sleep problems in the past three months. Inadequate sleep can affect an individual's mental health and wellbeing, increasing the risk of metabolic syndrome, which is associated with mood disorders, mental distress, depression, anxiety, obesity, poor psychological functioning, high cholesterol levels (Chaput et al., 2013), diabetes, and premature death (Cappuccio et al., 2010). Acute sleep disorders, such as insomnia, can cause depression and anxiety (Mason & Harvey, 2014; Neckelmann et al., 2007). Population health interventions to improve sleep duration and quality should be part of routine health care and a public health priority.

7.1.4 Smoking Cessation/Alcohol avoidance

It has been well established that tobacco smoking can have harmful physical effects and cause mortality (Pirie et al., 2013; Stringhini et al., 2017). In a systematic review and meta-analysis of 26 studies, smoking cessation was associated with reduced depression, anxiety, and stress. Smoking cessation also improved positive mood and quality of life compared to those who continued to smoke (Taylor et al., 2014). Similarly, a systematic review and meta-analysis of 20 studies reported that smoking cessation interventions effectively increased short-term and long-term smoking abstinence in individuals with current depression (Secades-Villa et al., 2017). Additionally, smoking abstinence was associated with improvements in

depressive symptoms. However, there was no conclusive evidence on the optimal abstinence treatment among depressed smokers. Bränström et al. (2010) found positive affect and mood management tools effective in helping participants quit smoking and maintain abstinence.

Studies have also shown that alcohol interventions positively impact alcohol misuse, depression, and quality of life. A meta-analysis of six studies reported the effectiveness of digital interventions in reducing depressive symptoms at three months follow-up and alcohol use at six months follow-up with people with comorbid depression and problematic alcohol use (Schouten et al., 2021). However, further research is warranted to replicate the current findings. An and Xiang (2015) tested the associations between smoking, heavy drinking, and depression. They found that smokers that were free from depression and were heavy drinking at baseline were more likely to develop depression and engage in heavy drinking during a follow-up period than those who did not smoke.

7.1.5 Multicomponent Lifestyle Interventions

Limited studies explore the influence of a comprehensive lifestyle intervention involving multicomponent lifestyle modification on mental health. Aldana et al. (2006) investigated the effectiveness of the Ornish Program for Reversing Heart Disease which promotes improvements in nutrition, physical activity, stress management, and social support, on twelve psychosocial risk factors, including depression, anxiety, and overall quality of life (Aldana et al., 2006). Compared to the control group, participants in the intervention group had significant improvements in all twelve-outcome measures. Notably, a high adherence rate of 89% was achieved at three months for the intervention and sustained after six months. However, participants were not randomly allocated to the control or

intervention group, which introduces confounding factors and might question conclusions of causality.

Lopresti et al. (2013) found that lifestyle factors such as diet, exercise, and sleep have a bi-directional relationship with major depression. Lifestyle factors play a significant mediating role in the development, advancement, and treatment of depression. In addition, lifestyle factors contribute to the dysregulated pathways such as oxidative stress, antioxidant defence systems, neuroprogression, and influence mitochondrial disturbances.

Nedley & Ramirez (2016) investigated the connection between lifestyle choices and non-modifiable factors on the diagnosis of depression among over 4,000 subjects. The authors concluded that depression, as diagnosed by the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5), was prevalent among participants who identified with any four of the following ten causalities categorised as genetic, developmental, lifestyle, circadian rhythm, addiction, nutrition, toxic, social/complicated grief, medical conditions, and frontal lobe.

A systematic review of 29 studies found that multicomponent interventions using psychological techniques to improve diet and physical activity also improved mental health (Blissmer et al., 2006; Dale et al., 2014). The authors highlighted a multicomponent intervention involving physical exercise, nutrition, and educational counselling with an extended support group sustained improvements to mental health for a longer-term two years. This evidence suggests that lifestyle interventions drawing on psychological behaviour change using cognitive, behavioural, motivational, and volitional approaches may offer an alternative to traditional mental health approaches (Dale et al., 2014).

A study among college students examining the effectiveness of a ten-week multimodal intervention on mental health and emotional wellness reported approximately 30% reductions in depression, anxiety, and stress, and 15-20% improvements in overall mental health (Morton et al., 2020). Several strategies such as exercise, diet, rest, positive thinking, and outlook were used in the intervention, resulting in a larger effect size than other single intervention studies, suggesting that multiple strategies can result in a compounding effect. Further research is required to understand causality and generalizability, as the target population was college students, and the intervention was a mandatory component of the student's course of study, which did not allow for randomization.

Schoeppe et al. (2016) conducted a systematic review of 23 studies using app-based interventions to improve diet, physical activity, and sedentary behaviours, resulting in improved wellbeing and preventing non-communicable diseases (NCDs). Multicomponent interventions were more effective than stand-alone app interventions. While a systematic review and meta-analysis of 23 studies examining the relative effectiveness of multiple-risk lifestyle interventions targeting depressive symptoms are inconclusive (Gomez-Gomez et al., 2020), given that physical activity, unhealthy diet, and smoking are associated with the risk of depression, it may be hypothesised that the multicomponent approach would likely confer greater benefits than a single modality approach.

In summary, there is compelling evidence that a range of lifestyle factors such as physical activity, diet, sleep, smoking cessation, and alcohol avoidance effectively prevent, manage, and treat common mental health disorders and promote mental wellbeing. The adoption of healthy lifestyle practices should be a first-line strategy to address mental health and wellbeing concerns as lifestyle medicine tends

to be cost-effective, free from stigma, and has minimal side effects as compared with pharmacology. In addition, positive psychology is an emerging discipline that uses evidenced-based non-pharmacological strategies to improve mental health and wellbeing. The following section will explore positive psychology interventions and the concept of flourishing.

2.7 The Emergence of the Discipline of Positive Psychology

Historically, psychological treatments for mental health centred around a deficit model which focused on stress (Roberts et al., 2015), depression (Orgeta et al., 2014), dysfunctional attitudes and behaviours, and inadequacies in organisational structures and cultures (Buse et al., 2013; Kobau et al., 2011). However, over the past two decades, a new discipline of psychology, called positive psychology, has emerged (Seligman, 2019). Martin Seligman, widely-recognised as the father of positive psychology, defined positive psychology as the scientific study of the strengths and virtues that empower individuals and communities to improve their quality of life and citizenship so they can flourish (Seligman & Csikszentmihalyi, 2000).

At an individual level, positive psychology focuses on virtues such as the capacity for love, courage, interpersonal skills, perseverance, forgiveness, originality, future-mindedness, spirituality, signature strengths, and wisdom. Positive psychology emphasises virtues that promote citizenship at a community level, including responsibility, nurturance, altruism, civility, moderation, tolerance, and work ethic (Seligman et al., 2005).

Interest in positive psychology is high for several reasons (Carleton, 2009). Firstly, researchers have found that positive psychology can effectively prevent and treat mental illness (Bolier et al., 2013). Secondly, cross-sectional, longitudinal, and

experimental studies have shown that high levels of wellbeing are related to positive outcomes, including learning, productivity, creativity, good relationships, positive social behaviour, higher quality of life, life expectancy, and possible effects on immune function (Diener, 2012; Huppert & So, 2013; Lyubomirsky et al., 2005). Thirdly, as more people in society have their basic needs met, their quest for psychological fulfilment, the pursuit of happiness and the meaning of life are sought (Maslow, 1943).

2.7.1 The Construct of Flourishing

Over the past two decades, positive psychology literature has developed an understanding of pathways to positive mental health and higher levels of functioning, commonly known as *flourishing*. Several theorists have defined the term flourishing however, they have not reached a consensus. Keyes (2007) advocates a two continua model with mental illness and mental health (flourishing). He defined flourishing as a state of positive emotions, positive psychological functioning, and positive social functioning. He asserted that anything less than complete mental health resulted in higher levels of impairment and disability. Flourishing is the antithesis of languishing which is typified by low levels of positive emotion and life satisfaction, high levels of distress (Keyes, 2010), increased risk of chronic disease, and higher rates of all-cause mortality (Diener & Chan, 2011; Keyes & Simoes, 2012). Diener (2012) stated that aspects such as prosperity (Ryff, 1989), social capital (Helliwell et al., 2009), good social relationships (Brown et al., 2003), and purpose in life (Steger et al., 2008) were key to flourishing.

While there are several constructs of flourishing, the PERMA wellbeing model is arguably the most well-known (Seligman, 2011). The acronym PERMA identifies five essential pillars for wellbeing, happiness, and the ability to flourish:

Positive emotion, Engagement, Relationships, Meaning, and Achievement. The first pillar, Positive emotions, is believed to drive many human actions, enhance performance at work, improve physical health, strengthen relationships, and create optimism and hope for the future. The second pillar, Engagement, refers to experiences in which one is engaged in the present moment, which may occur through involvement in recreation, hobbies, or work. The third pillar, Relationships, recognises that humans need love and connection. The fourth pillar, Positive relationships with family, friends, and work colleagues, leads to a sense of belonging and fulfilment. Meaning is considered an essential pillar and involves belonging to and serving something bigger than oneself (Seligman, 2011). In addition, meaning provides an individual with a sense of purpose and reason for living and hence is deemed crucial to achieving a life of fulfilment. Participating in a specific religion, community, or volunteering are examples where people can find meaning. Finally, the fifth pillar, Accomplishment, refers to an individual striving to be better and achieving a worthwhile goal.

Despite the lack of consensus in the definition, Seligman (2011) refers to flourishing as the "gold standard of measuring wellbeing" (p.13). People who are flourishing reported the least number of days absent from work, the healthiest psychosocial functioning, the lowest risk of cardiovascular disease, the least number of chronic physical disorders with age, and lower health care utilisation (Keyes, 2007). Flourishing was also associated with increased productivity, learning, creativity, and longevity (Schotanus-Dijkstra et al., 2017; VanderWeele, 2017).

Despite the popularity and benefits of flourishing, the term is still in its infancy, with no consistent conceptualisation and means to quantify it. While the term is continually developing (Węziak-Białowolska et al., 2018), Hone et al. (2014)

conducted a review of four frameworks (Huppert and So conceptual framework, Mental Health Continuum Short Form [MHC-SF], Flourishing Scale, and PERMA model) that measured flourishing and applied these on a large New Zealand cohort of 10,000 adults. The study observed significant variation in the prevalence of flourishing between the frameworks, with the Huppert and So conceptual framework indicating the lowest levels of flourishing among the cohort (Huppert and So [24%], MHC-SF [39%], Flourishing scale [41%] and PERMA model [47%]). While there are several frameworks for measuring flourishing (see Publication 2 for more details), the Huppert and So conceptual framework was used in this study as it was considered the most stringent conceptualisation of flourishing and reported the highest internal consistency of the four frameworks (Cronbach alpha= 0.83). The Methods chapter explains the Huppert and So conceptual framework in detail.

2.7.1.1 The Benefits of Positive Psychology Interventions on Mental Health and Wellbeing

Studies have examined the effectiveness of various positive psychological-based strategies, referred to as Positive Psychology Interventions (PPIs), for improving mental health and wellbeing. Evidenced-based strategies and exercises include fostering optimism (Boehm et al., 2011), expressing gratitude (Witvliet et al., 2018), three good things–writing down three good things that went well on that day and determining the emotions experienced (Proyer et al., 2014), practising hope (Cheavens et al., 2006), performing acts of kindness (Curry et al., 2018), engaging humour (Wellenzohn et al., 2016), positive thinking (Seligman et al., 2005), positive writing (Harrist et al., 2007), life coaching (Green et al., 2006), using memories to enhance happiness (Liberman et al., 2009), and identifying strengths (Ghielen et al., 2017).

Carr et al. (2020) conducted a recent meta-analysis of 347 PPIs on both clinical and nonclinical cohorts of children and adults across 41 countries and reported significant small to medium effects for depression (g = -0.39), stress (g = -0.58), anxiety (g = -0.62), wellbeing (g = - 0.39), and QoL (g = 0.48) . The results were generally sustained at three months follow-up, demonstrating the effectiveness of PPIs for improving mental health and wellbeing. Notably, the interventions were more effective when they: utilised multicomponent PPIs, were longer in duration, involved more sessions, and used an individual or group format rather than a self-help intervention. Multicomponent PPIs utilise a variety of evidence-based individual exercises that focus on two or more theoretically relevant hedonic and eudaimonic wellbeing components (Hendriks et al., 2019). The Carr et al. (2020) meta-analysis is consistent with six previous PPI meta-analyses (Boiler et al., 2013; Chakhssi et al., 2018; Hendriks et al., 2019; Sin & Lyubomirsky, 2009; Weiss et al., 2016), which concluded that PPIs were more effective in improving mental health and wellbeing than single modality approaches. However, Carr et al. (2020) included a greater number of studies (347 versus 27 to 51), evaluated more dependent variables (6 versus 2 to 4), analysed a larger number of moderating effects (16 versus 5 to 7), and was more methodologically robust, meeting 14 of the 16 AMSTAR 2 (a measurement tool to assess systematic reviews) quality criteria.

Whilst meta-analyses of PPIs have demonstrated significant improvements in mental health and wellbeing, only three studies have investigated the influence of PPIs on flourishing, and no studies have used the Huppert and So conceptual framework. In the first study, Feicht et al. (2013) observed in a RCT (n=147) significant improvement (p=0.002) from 43 at baseline to 46 at four-week post-intervention using the Flourishing Scale (scored out of a maximum of 56 points). The

intervention utilised a seven-week web-based multicomponent PPI applied in an occupational health setting. In the second study, Schotanus-Dijkstra et al. (2017) conducted a RCT (n=275) involving a multicomponent PPI and reported a significant increase in the percentage of individuals categorised as flourishing (from 7 to 34%, $p<0.001$), assessed using the MHC-SF. Most recently, in a RCT involving 654 university students, Bendtsen et al. (2020) utilised an online multicomponent PPI and observed an 8.5 point increase in the median MHC-SF flourishing score among the intervention group.

It is worth noting that a systematic review and meta-analysis of 22 studies reported the effectiveness of positive psychology in the workplace (Donaldson et al., 2019). Employees with high subjective wellbeing in the workplace have higher evaluations of happiness, work engagement, career satisfaction, psychological capital, and perceived organisation support (Joo & Lee, 2017). For these reasons, happiness has captured the attention of psychologists, economists, large-scale projects, and national indexes to guide decision-makers and public policy (Huppert & So, 2013).

Furthermore, the delivery of digital positive psychology interventions has gained popularity with the advancement of technology. The following section will describe the effectiveness of digital delivery and the influence of gender and age on mental health and wellbeing interventions.

2.8 Digital Mental Health and Wellbeing Interventions

Over the past decade, technology innovation has resulted in mental health and wellbeing interventions moving towards the digital mode of delivery. *Digital* is a broad term that describes the use of devices (e.g., mobile app and computers) and platforms (e.g., video-conferencing and social media platforms), whereas online

generally refers to connectivity to the internet and web. Despite the terms being used interchangeably in the literature, the term digital will be predominantly used throughout the thesis as the experimental studies are supported by a digital platform and mobile app.

Digital mental health interventions effectively provide evidence-based treatment to large samples of people experiencing depression (Himle et al., 2021). In addition, two systematic reviews and meta-analyses reported that digital mental health interventions for anxiety and depression were effective in preventing the onset of mental health disorders (Deady et al., 2017; Sander et al., 2016). Further, a systematic review of 89 studies found that digital mental health interventions were a plausible treatment for depression, anxiety, and psychological wellbeing enhancement among college students (Lattie et al., 2019).

Digital interventions have several advantages, including cost-effectiveness; flexibility of completing the intervention; accessibility to evidence-based treatments; minimising the need for trained staff; and assisting in overcoming personal obstacles (Aboujaoude et al., 2020; Hill et al., 2017; Richards et al., 2015; Torous et al., 2020). Lack of motivation to attend a venue due to provider shortages, stigma attached to mental illnesses and obstacles in seeking mental health diagnosis and support are examples of personal obstacles. However, the attrition rates in digital interventions are often as high as 45% for the intervention, with over 15% not completing the post-test or assigned exercises (Gander et al., 2016). Issues in missing data and follow-up trials are common (Mackinnon et al., 2008). In addition, adherence remains a challenge in digital mental health and wellbeing interventions.

2.8.1 Adherence

The literature is sparse, and the outcomes are unclear in understanding how to maximise adherence to digital mental health and wellbeing interventions (Schouten et al., 2021). In a systematic review of 69 studies, Donkin et al. (2011) acknowledged there was no standardised method to measure adherence, resulting in considerable variation in adherence reporting and the association of adherence and outcomes. In addition, adherence to mental health interventions is complex and multifactorial. Manager (2019) recognised the following factors could affect adherence to interventions: mental illness-related factors (e.g., paranoid symptoms), physical factors (e.g., side effects of medicine), cognitive factors, psychosocial factors, and clinician factors (e.g., mental illness stigma and inadequate clinical training).

Two decades ago, Fogg (2002) coined *interactive technology* as a design to leverage the principles of social influence to motivate and persuade human beings to change their attitude and behaviour for better adherence to interventions. Motivating and persuading human beings can be achieved by implementing features that reward people with positive feedback, modelling a target behaviour or attitude, and providing social support. Oinas-Kukkonen and Harjumaa (2009) progressed interactive technology by establishing a process for creating and evaluating persuasive systems, called the Persuasive Systems Design (PSD) model. There are three phases in persuasive systems development for behaviour or attitude change: first, understanding key issues behind persuasive systems, second, analysing the persuasion context, and third, design of system qualities. The Methods section provides a detailed explanation of the three phases. Common PSD principles used in digital mental health interventions include goal setting, feedback and reminders,

monitoring, personal feedback, social interaction (Cotter et al., 2014), and gamification, such as rewards, badges, and points (Looyestyn et al., 2017).

In a meta-analysis of 33 studies, Wildeboer et al. (2016) reported an association between the number of persuasive technology principles and the effectiveness of mental health digital-based interventions. Certain persuasive technology principles worked better together, such as tunnelling and tailoring, reminders and similarity, and social learning and comparison. The average adherence rate for the within-group analysis was 58%. In addition, there was no correlation between increased adherence and larger effect sizes.

Human support can increase the effectiveness of adherence. In a systematic review of 83 studies utilising persuasive design principles, Kelders et al. (2012) observed that RCTs (versus observational studies) had increased interaction with the counsellor, higher frequent intended usage, regular updates, and dialogue support, which significantly predicted higher adherence. In a scoping review of 27 studies, Lentferink et al. (2017) reported that key PSD features such as personalisation, praise messages, suggestions, reminders, and self-tracking using valid wearables incorporated with persuasive eCoaching in automated healthy lifestyle interventions had a positive effect on health outcomes.

Another meta-analysis of 66 RCTs reported that smartphone interventions significantly outperformed control conditions in improving depressive and general anxiety symptoms, stress levels, quality of life, general psychiatric distress, social anxiety symptoms, and positive affect (Linardon & Fuller-Tyszkiewicz, 2020). Professional guidance and reminders bolstered the effectiveness of smartphone interventions resulting in larger effect sizes, which is consistent with other studies (Baumeister et al., 2014; Ebert et al., 2018). The use of peer or automated support

may also be a viable option to reduce costs and allow for scalability (Spijkerman et al., 2016). In contrast, some studies suggest that providing human support does not significantly improve adherence (Aardoom et al., 2016; Renfrew et al., 2020). Although a systematic review and meta-analysis of 19 studies observed a significant effect on depression severity with additional moderate effects on anxiety (Josephine et al., 2017), human support did not affect the outcomes of digital mental health interventions despite the difference in duration, human support, and therapeutic approach.

Typical reasons for nonadherence include lack of time, disinterest in the intervention, treatment was no longer needed, hardware or technical issues, perceived ineffectiveness of the intervention, life events, discontinuation as participants felt better after undertaking a few modules, discontent with the group activity, holidays, work commitments, poor health, and no longer wished to participate (Wildeboer et al., 2016).

2.8.2 Gender & Age

There is a paucity of studies that have examined the gender outcomes of and the adherence to digital mental health and wellbeing interventions. Males tend to be more hesitant than females to seek help or treatment for mental health issues (Seaton et al., 2017). Further, self-selected mental health and wellbeing interventions commonly have a female bias in participation (Aardoom et al., 2016; Kavcic et al., 2021; Walsh et al., 2018), which is consistent with females rating the value of mental wellbeing interventions higher than males (Svedberg, 2011).

Promoting male role models, incorporating problem-solving tasks, and portraying positive male traits are viable strategies for improving mental health outcomes when targeting males (Sagar-Ouriaghili et al., 2019). Male-dominated

industries may benefit from using mental health and wellbeing interventions to improve mental health awareness, promote access to treatment, and reduce absenteeism (Lee et al., 2014). Mental health and wellbeing interventions can create sustainable cultures that advocate group comradery, encourage trust, and reduce the mental health stigma to normalise engagement. As males typically require additional encouragement to engage in digital interventions, focusing on implementation and subgroups that may be hesitant to receive help may be warranted (Batterham & Calear, 2017).

In addition, there is a lack of studies investigating the influence of age on the outcomes of and adherence to digital mental health and wellbeing interventions. Mental health issues have a higher prevalence in certain groups, such as young people and those with lower socioeconomic status; however, people of all gender and age groups are affected (Isaacs et al., 2018; Reiss et al., 2019; World Health Organization, 2019). The term *digital natives* is used for young adults born in the digital media era; however, this does not automatically mean their outcomes and adherence will be higher. In a web-based survey, Dunbar et al. (2018) observed a low utilisation rate of 3% for online mental health services, despite 60% indicating that they would be willing to use the mental health services.

Garrido et al. (2019) reported in a meta-analysis of nine studies that gender was a predictor of adherence in young people, with females more likely to complete the intervention than males. Further, those with higher mental health scores at pre-test in depression (e.g., high mental distress) or longer duration of mood disorders, or low scores in anxiety at pre-test (e.g., lower mental distress) predicted higher adherence.

In a digital mental wellbeing intervention targeting young males, an Australian Football League-themed app was utilised and observed 60-day improvements in flourishing and a sense of connection to the intervention community regardless of gender (Cheng et al., 2020). The intervention incorporated young male role models, psychoeducation, social connection, and applied games. Mandryk and Birk (2017) conducted a web-based survey and concluded that game-based digital mental health interventions were suitable across various mental health indicators. Although games appeal to young male demographics, the authors concluded that games were effective across a range of demographics; there was no association between gender and age and frequency of play.

Notably, older female adults responded similarly to younger adults in a digital positive psychology intervention designed to increase happiness and reduce depressive symptoms (Proyer et al., 2014). In a meta-analysis of positive psychology interventions, older adults benefited the most in reducing their depression (Sin & Lyubomirsky, 2009), suggesting that digital mental wellbeing interventions have the potential to be used for older adults.

Despite the increased popularity of digital mental health and wellbeing interventions, older adults often experience many barriers to uptake and adherence. Older adults have less access and usage to the internet than younger adults. In 2018, 62% of older adults in Australia used the internet in the previous three months, compared with 87% aged 15 to 65 years (Australian Bureau of Statistics, 2020). In New Zealand, 75% of older adults had access to the internet, compared with 99% of those younger than 26 years (New Zealand Government, 2018).

Older adults often have inadequate skills to use technology effectively (Kenny & Connolly, 2017). Digital mental health interventions are infrequently

designed for novice digital users or according to the digital guidelines of older participants (Wasilewski et al., 2017). The intervention's demands or a poor therapeutic program may result in discontinuing the intervention (Pywell et al., 2020). In addition, older adults may lack trust in the intervention as they feel more comfortable dealing with their general practitioner and are concerned with privacy and confidentiality.

In summary, an *innovativeness-needs paradox* seems to exist where the people in most need of the digital mental health and wellbeing interventions are those at highest risk of having the least access, training, skills, adoption rates, and adherence, therefore increasing health care inequalities (Seifert et al., 2019). Digital mental health interventions can potentially reduce the gap in health care provision for older adults as many patients have long wait times for mental health providers and need help in the prevention and management of a multitude of chronic diseases. Further, older adults have less access to mental health providers due to the inability to travel long distances and are anxious about the stigmatisation attached to mental health disorders and are more likely to avoid therapy (Seifert et al., 2019).

The COVID-19 pandemic has affected society physically, socially, mentally, environmentally, and economically. The subsequent section will discuss the impact of COVID-19 on mental health and wellbeing, and the urgent need for novel digital mental health and wellbeing interventions.

2.9 Coronavirus Disease 2019

The mental health and wellbeing landscape was bleak prior to the COVID-19 pandemic. Governments have implemented drastic restrictions such as wearing masks, business restrictions, social distancing, travel limitations and stay-at-home orders to curb the spread of COVID-19 and reduce the burden on health care systems

(Dubey et al., 2020). While the restrictions are imperative to reduce the spread of COVID-19, they have resulted in poorer lifestyle behaviours such as reduced physical and social activity, unhealthy eating behaviours (Ammar et al., 2020), and poor sleep quality (Osiogo et al., 2021). Globally, this has triggered poorer mental health and wellbeing among the general population, health workers, and those infected by the virus (Bueno-Notivol et al., 2021; Ettman et al., 2020; Pera, 2020). In Australia, mental health issues at least doubled in the first month of COVID-19 restrictions (Fisher et al., 2020). Similarly, in New Zealand, there was a significant increase in depression (2.91 to 7.88 for PHQ-9) and anxiety (2.96 to 6.26 GAD-7) from the norm to the end of the first ten weeks of the COVID-19 pandemic (Gasteiger et al., 2021)

In addition, the World Health Organization (2020a) found 121 (93%) out of the 130 countries surveyed had disrupted or halted their mental health services due to COVID-19 when the population needed it most. Prevention and promotion of mental health services and programs were most severely affected. The COVID-19 crisis has forced many clinicians and patients to use digital health for the first time as part of their routine care due to lockdowns and the inability to meet in person (Taylor et al., 2020). In the wake of COVID-19, there are calls for novel and innovative mental health and wellbeing solutions (Firth et al., 2020; Holmes et al., 2020). A recent review of the psychological impact of COVID-19 emphasised the need to build psychological resilience during or after stressful disabling circumstances and invest in specific prevention strategies on a community level (Serafini et al., 2020). The authors concluded it was imperative to implement innovative digital platforms to enhance health education and address mental health stigma and discrimination.

With the emerging growth of digital interventions, it has become apparent that digital health care tools and interventions effectively increase mental health and wellbeing (Deady et al., 2017; Kavcic et al., 2021; Naslund et al., 2019). A recent review of 83 studies concluded that there was good evidence for usability, safety, acceptance, and satisfaction for digital mental health and wellbeing interventions and that they were well suited to alleviate COVID-19 psychosocial consequences at a population-level (Rauschenberg et al., 2020). Indeed, in the second year of the COVID-19 pandemic, there is a greater need for an interdisciplinary approach to disseminating effective therapeutic strategies that meet the mental health challenges faced by societies in Australasia and worldwide. Providing wholistic care that involves physical, mental, social, and spiritual health to cope with personal adversity improves wellbeing and reduces suffering and disease (Ammar et al., 2020; Del Castillo, 2020; Ferrell et al., 2020; Lucchetti et al., 2020).

Indeed, the impact of COVID-19 has adversely affected mental health globally. A peer-reviewed article titled 'Addressing the COVID-19 mental health crisis: A perspective on using interdisciplinary universal interventions' was published in *Frontiers Psychology* (refer to the end of this chapter). This perspective delves into the impact of COVID-19 on lifestyle behaviours and mental health and calls for a paradigm shift to create well-designed digital interdisciplinary universal multicomponent mental health interventions to improve mental health and wellbeing and achieve scalability and accessibility.

2.10 Summary and Conclusions

Australasia and the world are experiencing an unprecedented global mental health and wellbeing crisis exacerbated by the COVID-19 pandemic. The current health care paradigm fails to address the mental health crisis at a population-level.

The current approach is unsustainable, with increased usage of antidepressant medication and increasing mental health expenditure, with no reduction in the prevalence of depression and anxiety. A highlighted gap in the literature is the lack of integration of lifestyle medicine and positive psychology strategies in addressing the mental health and wellbeing crisis. In addition, studies to date have mainly focused on a single strategy for improving mental health and wellbeing.

Furthermore, there is a paucity in the literature examining the responsiveness to gender and age in the promotion of mental health and wellbeing interventions using PSD. Therefore, this thesis aims first to determine the effectiveness of a digital multicomponent interdisciplinary intervention on the mental health and wellbeing of an Australasian nonclinical cohort; and second, to examine the influence of gender and age on the outcomes of and adherence to the intervention.

Publication 1–Addressing the COVID-19 mental health crisis: A perspective on using interdisciplinary universal interventions

2.11 Overview

This publication is entitled: “Addressing the COVID-19 mental health crisis: A perspective on using interdisciplinary universal interventions” and examines the impact of COVID-19 on mental health” (refer to Section 2.12), published in *Frontiers Psychology*, a Q2 ranked journal with an impact factor of 2.99. This perspective explores the impact of COVID-19 on lifestyle behaviours and mental health, and calls for the roll-out of well-designed digital interdisciplinary universal multicomponent mental health interventions to improve mental health, and achieve scalability and accessibility. The publication is significant as it is the first to promote digital interdisciplinary universal interventions to improve mental wellbeing, using lifestyle medicine and positive psychology strategies to address the COVID-19 mental health crisis.

2.12 Contribution of Authentication Statement

I attest that Research Higher Degree candidate Geraldine Lynn Chang Przybylko contributed to the publication entitled: **Addressing the COVID-19 Mental Health Crisis: A Perspective on using Interdisciplinary Universal Interventions.**

By:

- Contributing to the conceptualisation of the article.
- Contributing to the ideated structure.
- Leading the analysis of the literature.
- Leading the writing of the manuscript.
- Submitted the manuscript for review.
- Addressed reviewers' comments.

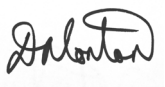
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Addressing the COVID-19 Mental Health Crisis: A Perspective on Using Interdisciplinary Universal Interventions

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Mental health is reaching a crisis point due to the ramifications of COVID-19. In an attempt to curb the spread of the virus and circumvent health systems from being overwhelmed, governments have imposed regulations such as lockdown restrictions and home confinement. These restrictions, while effective for infection control, have contributed to poorer lifestyle behaviors. Currently, Positive Psychology and Lifestyle Medicine are two distinct but complimentary disciplines that offer an array of evidence-based approaches for promoting mental health and well-being across a universal population. However, these strategies for improving mental health are typically used in isolation. This perspective calls for a new paradigm shift to create and rollout well-designed interdisciplinary universal multicomponent mental health interventions that integrates the benefits of both disciplines, and uses innovative digital mental health solutions to achieve scalability and accessibility within the limitations and beyond the COVID-19 lockdown and restrictions.

Keywords: universal, mental health, positive psychology, lifestyle medicine, digital, multicomponent, interdisciplinary

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INTRODUCTION

The prevalence of depression and anxiety is estimated at 586 million people worldwide (World Health Organization, 2017), with an annual economic burden of US$1 trillion, and less than one mental health professional for every 10,000 people (United Nations, 2020). This bleak backdrop predated the Coronavirus Disease 2019 (COVID-19) outbreak, of which 111 million cases and 2.5 million deaths have been reported as at 21 February 2021 (CNN health, 2021).

In an attempt to curb the spread of COVID-19 and circumvent health systems from being overwhelmed, governments have imposed regulations such as wearing masks, lockdown restrictions, social distancing, travel bans, and home confinement resulting in isolation (Dubey et al., 2020). These restrictions, while effective for infection control, have contributed to poorer lifestyle behaviors, such as physical and social inactivity, poor sleep quality, and unhealthy eating patterns (Ammar et al., 2020a). Unremarkably, poorer mental health has been observed within the general population, with health workers and COVID-19 sufferers being especially impacted (Deng et al., 2020; Pera, 2020; Rossi et al., 2020; Shi et al., 2020; Bueno-Notivol et al., 2021; CNN health, 2021). For example, a meta-analysis of 43 studies indicated that anxiety in the general population was at least 3 times higher during COVID-19 than before the pandemic (Santabarbara et al., 2020). Similarly, in the United States, Ettman et al. (2020) found 1 in 2 people reported depressive symptoms during COVID-19, which was three times higher than pre-pandemic circumstances. In Australia,

Fisher et al. (2020) found that mental health issues had at least doubled in the first month of COVID-19 restrictions.

Children and adolescents have also been affected during COVID-19 due to factors such as school closures and diminished opportunities for social interaction and connection (Cuartas, 2020). In a rapid review of 63 studies, Loades et al. (2020) observed higher rates of depression and anxiety during and after isolation. The authors encouraged preventative support and early intervention for children and adolescents to combat the increasing mental health issues. At the other end of the age spectrum, a number of studies have indicated that older adults are disproportionally affected by COVID-related mental health disorders, morbidity and mortality (Palmer et al., 2020; Zheng et al., 2020; Bae et al., 2021; Tsamakis et al., 2021).

Preserving the mental health and resilience of our population and already burdened health workers is paramount to ensuring global recovery from the pandemic (Santarone et al., 2020; Sharma and Verma, 2020). Hence, addressing the unprecedented mental health crisis must be an integral part of a comprehensive public health response to the COVID-19 pandemic and should involve the deployment and resourcing of: (1) population-based (universal) interventions to reduce the development of mental health disorders; (2) selective interventions to address those who are at high risk; and (3) clinical interventions to treat those who are suffering (Fisher et al., 2020). Currently, universal interventions are not commonly utilized, despite their potential to promote the mental health and resilience of all people. Keyes and Galea (2016) insightfully contend that when one reviews the health initiatives of the past century that have most significantly improved the lives of the population, only a small number are due to precise and personalized medicine. Hence, there are a number of calls for universal mental health interventions to mitigate the emerging mental health crisis due to COVID-19. This perspective article argues that widespread benefits can be achieved through: (1) the implementation of interdisciplinary universal mental health interventions; and (2) multicomponent interventions will likely confer greater benefits than a single modality approach.

UNIVERSAL MENTAL HEALTH INTERVENTIONS

Universal, or population-based, mental health interventions, are defined as non-clinical, primary prevention strategies directed at an entire population that address generic mental health risk and protective factors (Purtle et al., 2020; Rudd and Beidas, 2020). Universal mental health interventions aim to encourage general mental wellness through the promotion of psychoeducation and messages that destigmatize mental disorders, and deliver essential support to maintain psychological well-being. The literature suggests there are a number of benefits associated with universal mental health interventions including: the potential to reduce numerous risk factors; typically a lower cost per person; the ability to reach individuals who do not reach a diagnostic threshold; and a reduction in the stigma associated with mental health issues (Greenberg and Abenavoli, 2016).

While potential disadvantages of universal mental health interventions have been identified, including time and resources spent on participants who may not develop the adverse outcomes (Greenberg and Abenavoli, 2016) and the effect sizes tending to be smaller than selective interventions (Tan et al., 2014; Deady et al., 2017), there is a strong case for their benefits. For example, while effect sizes may be smaller, the impact can be large when translated to an entire population (Tan et al., 2014). Examples of successful, high-impact universal interventions include: vaccinations to reduce the spread of viruses; tobacco policy changes to reduce smoking-related mortality; mandatory use of seatbelts to reduced motor vehicle mortality (Sampson and Galea, 2018); and social distancing, the use of masks, hand washing and quarantine, to reduce the spread of the COVID-19, as previously mentioned. According to the Centers of Disease Control and Prevention, universal mental health interventions are relatively new, however, this approach is needed more than ever during COVID-19 (Evans and Bufka, 2020).

While there is a good case for universal mental health interventions, we argue that better outcomes can be achieved though interdisciplinary universal mental health interventions. Interdisciplinary interventions are characterized by the incorporation of evidence-based strategies and initiatives drawn from two or more disciplines. Specifically, we suggest that efficacious universal mental health interventions can be created by merging the disciplines of Positive Psychology and Lifestyle Medicine. These disparate but complimentary disciplines are providing an array of evidence-based approaches for promoting mental health and well-being across a universal population.

POSITIVE PSYCHOLOGY AND MENTAL HEALTH

Prior to the late 1990s, psychology was almost exclusively predicated on a deficit model, focusing on mental illness such as depression, stress, anxiety, and dysfunctional attitudes and behaviors (Kobau et al., 2011). During his time as president of the American Psychological Association in the late 1990s, Martin Seligman formalized the field of "Positive Psychology," characterized by the study of: positive emotions; positive character traits; optimal functioning; and empowering a state of "flourishing" for individuals, groups and institutions (Seligman et al., 2005). Over the past two decades Positive Psychology has experienced exponential growth in its size, reach, and impact (Rusk and Waters, 2013), and its influence continues to expand beyond the psychology discipline to education, psychiatry, neuroscience, health, and business (Rusk and Waters, 2013; Seligman, 2019). Further, there has been a proliferation in its supporting evidence-base and the use of Positive Psychology Interventions (PPIs).

PPIs involve a variety of strategies designed to increase positive affect and life satisfaction, including: expressing gratitude (Cunha et al., 2019), focusing on what went well (Mongrain and Anselmo-Matthews, 2012), performing acts of kindness (Curry et al., 2018), practicing forgiveness (Wade et al., 2014), expressing humor (Wellenzohn et al., 2016) and

identifying strengths (Ghielen et al., 2017). Carr et al. (2020) conducted a systematic review and meta-analysis of 347 studies of PPIs and reported significant small to medium effect sizes for improvements on: positive aspects of well-being (i.e., positive affect and life satisfaction), depression, anxiety and stress.

There are a limited number of studies that have examined the benefits of PPIs in the context of COVID-19 (Kavcic et al., 2020). A study of 1,059 adults in the United States found that sharing positive emotions prompted positivity resonance, resilience, and positive mental health during the pandemic (Prinzing et al., 2020). Despite a dearth of pandemic-based research, there are calls for Positive Psychology principles to be emphasized during COVID-19. For example, in a review of 34 meta-analyses, Fischer et al. (2020) argued that self-guided therapeutic approaches and Positive Psychology strategies (such as the expression of optimism, gratitude, and kindness) should be considered first-line interventions to be used during quarantine and social distancing to alleviate depression, anxiety and stress, and improve subjective well-being. Similarly, Waters et al. (2021) advocated for the incorporation of Positive Psychology knowledge, skills and practices (i.e., meaning, coping, self-compassion, courage, gratitude, character strengths, positive emotions, positive interpersonal processes, and high-quality connections) to support individuals by building positive processes and capacities to strengthen mental health during a pandemic. For practical Positive Psychology strategies refer to **Table 1**.

It is enlightening that a positive approach to mental well-being can alleviate depression, anxiety and stress, and improve positive emotion as PPIs do not have the stigma that can be associated with clinical interventions. Hence, PPIs might be more appropriate when targeting a population-level (i.e., universal interventions), as non-clinical individuals might be more inclined to engage with them.

Importantly, it has been argued that multicomponent PPIs are more beneficial than single modality approaches (Morton et al., 2020; Przybylko et al., 2021). Hendriks et al. (2019) conducted a systematic review and meta-analysis of 50 RCTs and concluded that Multicomponent PPIs (MPPIs) were efficacious, with a small to moderate effect on psychological well-being and a small effect on subjective well-being. Hence, Sin and Lyubomirsky (2009) encouraged practitioners to use MPPIs in a "shotgun" approach, asserting it to be more engaging and effective than single modality interventions.

LIFESTYLE MEDICINE AND MENTAL HEALTH

Like Positive Psychology, the discipline of Lifestyle Medicine is an evidence-based discipline that has emerged rapidly over the past two decades. Lifestyle Medicine seeks to "treat the cause" of chronic diseases and involves the application of lifestyle-based therapies such as positive nutrition, physical activity, sleep hygiene, stress management, smoking cessation, and limiting or avoiding alcohol.

The evidence base for "lifestyle as medicine" for improving physical health is well-established (Khaw et al., 2008; Ornish, 2009; James et al., 2013; Morton et al., 2014; Orlich and Fraser, 2014; An and Xiang, 2015; Dawber et al., 2015; Wright et al., 2017; Loprinzi and Joyner, 2018; Tan et al., 2018; Petrides et al., 2019), but the benefits of Lifestyle Medicine for mental health has only recently emerged (Velten et al., 2018; Kim et al., 2019; Riemann et al., 2020). A recent meta-analysis of 41 studies conducted by Firth et al. (2020b) reported that lifestyle modifications were effective for the prevention and treatment of mental health disorders. Further, positive mental health has a protective effect against unhealthy lifestyles, physical disease and social inequalities (Lange, 2018). Indeed, Lifestyle Medicine has not received its warranted attention in the psychological literature.

PHYSICAL ACTIVITY

Of all lifestyle factors, physical activity is most recognized for conferring mental health benefits and there is growing literature to support this. A meta-analysis of 49 prospective cohort studies ($n = 266{,}939$) reported that higher physical activity levels resulted in decreased odds of developing future depression and had a protective effect against depression regardless of age, sex, and geographical region (Schuch et al., 2018). Several other meta-analyses and reviews have also concluded that physical activity is an effective intervention for the treatment of depression (Cooney et al., 2013; Silveira et al., 2013; Josefsson et al., 2014; Kvam et al., 2016), and studies have shown exercise therapy to be comparable to pharmacotherapy for depression (Cooney et al., 2013; Kvam et al., 2016). Lathia et al. (2017) reported that among a cohort of over 12,000 adults, physically active individuals reported higher levels of happiness and increased positive affect while exercising.

Alarmingly, physical activity levels have declined worldwide during COVID-19 (Bentlage et al., 2020; Chtourou et al., 2020). Tison et al. (2020) used smartphone accelerometer data from 455,000 individuals across 187 countries, found a 5.5% decrease in the mean number of steps taken in the 10 days after the pandemic declaration, and then a 27.3% decrease at 30 days. Considerable variability was reported between countries, with Italy recording the greatest decrease in physical activity of 48.5%. Further, the ECLB-COVID-19 international online survey reported that time spent sitting increased by 28% and physical activity decreased for all fitness levels (Ammar et al., 2020b). Clearly, physical activity should be frontline in COVID-19 targeted universal mental health interventions. The World Health Organization (2020a) recommends that adults achieve at least 150–300 minutes of moderate-intensity aerobic physical activity per week and 60 minutes per day for children and adolescents aged 5–17 years. For practical strategies for increasing physical activity refer to **Table 1**.

NUTRITION

There is an increasing interest in the connection between nutrition and mental health (Firth et al., 2020a). A meta-analysis of 21 epidemiological studies concluded that the Western diet, characterized by a high intake of red and/or processed meat, refined grains, sweets, and high fat dairy products is associated

TABLE 1 | Practical Positive Psychology and lifestyle recommendations during COVID-19.

Strategy	Recommendation	Examples	Reference
Positive Psychology	Expressing gratitude	* Use a gratitude journal * Daily affirm and recognize others in a face-to-face or virtual environment	Fischer et al. (2020)
	Performing acts of kindness	* Perform an act of kindness each day	Fischer et al. (2020)
	Self-compassion	* Treating yourself each day with the same compassion as you show your friends	Waters et al. (2021)
	Resilience	* Keep perspective about life and challenges * Maintain a good social support * Be hopeful about life	Waters et al. (2021)
Physical Activity	Increase physical activity	* Join exercise classes online * Walk up and down the stairs	World Health Organization (2020b)
	Increase muscle strength and balance training	* Resistance exercises	World Health Organization (2020b)
	Breaking prolonged sitting	* Stand up while working, talking on the phone or watching TV	World Health Organization (2020b)
	Home-based physical tests	* Stair climb test * Balance test * Sit-and-reach test	da Cunha de Sá-Caputo et al. (2020)
Healthy Diet	Consumer regular meals	* Greatest intake of energy taking place in the morning	Ammar et al. (2020b)
	Reducing meal frequency	* Avoid eating in between meals	Ammar et al. (2020b)
	Healthy food and drink intake	* Eating more whole plant-based foods * Stay hydrated * Avoid refined and high glycemic foods	Ammar et al. (2020b) Ammar et al. (2020b)
	Adapting intermittent or long fasting period	* Fast 12 hours or more from dinner to breakfast	Ammar et al. (2020b)
Sleep Hygiene	Regular waking up and night schedule	* Use natural circadian preference to guide sleep patterns * Bring some structure to the day especially for children	Altena et al. (2020)
	Avoid or minimize screen time in your bedroom	* Do not take screen devices and tablets into the bedroom * Alternatively, switch off devices and tablets to reduce sleep disruption such as light and noise pollution	Altena et al. (2020)
	Engage in physical exercise	* Exercise regularly, preference during the day	Altena et al. (2020)

with a higher risk of depression (Li et al., 2017). Conversely, a healthy diet consisting of high intakes of vegetables, fruits, wholegrains, soy, fish, and low-fat dairy was found to be associated with a lower risk of depression. Extending these epidemiological observations, a recent meta-analysis of 15 RCTs (n = 45,826) also concluded that dietary interventions significantly reduced depressive symptoms across the population (Firth et al., 2019). Healthy eating patterns have also been associated with positive emotional states. In a systematic review of 10 studies (Tuck et al., 2019), consuming or exceeding the recommended amount of fruit and vegetables was associated with psychological well-being.

Mattioli et al. (2020) observed that the COVID-19 quarantine period was associated with poorer eating patterns. Of particular relevance is a decreased consumption of fruit and vegetables, which are rich sources of antioxidants and vitamins needed to help fight infections. Conversely, unhealthy diets may activate inflammatory processes that weaken the innate and adaptive immune systems (Butler and Barrientos, 2020). These findings align with the results of the ECLB-COVID19 international online survey which found eating unhealthy food, eating out of control, snacking between meals, and the number of main meals per day increased significantly ($p < 0.001$) during the pandemic. Interestingly, alcohol binging significantly decreased during the pandemic (Ammar et al., 2020b). In recognition of the COVID-19 mediated decline in diet quality (Ingram et al., 2020; Robinson et al., 2021), and the mental health and immune benefits associated with eating plant-based foods (Arshad et al., 2020), emphasis on positive nutrition is needed. For practical suggestions for a healthy diet refer to **Table 1**.

SLEEP

Sleep hygiene plays a crucial role in mental health and well-being. Loprinzi and Joyner (2018) conducted a prospective cohort study (n = 13,423) and found that attaining optimal levels of sleep of 7–9 h for adults, was associated with better Health-Related Quality of Life (HRQOL) and reduced premature mortality risk.

During COVID-19, sleep patterns and sleep quality has been adversely affected. In a survey of 6,041 Canadians, 77.8% reported disturbed sleep during the pandemic, with those 41–60 years of age being twice as likely to report sleep disturbances compared to those less than 25 years (Osiogo et al., 2021). An Italian study of 1,035 young adults under 35 years of age observed a shift in sleep-wake rhythms during lockdown, with people going to bed and waking up later (Cellini et al., 2020). The ECLB COVID-19 international study of 5,053 individuals in quarantine reported severe disruptions in sleep hygiene, although

sleep quality during home confinement was not as affected among highly active individuals (Trabelsi et al., 2021). For practical recommendations to improve sleep hygiene refer to **Table 1**.

MULTICOMPONENT LIFESTYLE INTERVENTIONS

In the same way that there has been a trend toward multicomponent PPIs, lifestyle interventions are commonly delivered in a multicomponent fashion. For example, combined nutrition and physical activity interventions are commonplace for addressing weight loss and certain chronic conditions, such as type 2 diabetes (Cradock et al., 2017; Chater et al., 2020) and cardiovascular disease (Barbaresko et al., 2018). While research examining the relative effectiveness of multicomponent lifestyle interventions targeting mental health and well-being is scant and inconclusive (Gomez-Gomez et al., 2020), we hypothesis that the multicomponent approach would likely confer greater benefits than a single modality approach. Indeed, in the ECLB-COVID19 international survey, Ammar et al. (2020c) concluded that the adverse psychosocial impact of home quarantine was correlated with multiple unhealthy lifestyle behaviors and they called for the urgent deployment of interdisciplinary interventions that foster an active healthy confinement lifestyle (AHCL).

A CALL FOR INTERDISCIPLINARY UNIVERSAL MENTAL HEALTH INTERVENTIONS

Historically, the disciplines of Lifestyle Medicine and Positive Psychology have functioned independently, but there is growing awareness of their complimentary nature. For example, a commonly cited well-being framework within the Positive Psychological literature is PERMA, an acronym asserted by Seligman a decade ago to encapsulate the components of a "flourishing life": Positive emotion, Engagement, Relationships, Meaning and Achievement (Seligman, 2011). The PERMA model has subsequently been expanded to PERMA-H (Health) (Lai et al., 2018; Mayer, 2019), in recognition of the contribution of lifestyle behaviors to well-being. Similarly, within the Lifestyle Medicine discipline, which has historically focused on modifiable health behaviors for improving health outcomes, there has been the formalization of a "Positive Health" initiative (Seligman, 2008) which has the remit of embedding Positive Psychology principles into clinical practice. Hence, there is an increasing recognition that optimal health and well-being outcomes can be achieved through an interdisciplinary approach. Notably, in his seminal paper published one decade ago in American Psychologist, Walsh (2011) aptly identified interdisciplinary contributors to mental health and wellbeing, and advocated for greater attention to be placed on them. Indeed, in the midst and wake of the COVID-19 pandemic there has never been a greater need for a universal and interdisciplinary approach to disseminate effective therapeutic strategies that not only meets the mental health challenges faced by societies around the world, but also provides wholistic care. Incorporating physical, mental, social, and spiritual health are critical elements to cope with personal adversity, improve well-being, and reduce suffering and disease (Ammar et al., 2020a; Del Castillo, 2020; Ferrell et al., 2020; Lucchetti et al., 2020).

Accordingly, we argue that to optimize the effectiveness of mental health and well-being interventions, they should adopt an interdisciplinary approach, integrating evidence-based strategies from both the Positive Psychology and Lifestyle Medicine literature. The literature is scant in bringing these two disciplines together to improve mental health and well-being, although several studies (Morton et al., 2020; Przybylko et al., 2021; Renfrew et al., 2020) have suggested this interdisciplinary and multimodal approach may result in better outcomes than single modality interventions alone.

With many countries calling for population-level mental health and well-being solutions, the digital delivery of universal interdisciplinary mental health interventions offers a cost-effective and scalable way forward for promoting mental health, even given the limitations imposed by COVID-19, such as confinement, social isolation and the financial crisis. Innovation in digital technology has resulted in the ability to offer interventions that: involve fewer resources and personnel required for rollout and implementation; overcome geographic barriers and hence have a larger reach; are cheaper to disseminate; overcome issues of anonymity; and provide more flexibility for participants (Deady et al., 2017). In a recent review, Rauschenberg et al. (2020) concluded that eHealth interventions are well-suited to mitigate the adverse psychological effects of the COVID-19 pandemic at a population level, and encouraged the development of digital strategies for the development of mental health promotion, prevention and care. Similarly, Ammar et al. (2021) encouraged innovative digital approaches to track, predict and facilitate the user's adherence to AHCL. Further, Torous et al. (2020) argued that COVID-19 has presented an impetus to increase investment in digital health to provide high-quality mental health care for the future.

In the wake of the unprecedented mental health crisis caused by COVID-19, multiple calls have been made for novel and innovative mental health solutions (Firth et al., 2020b; Holmes et al., 2020). Rudd and Beidas (2020) called for a paradigm shift to include novel interventions that deliver mental health support for all people with a greater focus in the delivery of mental health prevention. Hence, we call for the creation and rollout of well-designed interdisciplinary universal mental health interventions, involving multiple evidence-based strategies from both Positive Psychology and Lifestyle Medicine, that can be provided cost-effectively at a population level through digital delivery in the wake of the COVID-19 pandemic and beyond.

The strength of this perspective article is that it argues for a novel approach, using universal interdisciplinary interventions that combine Positive Psychology and Lifestyle Medicine, for improving mental well-being. Further, it calls for the use of digital mental health solutions to achieve scalability and accessibility within the limitations of COVID-19 lockdown and restrictions.

The main limitation of this perspective article is the scant research in the area of universal interdisciplinary interventions in the context of COVID-19.

CONCLUSION

In this perspective article, interdisciplinary universal mental health interventions, delivered digitally, have been presented as a potential strategy for improving the mental health of populations during the COVID-19 pandemic and beyond. We argue that the application of universal interventions that combine evidenced-based strategies from the Positive Psychology and Lifestyle Medicine literature provides an innovative way to protect and buffer the mental well-being of populations. Future research could be undertaken to investigate an integrated mental healthcare model that incorporates universal interventions, clinical practice, and digital support.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

GP and DM conceptualized the work and ideated the structure. GP analyzed the literature and wrote the manuscript. All authors contributed to the revision and editing of the manuscript.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Chapter Three: Methodology

3.1 Chapter Overview

There are six sections in the methodology chapter. Section one reiterates the thesis aims and questions. Section two describes Studies 1 and 2 utilised in the thesis. Section three outlines the intervention, theoretical framework, and principles underpinning the intervention. Section four details the measurements used for mental health, wellbeing, and adherence. Section five outlines the procedures and methods used to analyse the data. The final section describes the ethical considerations and handling of data.

3.2 Thesis Aims

The aim of this thesis was first, to determine the effectiveness of a digital multicomponent interdisciplinary intervention on the mental health and wellbeing of an Australasian nonclinical cohort, and second, to examine the influence of gender and age on the outcomes of and adherence to the intervention.

3.2.1 Research questions

The specific research questions for this thesis are:

- Can a digital multicomponent interdisciplinary intervention improve the mental health and wellbeing of an Australasian nonclinical cohort?
- What is the influence of gender and age on the outcomes of and adherence to a digital multicomponent interdisciplinary mental wellbeing intervention amongst an Australasian nonclinical cohort?

3.3 Study Design and Recruitment

Research in mental health and wellbeing utilises a variety of approaches: quantitative, qualitative or mixed-methods (Khaldi, 2017; Povee & Roberts, 2015). The research design for Studies 1 and 2 used a quantitative approach. Quantitative designs explain, predict, and control phenomena by collecting and analysing variables across different settings (Queirós et al., 2017). There are four main types of quantitative designs: descriptive research, correlational research, causal-comparative/quasi-experimental research, and experimental research. Not all approaches are suitable for all research questions. Studies 1 and 2 utilised an experimental design (Khaldi, 2017) as it contains numerical data, allowed the randomisation of participants, and Study 1 examined the cause and effect relationship between variables.

3.3.1 Studies 1 & 2 Population

The thesis involved two experimental studies—Study 1, a RCT, n=421; and Study 2, a randomized comparative study, n=458) —to assess the efficacy of a ten-week digital multicomponent interdisciplinary mental wellbeing intervention that combined strategies from lifestyle medicine and positive psychology.

3.3.2 Addressing the Study Population

Participants from Studies 1 and 2 were self-selected from the Seventh-day Adventist membership across Australia and New Zealand. The Seventh-day Adventist leadership in the South Pacific recognises the worldwide mental health and wellbeing crisis and aims to look at lifestyle medicine solutions to combat this problem. The emphasis of the intervention used in the studies contained in this thesis aligns with the Seventh-day Adventist mission of bringing health, healing, and hope

to the community (Robinson, 1965). The Seventh-day Adventist Church has a rich heritage in whole-person health that started in the early 1860s (Robinson, 1965). However, Seventh-day Adventist health indicators are declining in some areas, such as physical activity and dietary patterns, to an eating pattern more consistent with a western lifestyle (Kent & Worsley, 2008). This shift can increase the prevalence of common mental health disorders.

Studies have shown that faith-based organisations are effective delivery channels of health promotion and prevention programs, particularly as they have a history of health education, promotion and community outreach (Campbell et al., 2007). A qualitative study indicated support from religious leaders to provide spiritual guidance and embrace a wholistic approach to health, as clergy played an important role and support in their members' lives (Rivera-Hernandez, 2015). The authors found that the clergy believed it was essential to seek medical advice and fortify health care with faith and prayer.

3.3.3 Recruitment

The recruitment was conducted from July to September 2017 for Study 1, and July to September 2018 for Study 2. Advertising was through the organisation's internal communication channels, including emails, bulletins, magazines, and social media. The advertising materials did not target a clinical population. Instead, the intervention was promoting an *emotional wellness* program. The advertising material directed the potential applicants to the digital platform that provided information and expectations of participation in the research, detailed the inclusion and exclusion criteria, and requested the completion of the informed consent and application form. All completed documentation was to be completed on the digital platform by the

beginning of September 2017 for Study 1 and by the start of September 2018 for Study 2 (refer to the Appendix 3).

3.3.4 Inclusion and Exclusion criteria

The inclusion criteria for participation in the study included: 18 years and older; fluency in English; resident of Australia or New Zealand, email and internet access, willingness for data to be anonymously and confidentially used for research purposes and provide informed consent. The exclusion criteria for participation in the study was the inability to partake in moderate-intensity physical activity, such as walking.

3.3.5 Design of Study 1

Study 1 used an unblinded RCT design as it provides the most robust empirical evidence for the efficacy of an intervention by minimising allocation bias, assessment bias, allocation concealment, and confounding of unknown variables (Arvina & Kumar, 2019; Guyatt et al., 2008). Participants were randomly assigned to a ten-week mental health and wellbeing intervention or delay-control group. The control group participants received usual care. The trial commenced in September 2017 and concluded in February 2018. The delay-control group had the opportunity to participate in the intervention free of charge after completing the study.

3.3.5.1 Ethical Considerations

The Avondale Human Research Ethics Committee approved all procedures involving human subjects (Approval No. 2017:13), as seen in Appendix 2. The trial protocol was registered at the Australian New Zealand Clinical Trials Registry (ACTRN12619000993190).

3.3.5.2 Randomization

Before randomization, the subjects agreed to participate in either study arm. The participants were randomized, non-blinded into the intervention, or wait-list controlled by a non-member of the research team using computer random number generation. Participants were then notified of their group allocation.

3.3.5.3 Participants

Of the 510 participants assessed for eligibility (as shown in Figure 3), two participants did not meet the inclusion criteria as they resided outside Australia and New Zealand. The 508 eligible participants were randomized, with 255 allocated to the intervention group and 253 to the wait-list control group. Of 508 participants, 425 participants, 217 of the intervention group and 208 of the control group, completed the baseline (Refer to Figure 3) and entered the study, and 87 participants withdrew from the study. Of the 38 participants who withdrew from the intervention group, the following reasons were cited: time commitment (50%), ill health (8%), no longer interested (3%) and not stated (40%). Similarly, of the 45 participants who withdrew from the control group, the following reasons were cited: time commitment (44%), ill health (4%), no longer interested (11%) and not stated (40%).

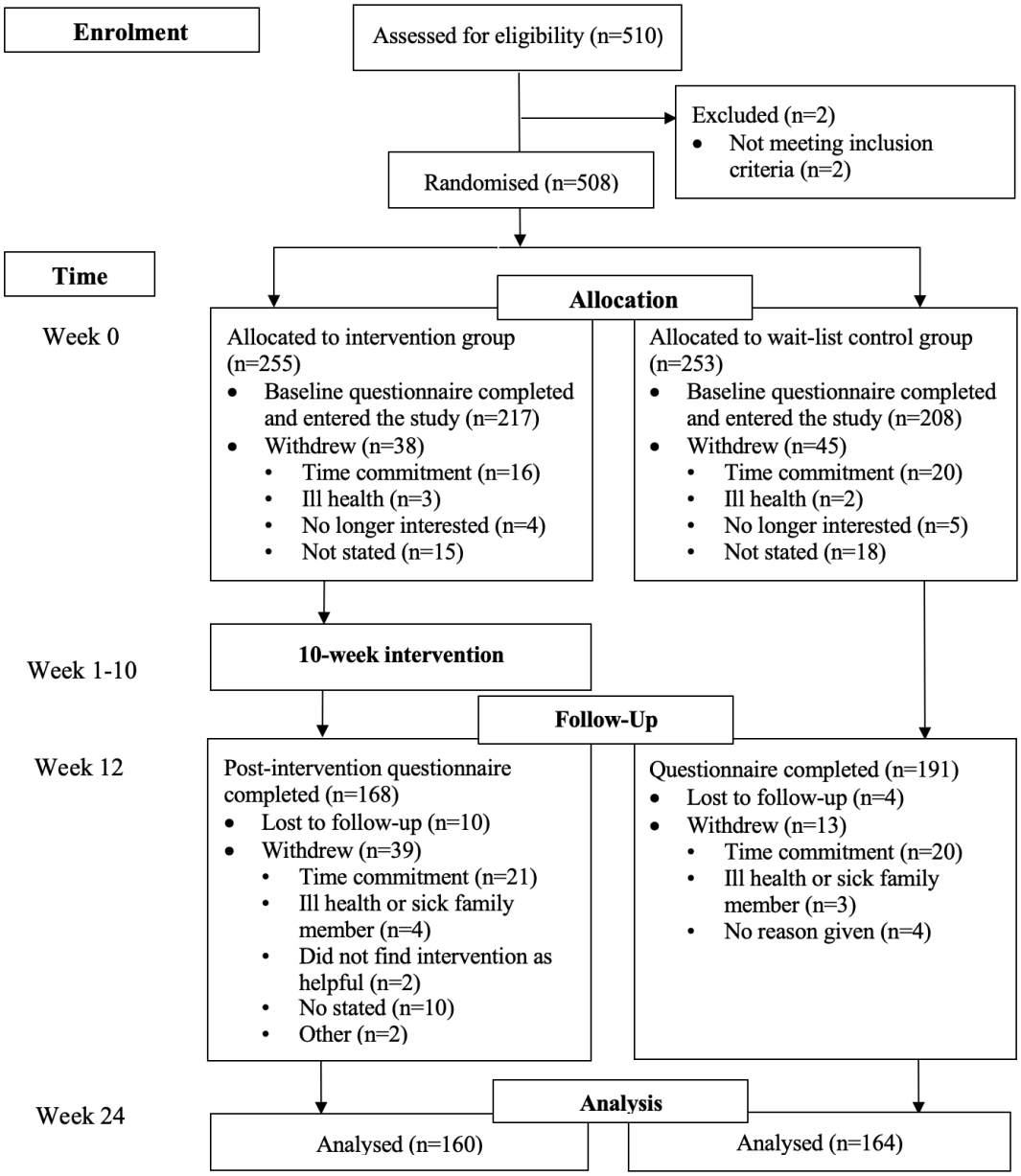


Figure 3. *Study 1 Research Design and Implementation*

As shown in Table 3, the participants were aged 47.0 ± 14.5 years, were mainly female (69.9%), of White ethnic representation (82.4%), and tertiary educated (84.9%). The intervention and delay-control groups were similar in age ($p<0.510$), gender ($p<0.510$), ethnic representation ($p<0.081$), and highest education level obtained ($p<0.307$).

Table 3. *Pre-intervention demographic characteristics of participants*

Characteristics	**Intervention (n=217)**	**Control (n=208)**
Age, mean (s.d.)	47.6 (14.7)	46.4 (14.3)
Gender, n (%)		
Men	67 (30.9)	61 (29.3)
Women	150 (69.1)	147 (70.7)
Ethnicity, n (%)		
White/Caucasian	183 (84.3)	166 (79.8)
Asian	12 (5.5)	11 (5.3)
Pacific Islander	4 (1.8)	17 (8.2)
Spanish/Hispanic/Latino	3 (1.4)	5 (2.4)
Indigenous	2 (0.9)	0 (0.0)
Black/African American	6 (2.8)	5 (2.4)
Other	7 (3.2)	4 (1.9%)
Education status, n (%)		
Primary/Elementary	2 (0.9)	1 (0.5)
Secondary/High School	24 (11.1)	37 (17.8)
Tertiary/University Undergraduate	102 (47.0)	92 (44.2)
Tertiary/University Postgraduate	89 (41.0)	78 (47.5)

Similarly, there were no significant differences between the intervention and delay-control groups in the baseline measures of: mental health ($t(320) = -0.843$, $p = 0.400$), vitality ($t(320) = 0.881$, $p = 0.379$), depression ($t(320) = 0.277$, $p = 0.782$), anxiety ($t(320) = -0.668$, $p = 0.504$), stress ($t(320) = 0.982$, $p = 0.327$), and life satisfaction ($t(320) = -0.605$, $p = 0.546$). All baseline measures were within the nonclinical range. Refer to Section 4.1 for more detail.

3.3.6 Design of Study 2

Study 2 used a multi-arm, unblinded randomized comparative design as it minimises the allocation bias and provides the ability to assign participants to different conditions for a given duration and analyse differences (Lau & Kuziemsky,

2016). Participants were randomly allocated into three intervention groups that differed according to the modes of human support added to the ten-week mental health and wellbeing intervention:

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

3.3.6.1 Ethical Considerations

The Avondale Human Research Ethics Committee approved all procedures involving human subjects (Approval No. 2018:09), as seen in Appendix 2. The trial was registered with the Australian New Zealand Clinical Trials Registry (ACTRN12619001009101) and was conducted from July to December 2018.

3.3.6.2 Randomization

Before randomization, the subjects agreed to take part in the intervention. The computer-generated software randomly allocated the participants into three groups. Participants completed the registration on the digital platform using a unique link to activate the registration process. Registered participants accessed the intervention and completed the required questionnaire through the digital platform or app.

3.3.6.3 Participants

As shown in Figure 4, all 605 applicants met the eligibility criteria. The 605 eligible participants were randomized into three-arms: S (n=202), S+pSMS (n=202) and S+VCS (n=201). Of the eligible participants, 458 completed the baseline questionnaire and entered the study (S=157, S+pSMS=163, S+VCS=138), and 247 participants withdrew. Of the 44 that withdrew from the S group, 32% requested a

withdrawal, 50% did not register, 7% did not complete registration, and 11% did not complete the questionnaire. Of the 139 participants that withdrew from the S+pSMS group, 23% requested a withdrawal, 49% did not register, 10% did not complete registration, and 18% did not complete the questionnaire. Of the 64 that withdrew from the S+VCS group, 38% requested a withdrawal, 52% did not register, 8% did not complete registration, and 2% did not complete the questionnaire.

At 12 weeks, 320 (69.9%) participants completed the post-intervention questionnaire (S=103, S+pSMS=114, S+VCS=103) and 138 withdrew from the study. Of the 54 participants that withdrew from the S group, 9% were too busy, 2% cited ill health, and 89% did not respond. Of the 49 participants that withdrew from the S+pSMS group, 4% were too busy, 6% cited 'other', and 90% did not respond to the questionnaire. Of the 64 that withdrew from the S+VCS group, 9% were too busy, 2% cited ill health, 8% other, and 71% did not respond or complete the questionnaire.

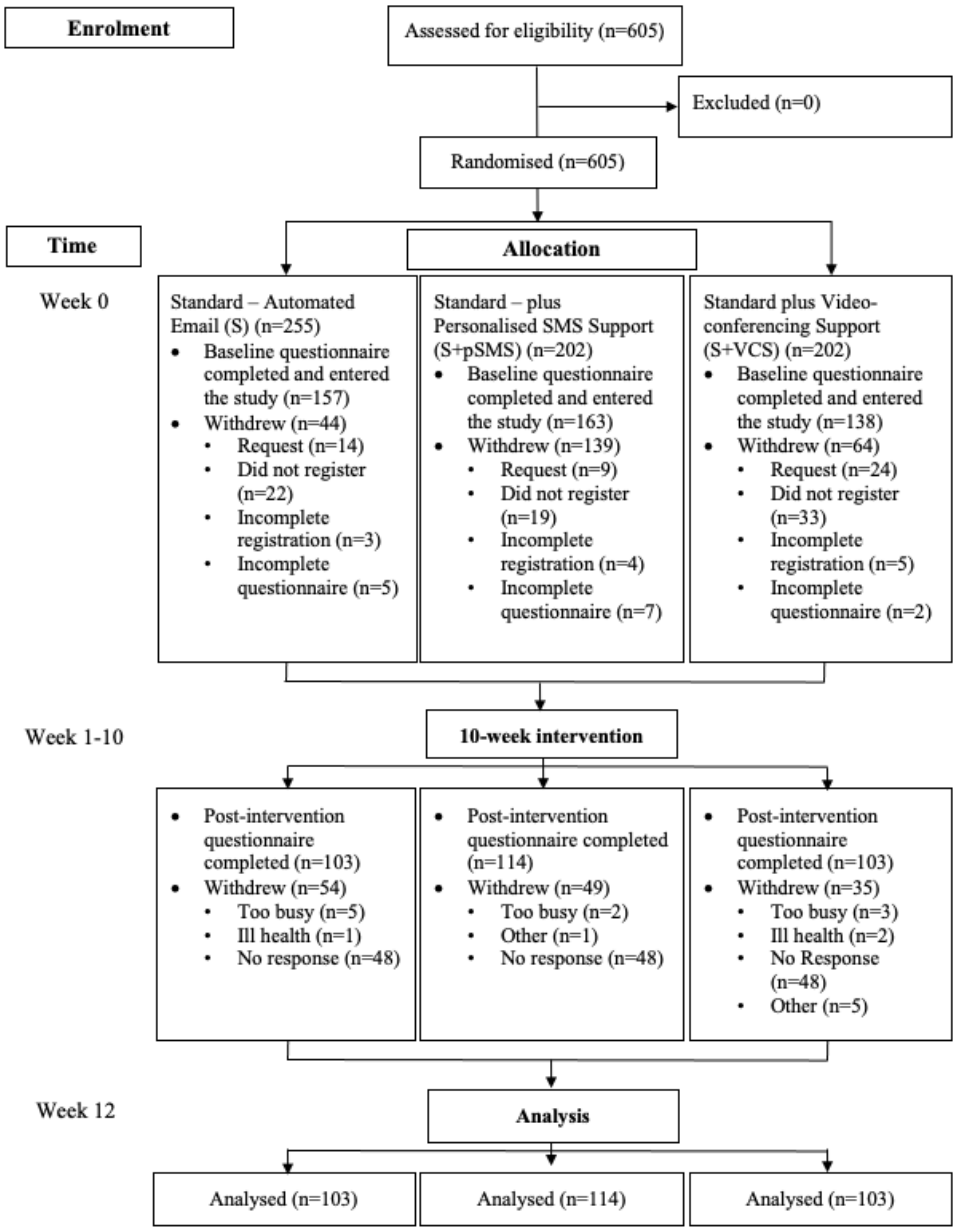


Figure 4. *Study 2 Research Design and Implementation*

The baseline characteristics of the Study 2 groups are shown in Table 4. The 458 participants had a mean age of 45.4 ± 13.7 years, and were predominantly female (77.1%), of White ethnic representation (76.9%), and tertiary educated (78.0%).

Table 4. Study 2 participant baseline characteristics

Baseline characteristics	Group 1 S	Group 2 S+pSMS	Group 3 S+VCS	Combined
Age, mean (s.d.)	45.6 (13.9)	46.5 (13.4)	44.3 (13.9)	45.5 (13.7)
Gender, n (%)				
Men	33 (21.0)	37 (22.7)	31 (22.5)	101 (22.1)
Women	124 (79.0)	126 (77.3)	106 (76.8)	356 (77.1)
Other	0	0	0	1 (0.2)
Ethnicity, n (%)				
White/Caucasian	124 (79.0)	118 (72.4)	110 (79.7)	352 (76.9)
Asian	5 (3.2)	11 (6.7)	2 (1.4)	18 (3.9)
Pacific Islander	12 (7.6)	16 (9.8)	7 (5.1)	35 (7.6)
Spanish/Hispanic/Latino	5 (3.2)	3 (1.8)	4 (2.9)	12 (2.6)
Indigenous	0	0	1 (0.7)	1 (0.2)
Black/African American	4 (2.5)	3 (1.8)	3 (2.2)	10 (2.2)
Other	7 (4.5)	12 (7.5)	11 (8.0)	30 (6.6)
Education status, n (%)				
Primary/Elementary	0	2 (1.2)	0	2 (0.4)
Secondary/High School	36 (22.9)	39 (23.9)	24 (17.4)	99 (21.6)
Tertiary/University Undergraduate	74 (47.2)	65 (39.9)	75 (54.3)	214 (46.7)
Tertiary/University Postgraduate	47 (29.9)	57 (35)	39 (28.3)	143 (31.3)

3.4 The Intervention and Theoretical Framework

3.4.1 Intervention

Studies 1 and 2 used the same intervention, referred to as *The Live More Project* or *The Lift Project.* The intervention comprised of ten sessions that integrated lifestyle medicine and positive psychology strategies and were accessed through an e-learning management system, as seen in Appendix 4. Table 5 below describes the ten sessions.

Table 5. *Weekly topics and challenges for the Live More Project Intervention*

Week / Topic	**Session**	**Daily Challenge**	**Weekly Challenge**
1. Language and Emotion	This session provides an overview of the emotional brain, its responsibilities, and the need to speak positively.	Offer a genuine compliment.	Memorise an inspirational text or saying.
2. Posture and Regular Physical Activity	This session uses scientific research to show the positive impact of exercise on emotional wellness.	Spend 30 minutes of moderate exercise or 10,000 steps.	Spend 20 minutes of guided resistance exercises.
3. Sunlight and Natural Environments	This session uses evidence to show how natural environments positively affect the emotional brain and its senses.	Spend 30 minutes in an uplifting natural environment.	Experience a sunrise.
4. Social Connections	This session uses studies to show how happiness and depression are socially contagious up to three degrees of separation and explains how mirror	Do something intentional to show you care.	Forgive someone who has hurt you.

Week / Topic	Session	Daily Challenge	Weekly Challenge
	neurons connect us with others.		
5. Positive Outlook	This session uses evidence to show how the emotional brain and higher brain are connected and can arrest downward spirals by changing thought processes.	Spend 15 minutes reflecting on three things that went well.	Write a letter of gratitude to someone and share it with them.
6. Diet and the Gut Health Connection	This session explains the intimate connection between the emotional brain and gut, mediated through trillions of gut bacteria. In addition, research also shows the importance of eating more plant-based foods, which are high in fibre, to improve gut bacteria.	Eat eight serves of plant-based food.	Prepare a high-fibre, plant-based meal with one or more friends.
7. Rest	This session explains why many people are sleep deprived due to modern living and artificial light, whilst emphasising the importance of sleep.	Spend eight hours in bed without a device.	Spend an evening by firelight.
8. Stress Management	This session uses studies to show the impact of stress on our lives and provides strategies to reduce stress levels like a digital Sabbath (going *off-line* for 24 hours to recharge).	Spend 15 minutes in a quiet place, relaxing and being mindful of your surroundings.	Take a day off work and a digital Sabbath.

Week / Topic	Session	Daily Challenge	Weekly Challenge
9. Signature Strengths and Serving Smart	This session uses scientific studies to confirm that human beings have an inbuilt desire to contribute and serve, which can result in a positive uplift in emotional wellness.	Perform a random act of kindness.	Use signature strength to perform an act of service.
10. Flourishing	This session introduces Martin Seligman's theoretical model of happiness (PERMA).	Continue challenges found to be helpful.	Continue challenges found to be helpful.

The participants viewed a weekly 30-minute video session to educate and empower participants to make positive behavioural changes. Daily and weekly experiential challenges provided a practical application of the topic. The participants were provided with an e-book and e-workbook to expand their knowledge and journal their experiences.

3.4.2 The Theoretical Framework Underpinning the Intervention

Underpinning the intervention (the Live More Project) is the Theory of Planned Behaviour (TPB) developed by Ajzen (1985). TPB has been a dominant theoretical model for predicting human behaviour over the past thirty years (Ajzen, 2011).

As seen below in Figure 5, TPB asserts that behaviour, mediated by intentions, is driven by behavioural, normative and control beliefs. Behavioural beliefs consider the expectations, consequences, and outcomes of performing a particular behaviour; this assessment by the individual influences their attitude,

which forms intentions and behaviours. Normative beliefs relate to an individual's judgement and perception regarding how significant others, such as family, friends, and society approve and support a specific behaviour. Normative beliefs impact the subjective norm, which assesses the perceived motivation and validity of the social influence and belief of whether to carry out the behaviour.

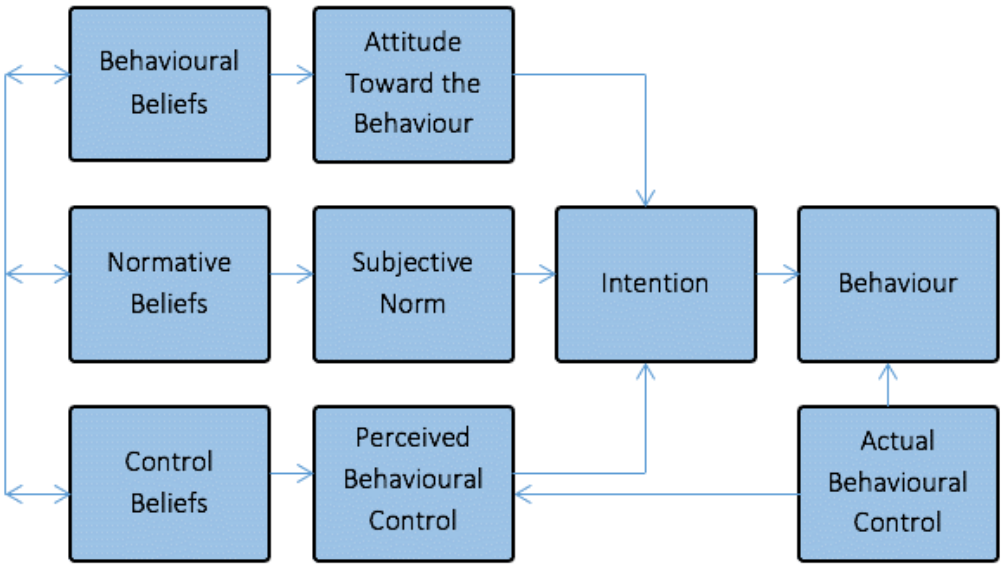


Figure 5. *Theory of Planned Behaviour adapted from Ajzen (1991)*

Control beliefs consider a person's beliefs about the influences and perception of what may assist or hinder their behaviour performance. Perceived behavioural control refers to an individual's belief that the behaviour is under their control and involves two key aspects: perceived capacity and perceived autonomy (Yzer, 2012). Therefore, the more resources available and fewer barriers to the behaviour, the greater the perceived behavioural control. Hence, the theory suggests that an individual's belief predicts their intention, motivation, and influences their actions. In addition, Ajzen (2011) states that the individual's intention is more likely when the subjective norm and perceived control are favourable. However, the outcome of the behaviour is not guaranteed.

As with most theories, the TPB has undergone criticism over the past 30 years. Sniehotta et al. (2014) outlined several concerns regarding the validity of TPB and the lack of utility for helping clinicians develop interventions. In response to the criticisms, Steinmetz et al. (2016) conducted a meta-analysis of 123 TPB-based interventions across a range of behavioural domains—activity, nutrition, behaviour at work and school, substance abuse, traffic-related behaviours, sexual behaviour, and medical regimes—and observed significant effects on all TPB variables with small to medium effect sizes. The exception to significant effects were substance abuse and traffic-related behaviours. In addition, group-based interventions had higher effectiveness than individual-based interventions.

Notably, digital interventions were more effective than interventions that required a facilitator, as enhanced control is higher as the material is presented online, at the participant's pace and avoids confrontation from a live facilitator. TPB was used to underpin the study's intervention due to its intentionality. The evidence across a range of lifestyle behavioural domains indicates the theoretical model's generalisability and effectiveness with both face-to-face and digital delivery modes.

The intervention used several strategies to increase intention and improve behaviour. The intervention used a robust educational component that provides evidence to show the importance of using mental health and wellbeing strategies to positively affect the participant’s attitude towards the behaviour. The intervention also used an eLMS to impact the subjective norm by providing daily and weekly challenges to encourage participation and social interaction. Brouwer et al. (2011) state that peer support is key to cultivating new social norms and accountability. Successful digital interventions have incorporated interactive modules and personalised components from health professionals, such as emails and telephone

contact (Cotter et al., 2014; Looyestyn et al., 2017). Thirdly, the intervention calculated a participant's challenge score tracked daily, weekly and an aggregated total. Additionally, the participant could continue with the daily and weekly challenges from the previous week(s) that they deemed most beneficial to increase perceived control. The strategies used by the intervention aimed to improve mental health wellbeing through intentionality, which is a hallmark component of this intervention.

3.4.2.1 Persuasive Systems Design

Studies 1 and 2 utilised Persuasive Systems Design principles proposed by Oinas-Kukkonen and Harjumaa (2009) to develop the eLMS and intervention. As shown in Figure 6, there are three phases in persuasive systems development for behaviour and attitude change: understanding the critical issues behind persuasive systems, analysing the persuasion context, and designing system qualities. Phase 1 highlights seven underlying postulates when designing or reviewing persuasive systems. First, information technology is constantly influencing an individual's attitude and behaviour. Second, individuals desire cognitive consistency in their life and seek systems that support their private and public commitments to perform a particular behaviour.

Third, direct and indirect routes are key persuasion strategies that can be acted upon simultaneously and supported by several software features. An individual's background, experience, and motivation can influence how they process information. For example, an individual with both high motivation and ability is more likely to engage in the content than someone with low motivation and ability. Fourth, persuasion is often incremental; therefore, it is easier to motivate an individual to perform a series of actions to achieve a goal rather than a more

considerable one-time action. Fifth, persuasion through persuasive systems should always be open, honest and reveal any designer bias. These principles are essential to develop trust and encourage an individual to change their attitude or behaviour voluntarily. Sixth, persuasive systems should aim to be unobtrusive, not disturbing individuals during inappropriate times. Last, persuasive systems should aim at being both valuable and easy to use, with the primary objective to create positive user experiences by meeting the needs of the individual.

Phase II involves analysing the context of three considerations: the intent, the event, and the strategy. The persuader must consider whether they aim to change an attitude or behaviour. Changing a permanent behaviour is harder than changing a one-time behaviour change. The strongest predictor of behaviour is intentionality (which was discussed in the TPB section). It is important to analyse an event to understand the user context such as an individual's goals, current performance, and potential past performance. The aim of persuasive systems is to motivate users to set goals and explore ways of realising them in a systematic and efficient manner. It is important to define persuasion strategies, determine the emotions the persuader wants to trigger and the desired convictions. The direct route of persuasion is predominantly used as it appeals to the intelligence of the persuader.

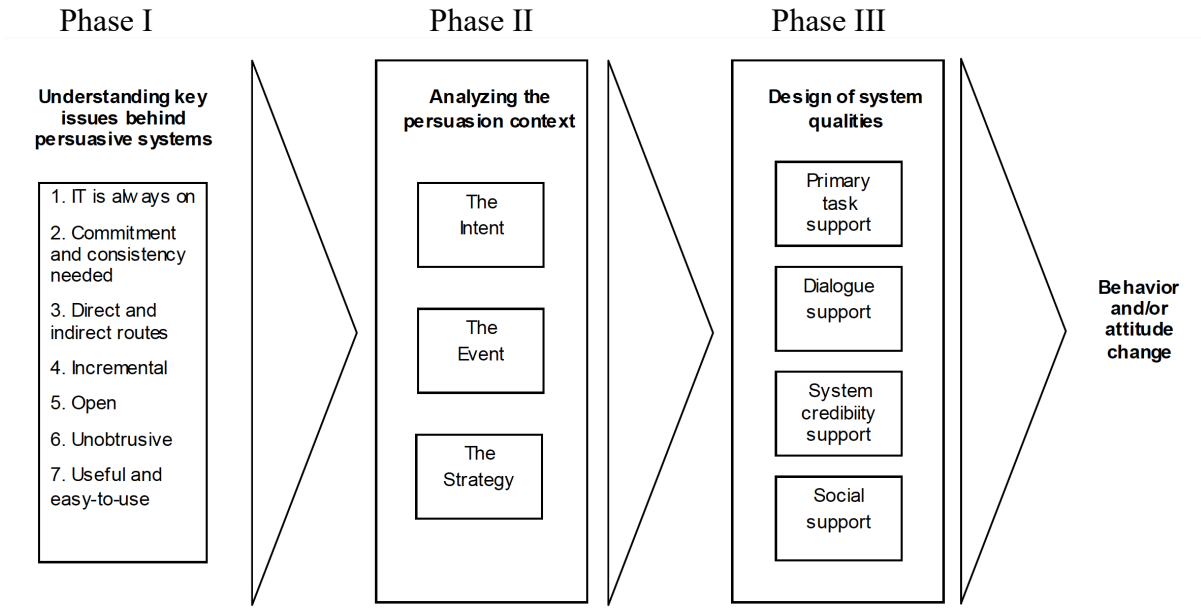


Figure 6. *Phases in Persuasive Systems Development (Oinas-Kukkonen & Harjumaa, 2009)*

Phase III focuses on how the design principles can be transformed into software requirements and system features which is key to software development. There are four categories that outline the PSD principles: primary task, dialogue, system creditability, and social support. As shown in Table 6, each category comprises of seven design principles, with a total of twenty-eight. The primary task category is focused on the design features that optimise the user's main task and include reduction, tunnelling, tailoring, personalisation, simulation, and rehearsal. The dialogue support category includes design features that enhance the computer-human dialogue to help facilitate the individual's goal or target behaviour. The design principles include praise, rewards, reminders, suggestion, similarity, liking, and social role, with the aim of providing the support at the right time to provide the motivation needed to achieve the desired outcome.

The system credibility category includes design features that will increase persuasion by leveraging the expertise and credibility of people and/or organisations. The design principles comprise of trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. The social support category is concerned with developing the system to motivate users to adopt a target attitude or behaviour by leveraging the persuader's social influence. Design principles consist of social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition.

Table 6. *Persuasive System Design adapted from Oinas-Kukkonen and Harjumaa (2009)*

Primary Task Support	**Dialogue Support**	**System Credibility Support**	**Social Support**
Reduction A system transforms complex behaviour to simple tasks to achieve the behaviour.	**Praise** A system can make people open to persuasion by offering praise.	**Trustworthiness** A system that is deemed trustworthy will have greater powers of persuasion.	**Social learning** Observing someone else's behaviour to achieve a task can motivate an individual.
Tunnelling A system persuades and navigates users through a process or experience.	**Rewards** Rewards for achieving certain behaviours can increase persuasion.	**Expertise** A system that incorporates expertise will have increased powers of persuasion.	**Social comparison** A system user can increase motivation when they can compare their performance with others.

Primary Task Support	Dialogue Support	System Credibility Support	Social Support
Tailoring A system tailors' information to match the needs of the interests, personality, usage, and context of a particular audience.	**Reminders** A system with reminder capability will help individuals adhere to targets and behaviour.	**Surface credibility** Individual's initial assessments of the system is made on first-hand inspection.	**Normative influence** A system can leverage normative influence so there is social pressure to increase probability of individuals adopting the target behaviour.
Personalisation A system that provides personalised content will optimise the ability to persuade.	**Suggestion** Increased persuasion can be achieved through the offering.	**Real-world feel** A system highlighting the people or organisations behind its content or services increases credibility.	**Social facilitation** System users will increase the probability to perform target behaviour when they feel others are also performing the task with them.
Self-monitoring A system that provides the ability to keep track of the individual's performance or status helps the user achieve goals.	**Similarity** Persuasion is easier when systems remind individuals of something meaningful about themselves.	**Authority** Increased powers of persuasion can be achieved through leveraging roles of authority.	**Cooperation** A system can harness the natural drive of people to work together to achieve a target attitude or behaviour.
Simulation A system that offers simulation can persuade individuals to make changes by helping them observe cause and effect.	**Liking** A system that is visually appealing is more likely to be persuasive.	**Third-party endorsements** Increased creditability can be achieved through third-party endorsements, particularly if well-known.	**Competition** A system can leverage a human being's natural drive to compete to encourage users to adopt a target or behaviour.

Primary Task Support	Dialogue Support	System Credibility Support	Social Support
Rehearsal The opportunity to rehearse a behaviour can encourage people to alter their behaviour in the real world.	**Social Role** Users will use the system for persuasive purposes when a system adopts a social role.	**Verifiability** Credibility can be increased if the system's content is easy to verify.	**Recognition** A system can increase the likelihood of an individual/group achieving the attitude or behaviour by public recognition.

The PSD model was utilised for the intervention as it provided a comprehensive framework for designing persuasive systems. Additionally, the intervention aimed to engage and motivate the participant to transform their current situation and achieve their desired outcome (Oduor & Oinas-Kukkonen, 2019).

In a systematic review of 83 studies, Kelders et al. (2012) reported that digital interventions are typically used once a week, modular, and of ten weeks in duration, which was the basis of the intervention in this study. The intervention in this thesis used the reduction, tunnelling, and self-monitoring principles from the primary task category, to create a simple user experience that helped navigate the participant from completing the questionnaire; watching the videos; marking or commenting on a challenge when completed; and tracking their performance using the leaderboard.

In addition, principles including rewards, reminders, and liking from the dialogue support category were incorporated into the intervention. For example, by rewarding badges for completing daily and weekly challenges, reminding users through emails of what was coming up in the next session from the presenter, and sending encouraging emails from the presenter if the participant had not completed the task. Further, principles including real-world feel and verifiability were used from the system credibility support category. The intervention featured an internationally-recognised presenter who is Board Certified in the area of Lifestyle

Medicine, a Fellow of the Australasian Society of Lifestyle Medicine and an Associate Professor and Director of the Lifestyle Medicine and Health Research Centre at Avondale University, which provided credibility to the intervention to build trust with the participant.

Lastly, the intervention's design principles, such as social learning, social comparison, normative influence, social facilitation, and competition from the social support category, were used in the intervention. The participant was awarded daily and weekly challenge points for completing the tasks to allow for healthy competition, as well as the ability to write comments and post pictures relating to the challenges—such as watching a sunrise or making a healthy plant-based meal—allowed users to learn together, socially interact, motivate, and influence each other, and compare performance.

3.5 Measurements

All participants completed a self-reported wellness questionnaire (refer to Appendix 1) called the *7 Dimensions of Wellness Index* on the digital platform (www.eliawellness.com) at baseline (Week 1), post-intervention (Week 12), and at 12 weeks post-intervention (Week 24) for Study 1, and at baseline (Week 1) and post-intervention (Week 12) for Study 2. Participants were followed up by email and text messages up to three times to prompt the participant to complete the questionnaire. The questionnaire surveyed sociodemographic characteristics, including age, gender, ethnicity, level of education, and country of birth. Validated instruments were included in the questionnaire to assess mental health and wellbeing outcomes.

3.5.1 Mental health and wellbeing outcomes

The 7 Dimensions of Wellness Index included the following validated instruments:

3.5.1.1 Short Form 36-Item Health Survey

The Short Form 36-item Health Survey is a self-reported health questionnaire appropriate for use among general populations (Brazier et al., 1992). The survey contains 36 items consisting of eight scales: general health, mental health, vitality, social function, physical function, role limitations due to physical health, role limitations due to emotional problems, and bodily pain. The scales can be used separately or as an aggregate. The study used two subscales (i.e., mental health and vitality) to measure positive affect (Pressman et al., 2019). The mental health five-item subscale has the following questions "How much of the time during the last four weeks": 1."Have you been a very nervous person?", 2."Have you felt so down in the dumps that nothing could cheer you up?", 3."Have you felt calm and peaceful?", 4. "Have you felt down?", and 5. "Have you been a happy person?". The "vitality" four-item subscale includes the following questions "How much of the time during the last four weeks": 1. "Do you feel full of life?", 2. "Did you have a lot of energy?", 3. "Did you feel worn out?", and 4. "Did you feel tired?". The mental health and vitality subscales used a Likert scale containing six response options from "All of the time" to "Not at all."

The responses were allocated a score and recoded to create a standardised score from 0 to 100, with a higher score representing a higher level of mental health and vitality (RAND Health care, n.s.). Although exact cut-off scores do not exist for the two subscales, studies have indicated that a mental health score of less than 56 is indicative of major depression (Shaw et al., 2000), and a score less than 45 on the

vitality subscale is indicative of fatigued (Donovan et al., 2008). Studies have shown a Cronbach alpha of 0.90 for the mental health subscale and 0.87 for the vitality subscale, indicating a good internal consistency (Brazier et al., 1992; Jenkinson et al., 1994).

3.5.1.2 Depression, Anxiety and Stress Scale

The 42-item Depression, Anxiety and Stress scale consists of three subscales that assess the negative affect of emotional states (Lovibond & Lovibond, 1995). A short-version with comparative psychometric properties was later derived and consisted of a 21-item Depression, Anxiety and Stress Scale (DASS-21). The short-version was suitable for measuring depression, anxiety, and stress (Seven items per subscale) in both a clinical and nonclinical population (Dreyer et al., 2019; Scholten et al., 2017). The 21 items are randomly presented and include the following instructions, "Please read each statement and circle a number 0, 1, 2 or 3, which indicates how much the statement applied to you over the past week". The depression subscale has the following questions 3. "I couldn't seem to experience any positive feeling at all", 5. "I found it difficult to work up the initiative to do things", 10. "I felt that I had nothing to look forward to", 13. "I felt down-hearted and blue", 16. "I was unable to become enthusiastic about anything", 17. "I felt I wasn't worth much as a person" and 21. "I felt that life was meaningless".

The anxiety subscale is made up of the following questions 2. "I was aware of dryness of my mouth", 4. "I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)", 7. "I experienced trembling (e.g., in the hands)", 9. "I was worried about situations in which I might panic and make a fool of myself", 15. "I felt I was close to panic", 19. "I was aware of the action of my heart in the absence of physical exertion (e.g., sense

of heart rate increase, heart missing a beat)", and 20. "I felt scared without any good reason". The stress subscale consisted of the following questions 1. "I found it hard to wind down", 6. "I tended to over-react to situations", 8. "I felt that I was using a lot of nervous energy", 11. "I found myself getting agitated", 12. "I found it difficult to relax", 14. "I was intolerant of anything that kept me from getting on with what I was doing" and 18. "I felt that I was rather touchy". The 21-item survey rates depression, anxiety, and stress symptoms using a four-point Likert scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time).

The questionnaire generates a score between 0 and 21, with a higher score representing increasing levels of mental distress (Shea et al., 2009). Individuals were considered symptomatic if they reached the threshold of greater than four for depression, greater than three for anxiety and greater than seven for stress. Studies have indicated a good internal consistency with a Cronbach alpha range of 0.76 to 0.91 for the three subscales (Le et al., 2017; Lovibond & Lovibond, 1995) and greater than 0.90 for an overall score (Osman et al., 2012).

3.5.1.3 Satisfaction With Life Scale

The five-item Satisfaction With Life Scale (SWLS) assesses global life satisfaction (Diener et al., 1985) across numerous settings (Jang et al., 2017; Pavot et al., 1991). Participants indicate whether they agree or disagree with the following questions 1. "In most ways my life is close to my ideal", 2. "The conditions of my life are excellent", 3. "I am satisfied with my life", 4. "So far, I have gotten the important things I want in life", and 5. "If I could live my life over, I would change almost nothing". The five items use a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The sum of the scores ranges from 5 to 35, with a cut-

off of 19 for at least average life satisfaction. A meta-analysis indicated a good internal consistency of the SWLS with a reported mean Cronbach alpha of 0.78 (Vassar, 2008).

3.5.1.4 Huppert and So Conceptual Framework

The ten-item Huppert and So flourishing assessment (Huppert & So, 2013) uses internationally agreed criteria derived from the Diagnostic and Statistical Disorders (DSM-IV) of the American Psychiatric Association (1994) and the International Classification of Diseases (ICD-10) of the World Health Organization (1993). Most common mental health disorders belong to two vital diagnostic categories—Major Depressive Episode (DSM-IV)/Depressive Episode (ICD-10) and Generalised Anxiety Disorder—and these categories were systematically examined, and the mirror—opposite symptoms associated with these disorders were determined. The ten-item assessment of flourishing incorporates the following questions: "1. Most days I feel a sense of accomplishment from what I do", "2. (In the past week) I felt calm and peaceful", "3. I love learning new things", "4. I generally feel that what I do in my life is valuable and worthwhile", "5. I am always optimistic about my future", "6. Taking all things together, how happy would you say you are?", "7. There are people in my life who really care about me", "8. When things go wrong in my life it generally takes me a long time to get back to normal", "9. In general, I feel very positive about myself", and "10. (In the past week) I had a lot of energy".

Individuals achieved a flourishing status if they met the following criteria: 1. A high level of "positive emotion", as indicated by a score of 8 or above on a scale from 0 (extremely unhappy) to 10 (extremely happy), 2. A high "positive characteristics" rating, determined by the individual reporting in the highest two

rankings on a four-point Likert scale for four out of five positive characteristics (emotional stability, vitality, optimism, resilience, and self-esteem), and 3. A high 'positive functioning' rating, is indicated by the individual reporting in the highest two rankings on a four-point Likert scale for three out of four items relating to positive functioning (competence, engagement, meaning and positive relationships).

Positive rankings in the *positive emotion* and *positive characteristics* domains assessed hedonic wellbeing while the *positive functioning* domain captured expressions of eudemonic wellbeing. Hone et al. (2014) assessed four flourishing scales (The Mental Health Continuum Short form, Flourishing scale, PERMA model and Huppert and So) and found that the Huppert and So model was the most stringent conceptualisation of flourishing and had the highest internal consistency of the four frameworks with a Cronbach alpha of 0.83.

3.5.2 Measurement - Adherence

The following measures were used to assess adherence to the intervention.

3.5.2.1 Videos Viewed

Each week the participants watched an educational video presentation, as described in Table 5. The total number of weekly videos viewed out of ten measured the primary adherence. A video was marked as *viewed* when 80% or more of the presentation was played.

3.5.2.2 Experiential Challenge Activities

Participants were encouraged to put what they had learned each week into action by participating in experiential challenge activities, as shown in Table 5. The total weekly challenge score and the number of weeks the participants had completed the challenge measured adherence. The daily challenge was awarded ten points each

with a maximum of 70 points per week. The weekly challenge was allocated 30 points. Participants had the opportunity to achieve 100 points per week, totalling 1,000 points at the end of the ten-week intervention.

3.6 Statistical Analyses

3.6.1 Sample size

The sample size calculation was based on changes in the "life satisfaction" scale as this was the least labile of the psychometric metrics recorded in a pilot study (Morton et al., 2020). The sample size was also based on an equal allocation of participants to each group, a 20% increase in the treatment group, a 40% attrition rate based on reported levels of attrition in other digital interventions (Gander et al., 2016), and 80% power and a significance level of 0.05 (95% confidence interval). The mean effect size was 0.33.

3.6.2 Data Entry, Screening and Preparation

The data were entered into the e-learning management system by the participant. Formatting of the data took place in preparation for the statistical analysis. The data were formatted in Microsoft Excel and then imported into IBM SPSS Statistics for Macintosh, Version 25.0. Armonk, NY: IBM Corp. The data were then formatted to include names, types, decimals, labels, and measures. The *compute variable* function transformed the data to determine the mental health and wellbeing outcomes and adherence measures. Descriptive statistics, frequencies, and graphs were used to cross-check the recoded variables into new variables. Data cleaning took place to assess for missing data and remove outliers.

3.6.3 Analysis

The data were analysed using SPSS Statistics (Version 25.0). Descriptive statistics involving frequencies, means, standard deviations, and confidence intervals were used to present the data. Paired and independent sample t-tests were used to explore gender differences in the mental health and wellbeing outcome measures. A chi-square (χ^2) test was used to examine the difference in the baseline characteristics and wellbeing (flourishing) outcomes. Analysis of Variance (ANOVA) was used to compare the changes experienced between the age categories. Repeated-measures Analysis of Variance (ANOVA), using the General Linear Modelling (GLM) function in SPSS was used to test for group effects (intervention versus control), time effects (baseline to post-intervention, and baseline to 12 weeks post-intervention), and group versus time interactions. Only data from participants who had completed all three assessment periods were included in the analyses, except where specified.

Multivariate analysis of variance (MANOVA) was used for comparisons as there were several categorical independent variables and continuous dependent variables. Data were pre-screened and cleaned to ensure the robustness of the MANOVA, aided by the large sample size. MANOVA, using the general linear modelling (GLM) function in SPSS, was used to test for time effects (pre- to post-intervention), gender and age effects, and their interactions. When significant, Bonferroni post hoc analyses were utilised to determine significant changes from pre- to post-intervention to compare gender and age differences and explore significant interactions.

Pearson's correlation was used to analyse the relationship between mental health and wellbeing outcomes and adherence measures. An exact McNemar's test analysed the changes in the proportion of participants flourishing from baseline to

post-intervention and 12 weeks post-intervention. The standardised difference method was used to calculate effect sizes (Cohen's d), calculated as the mean change between the respective time points divided by the standard deviation of the subjects' mean difference scores. Missing data for age (n=4) were replaced with the mean age, and missing data (n=14) for mental health outcomes were removed from the analysis in Studies 1 and 2.

3.7 Consent

3.7.1 Informed Consent

The Information Statement detailing the purpose and importance of the research and vital aspects of the study was provided to participants, as shown in Appendix 3. Participants were invited to contact the researcher for further information if required. Participants were required to complete their enrolment and submit their informed consent before completing the questionnaire on the digital platform and entering the study.

3.7.2 Freedom of Consent

Participants were informed that the research was voluntary and that there was no obligation to participate. In addition, participants were informed that they could withdraw at any time and retrieve their data if requested.

3.7.3 Benefits and Risks

The potential benefits and risks of the study were outlined to the participants. The potential benefits of the study were that the participants would learn evidence-based strategies for increasing their wellbeing, especially their emotional wellbeing. The participants would also receive the 7 Dimensions of Wellness questionnaire results through the digital platform and app. The only potential risk identified for the

participants was the time commitment of the study. It was essential for participants to provide their consent.

3.7.4 Confidentiality and Anonymity

The confidentiality and anonymity of the participants were paramount. Once the data was entered directly into the eLMS, the participant's name was de-identified, and a unique identifier was allocated to each participant to ensure the data was anonymous. The researcher maintained a record of who participated during the study to allow participants to withdraw if required. The data was stored on a password-protected computer. The researcher and supervisors maintained confidentiality and anonymity of the participants' data. To protect participant identity, no individual participants results will be published.

3.7.5 Data Storage

The original data was stored on a google drive at Avondale University Lake Macquarie Campus. The data will be destroyed five years after the data analysis and the conclusion of the research in accordance with the National Health and Medical Research (NHMRC) guidelines (National Health and Medical Research Council, 2019).

CHAPTER FOUR: PUBLICATION 2 – THE EFFECTIVENESS OF AN ONLINE INTERDISCIPLINARY INTERVENTION FOR MENTAL HEALTH PROMOTION: A RANDOMIZED CONTROLLED TRIAL

4.1 Chapter Overview

This chapter addresses the first objective of this thesis: “Can a digital multicomponent interdisciplinary intervention improve the mental health and wellbeing of an Australasian nonclinical cohort?” This chapter is presented as a manuscript titled, "The effectiveness of an online interdisciplinary intervention for mental health promotion: A randomized controlled trial" (refer to Section 4.2) published in *BMC Psychology,* a Q2 ranked journal with an impact factor of 2.54. The objective of this study was to examine whether a ten-week online interdisciplinary intervention incorporating evidence-based strategies from the disciplines of lifestyle medicine and positive psychology improves outcomes of mental health and wellbeing. This study adds to the body of knowledge as it is the first to report a randomized controlled trial using an interdisciplinary and multicomponent approach to improve mental health and wellbeing in a digital nonclinical setting. In addition, the study provides further evidence for scalable and easily disseminated digital mental health and wellbeing interventions that do not require the support of health professionals. The results of the publication are addressed in this chapter.

4.2 Co-Author Statement

I attest that Research Higher Degree candidate Geraldine Lynn Chang Przybylko contributed to the paper/publication entitled: **The effectiveness of an online interdisciplinary intervention for mental health promotion: A randomized controlled trial.**

By:

- Contributing to the conception and design of the study and intervention.
- Contributing to the development of the digital platform and eLMS.
- Leading the randomized controlled trial.
- Contributing to the measures used.
- Leading the data analysis and interpretation of the data.
- Leading the writing of the manuscript.
- Submitting the manuscript for review.
- Addressing reviewers' comments.

Signature of Candidate:



Name of Candidate: Geraldine Lynn Chang Przybylko

Date: 16 December 2021

Signature of Principal Supervisor:



Name of Principal Supervisor: Associate Professor Darren Morton

Date: 16 December 2021

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RESEARCH ARTICLE Open Access

The effectiveness of an online interdisciplinary intervention for mental health promotion: a randomized controlled trial

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Abstract

Background: There is an urgent need for efficacious interventions to combat the global mental health crisis, and mental health promotion and primary prevention approaches are paramount. The aim of this study is to examine whether an online interdisciplinary intervention that incorporates evidence-based strategies from the disciplines of Lifestyle Medicine and Positive Psychology improves measures of mental health and emotional wellness.

Methods: A randomized controlled trial with a wait-list control (N = 425, aged 46.97 ± 14.5, 69.9% females) was conducted in Australia and New Zealand. The intervention group participated in a 10-week online interdisciplinary intervention. Primary outcome measures of mental health and emotional wellness were taken at baseline (Week 1), post-intervention (Week 12), and 12 weeks post-intervention (Week 24). The wait-list control completed the same assessments.

Results: General Linear Modelling analyses indicated that the intervention group experienced significantly greater improvements than the wait-list control group over time in all outcome measures: mental health ($F(319) = 7.326$, $p = 0.007$) and vitality ($F(319) = 9.445$, $p = 0.002$) subscales of the Short Form Survey (SF-36); depression ($F(319) = 7.841$, $p = 0.005$), anxiety ($F(319) = 4.440$, $p = 0.36$) and stress ($F(319) = 12.494$, $p < 0.001$) scales of the Depression, Anxiety and Stress Scale (DASS-21); and life satisfaction ($F(319) = 8.731$, $p = 0.003$) as measured by the Satisfaction With Life Scale. Within the intervention group, significant improvements were observed from Week 1 to 12 in all outcome measures: mental health (10%, $t(167) = -6.423$, $p < 0.001$, $dz = 0.50$), vitality (22%, $t(167) = -7.043$, $p < 0.001$, $dz = 0.54$), depression (− 41%, $t(167) = 6.189$, $p < 0.001$, $dz = 0.48$), anxiety (− 38%, $t(167) = 5.030$, $p < 0.001$, $dz = 0.39$), stress (− 31%, $t(167) = 6.702$, $p < 0.001$, $dz = 0.52$) and life satisfaction (8%, $t(167) = -6.199$, $p < 0.001$, $dz = 0.48$). Improvements in the outcome measures remained significant in the intervention group at 12 weeks post-intervention.

Conclusion: The online interdisciplinary intervention improved measures of mental health and emotional wellness suggesting that such interventions may be useful for mental health promotion and prevention.

Trial registration The Australian New Zealand Clinical Trials Registry. ACTRN12619000993190. Registered on 12 July 2019 (Retrospectively registered). The ANZCTRN is part of the WHO Primary Registries.

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Keywords: Mental health promotion, Lifestyle medicine, Positive psychology, Randomized controlled trial, Online, Interdisciplinary

Background

Mental health disorders have reached epidemic proportions worldwide [1]. In the United States (U.S.), the burgeoning costs of mental disorders constituent the most costly medical condition, amounting to 201 billion U.S. dollars annually, which surpasses heart conditions (147 billion U.S. dollars), trauma (143 billion U.S. dollars) and cancer (122 billion U.S. dollars) [2]. The current paradigm for the frontline treatment of affective disorders centres on pharmacological intervention. Antidepressant usage has doubled over the past decade in the United Kingdom [3]; is now ranked in the top three most commonly used therapeutic drug classes in the U.S. [4]; and is the most commonly used psychotropic medication in Australia [5]. Despite this increase, the incidence of depression continues to escalate [5–7].

This has led to repeated calls to address mental health on a population-level using a more integrative approach that includes non-pharmacological strategies such as lifestyle interventions, mental health promotion, education programs and psychological therapies [5, 7–12]. Greater focus on mental health promotion and prevention initiatives are needed to enhance the mental health on a population-level to serve as a protective buffer against mental illness [13] and reduce the burden of mental health disorders [14].

Over the past few decades, numerous evidence-based strategies for improving mental health and emotional wellness have emerged in the literature underpinning the disciplines of 'Lifestyle Medicine' and 'Positive Psychology' [15–18]. Lifestyle Medicine has historically focused on the prevention, management and reversal of chronic diseases through the promotion of exercise, a healthy diet, and sleep [16, 19–26], however, there is growing evidence that these lifestyle practices also have positive benefits on mental health [9, 27–31], For example, considerable literature is showing that dietary interventions can be used as an effective treatment strategy for depression [32]. Further, a meta-analysis has shown that exercise is beneficial for mental health [33]. The causal relationship between insomnia and depression [34] is well established; and quality sleep is known to be paramount to good physical and mental health [35, 36].

Positive Psychology focuses on pathways to promote human flourishing through exercises such as practicing gratitude, activating signature strengths, engaging in service activities and nurturing relationships [37–40]. The conclusion of two meta-analyses was that Positive Psychology interventions significantly enhance emotional wellbeing and decrease depressive symptoms [14, 41].

Lifestyle Medicine and Positive Psychology strategies have demonstrated efficacy for enhancing mental health and emotional wellness, however, they are often used in isolation. Interestingly, practitioners have been encouraged to prescribe multiple Positive Psychology strategies in a "shotgun approach", rather than using a single strategy, as it may be more efficacious for their clients [41]. Additionally, the potential "compounding effects" of combining diet and exercise together, warrants further investigation of a more integrated approach using multiple lifestyle modifications [32].

Advances in online technology presents an opportunity to provide mental health promotion and primary prevention strategies that are easily accessible and available population-wide, as well as overcome barriers with face-to-face interventions and the stigma of mental health disorders [42–45]. Online interventions can also provide low-cost solutions for dissemination on a population-level.

This study investigated the effectiveness of a 10-week online interdisciplinary intervention, incorporating both Lifestyle Medicine and Positive Psychology strategies, for improving the mental health and emotional wellness of a community-based cohort.

Methods

Design and participants

The study used a non-blinded randomized controlled design. The treatment group participated in a 10-week intervention consisting of themed weekly sessions (see Table 1). Measurements of mental health and emotional wellness (mental health, vitality, depression, anxiety, stress and life satisfaction) were taken at baseline (Week 1), post-intervention (Week 12) and 12 weeks post-intervention (Week 24) (see Fig. 1). The wait-list control underwent the same measurements at times corresponding to the intervention group. The intervention was made freely available to the wait-list control at the completion of the study. Data was collected from July 2017 to February 2018 and analysed between 2018 and 2020. All procedures involving human subjects were approved by Avondale Human Research Ethics Committee [project number 2017:13]. The trial

Table 1 Weekly topics and challenges for the Live More Project Intervention

Week/topic	Daily challenge	Weekly challenge
1. Language and Emotion	Offer a genuine compliment	Memorise an inspirational text or saying
2. Posture and Regular Physical Activity	Spend 30 min of moderate exercise or 10,000 steps	20 min of guided resistance exercises
3. Sunlight and Natural Environments	Spend 30 min in an uplifting natural environment	Experience a sunrise
4. Social Connections	Do something intentional to show you care	Forgive someone who has hurt you
5. Positive Outlook	Spend 15 min to reflect on three things that went well	Write a letter of gratitude to someone and share it with them
6. Diet and the Gut Health Connection	Eat eight serves of plant-based food	Prepare a high-fibre, plant-based meal with one or more friends
7. Rest	Spend eight hours in bed without a device	Spend an evening by firelight
8. Stress Management	Spend 15 min in a quiet place, relaxing and being mindful of surroundings	Take a day off work and a digital Sabbath (going "off-line" for 24 hr to recharge)
9. Signature Strengths and Serving Smart	Perform a random act of kindness	Use signature strength to perform an act of service
10. Flourishing	Continue challenges found to be helpful	Continue challenges found to be helpful

protocol is registered at The Australian New Zealand Clinical Trials Registry (ACTRN12619000993190).

The participants comprised of self-selected men and women from Australia and New Zealand who were recruited through a faith-based organization. The study was advertised in the faith-based organization's internal communication channels including bulletins and magazines. The advertising materials did not target a clinical population. Instead, the intervention was promoted as an "emotional wellness" program. Inclusion criteria for participation in the study included: 18 years and older; fluent in English; and email and internet access. The inability to participate in moderate-intensity physical activity, such as walking, was an exclusion criteria for the study. Before randomization, the subjects agreed to participate in either arm of the study. The participants were then randomized into the intervention or wait-list control by a non-member of the research team using computer random number generation. Participants were then notified of their group allocation and were required to complete their enrollment and submit their informed consent.

Intervention

The intervention, referred to as "The Live More Project" or "The Lift Project" [46–49], is a 10-week program that integrates strategies from the Lifestyle Medicine and Positive Psychology literature. Underpinning the intervention is the Theory of Planned Behaviour (TPB) that aimed to facilitate behavioral change through three key areas: a shift in attitude towards emotional wellness through education; a change in perceived norms by promoting social engagement; and an increase in perceived control by encouraging the participants to achieve weekly challenges [50].

The intervention used an experiential pedagogical framework of Learn, Experience, Think, and Share (LETS) [46] facilitated through an e-learning management system. In each weekly session, the participants viewed a themed educational video that presented evidence-based strategies for promoting mental health and emotional wellness. The participants were then encouraged to engage in daily and weekly challenges by practically applying the lessons learnt from each topic (Table 1). The participants were awarded challenge points for successfully completing the tasks with a maximum of 100 challenge points per week. The e-learning management system incorporated gamification by ranking the participants' challenge points on a leaderboard. The e-learning management system also included a social forum that allowed interaction between the participants. The participants were able to post pictures and comments relating to the challenges. The participants also received reading materials to expand upon the content presented in the videos, an e-workbook for journaling and reminder notifications to complete the weekly topics and challenges.

Outcomes and measures

All participants completed a self-reported wellness questionnaire, called the '7 Dimensions of Wellness Index', three times during the study corresponding to baseline (Week 1), post-intervention (Week 12), and 12 weeks post-intervention (Week 24) of the intervention group. The questionnaire surveyed sociodemographic characteristics including age, sex ethnicity, marriage status, level of education, country of birth and validated instruments to determine the primary outcomes of mental health and emotional wellness as, outlined below.

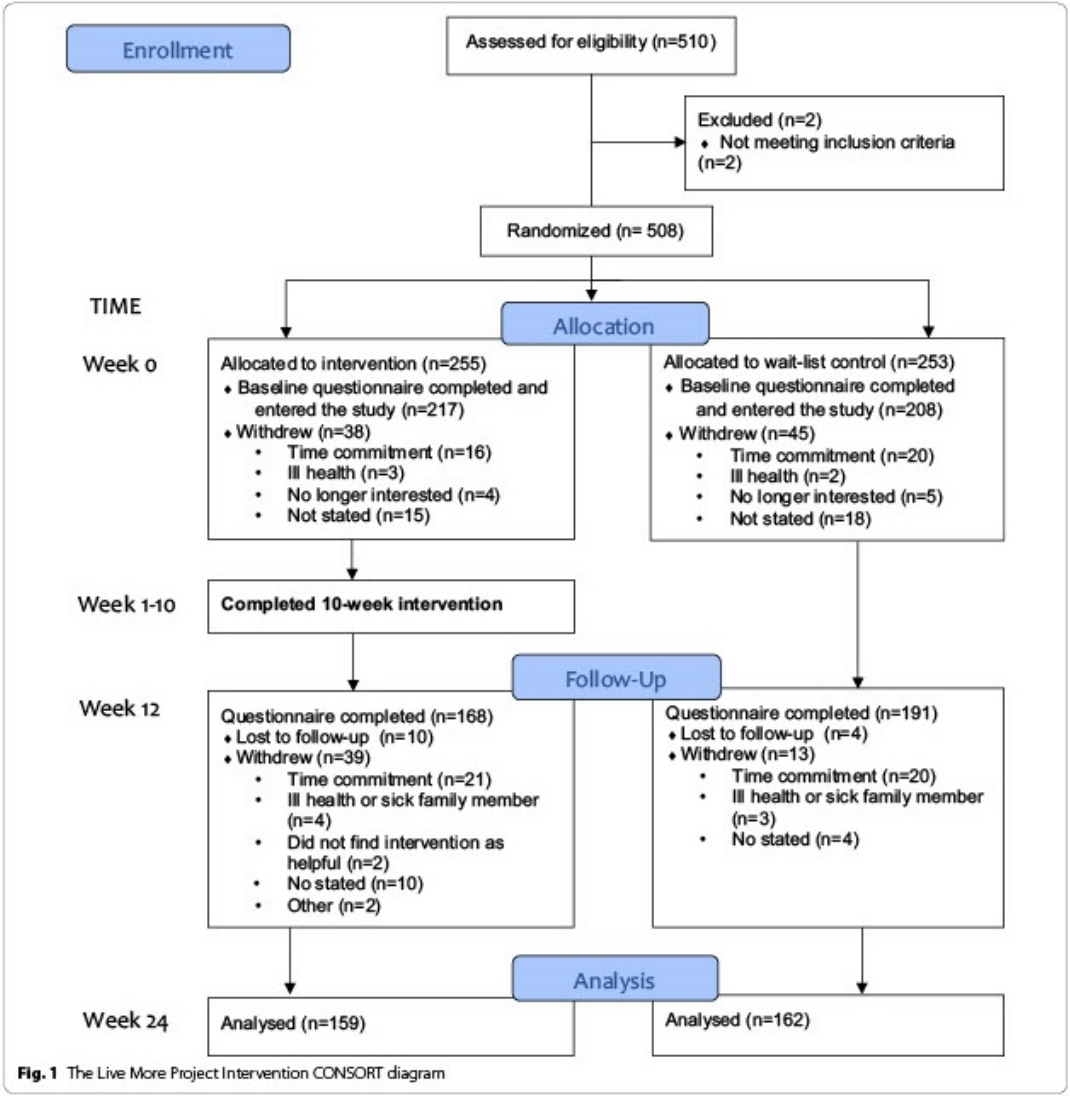


Fig. 1 The Live More Project Intervention CONSORT diagram

Mental Health and Vitality

The 36-item Short Form Health Survey is deemed appropriate for use in general populations [51]. Two subscales where used in this present study: mental health (5 items) and vitality (4 items) subscale [52]. Studies have shown a Cronbach alpha of 0.90 for the mental health subscale and 0.87 for the vitality scale, indicating a good internal consistency [53, 54]. The present study observed a Cronbach alpha of 0.88 for mental health, 0.85 for vitality and 0.90 overall, indicating a good internal consistency.

Depression, Anxiety and Stress Scale

The 21-item Depression, Anxiety and Stress Scale (DASS-21) is suitable to measure depression, anxiety and stress (7 items per subscale) in both clinical and nonclinical populations [55]. Studies have indicated a good internal consistency with a Cronbach alpha range

of 0.76 to 0.91 for the 3 subscales [56, 57] and >0.90 for an overall score [58]. The present study observed a good internal consistency with a Cronbach alpha of 0.86 for depression, 0.68 for anxiety, 0.82 for stress and 0.79 for an overall score.

Satisfaction With Life Scale

The 5-item Satisfaction With Life Scale (SWLS) is used to measure global life satisfaction [59] across a broad age-range and applications [60]. A meta-analysis observed good internal consistency with a mean Cronbach alpha of 0.78 [61]. The present study observed a Cronbach alpha of 0.88 indicating good internal consistency.

Sample size calculation

The sample size was calculated using assumptions based on published pilot data [47] and included the following assumptions: equal allocation of participants to each group; an improvement in depression, anxiety and stress scores of over 20% within the treatment group; a 40% attrition rate, based on reported levels of attrition in other online interventions [39]; 80% power and significance level of 0.05 (95% confidence interval). A small to moderate effect size was predicted based on comparative primary prevention interventions [62].

Statistical analysis

The data were analysed using SPSS Statistics (version 25). Descriptive statistics, involving frequencies, means, standard deviations and confidence intervals were used to present the data. Repeated-measures analysis of variance (ANOVA), using the General Linear Modelling (GLM) function in SPSS, was used to test for group effects (intervention versus control), time effects (baseline to Week 12 and Week 24) and group versus time interactions. Only data from participants who had completed all three assessment periods were included in the analyses, except where specified. When significant, Bonferroni post-hoc analyses were used to determine significant changes from baseline to Week 12 and Week 24. Pearson's correlation analysis was used to report the relationship between the outcome measures (see Additional file 2). The standardized difference method was used to calculate effect sizes (Cohen's dz), calculated as the mean change between the respective timepoints divided by the standard deviation of the subjects' mean difference scores. Missing data for age (n=4) was replaced with the mean age and missing data for mental health outcomes were not included in the analysis.

Results

Between July and August 2017, 510 participants self-selected to participate in the study (see Fig. 1). The trial commenced in September 2017 and was completed February 2018 (Week 24). Of the 508 eligible participants, 425 (69.9% females, aged 46.97±14.50) completed the baseline assessment and entered the study (217 intervention, 208 control). A total of 359 (85%) participants completed the post-intervention questionnaire (168 intervention, 191 control participants) and 321 (76%) completed the 12 weeks post-intervention questionnaire (159 intervention, 162 control). As shown in Table 2, the intervention and wait-list control were similar in age, sex, ethnicity, and education for the analysed data. There were no significant differences between the intervention and wait-list control in the baseline measures of: mental health ($t(320) = -0.843$, $p=0.400$) and vitality ($t(320)=0.881$, $p=0.379$) subscales of the Short Form Survey (SF-36); depression ($t(320)=0.277$, $p=0.782$), anxiety ($t(320) = -0.668$, $p=0.504$) and stress ($t(320)=0.982$, $p=0.327$) scales of the Depression, Anxiety and Stress Scale (DASS-21); and life satisfaction ($t(320) = -0.605$, $p=0.546$) as measured by the Satisfaction With Life Scale. All baseline measures were within the normal range (Fig. 2).

Outcome measures

As illustrated in Fig. 2, the GLM analyses indicated that the intervention group experienced significantly greater improvements than the wait-list control group over

Table 2 The Live More Project Intervention

Baseline characteristics	Intervention (n=159)	Control (n=162)
Age, mean (s.d.)	49.5 (14.3)	45.4 (14.2)
Sex, n (%)		
Men	48 (30.2)	43 (26.7)
Women	111 (69.8)	119 (73.3)
Ethnicity, n (%)		
White/Caucasian	128 (80.5)	135 (83.2)
Asian	10 (6.3)	6 (3.7)
Pacific Islander	5 (3.1)	11 (6.8)
Spanish/Hispanic/Latino	3 (1.9)	5 (3.1)
Indigenous	2 (1.3)	1 (0.6)
Black/African American	5 (3.1)	2 (1.2)
Other	6 (3.8)	2 (1.2%)
Education status, n (%)		
Primary/elementary	0 (0.0)	2 (1.2)
Secondary/high school	19 (11.9)	25 (15.5)
Tertiary/university undergraduate	75 (47.2)	72 (44.1)
Tertiary/university postgraduate	65 (40.9)	63 (39.1)

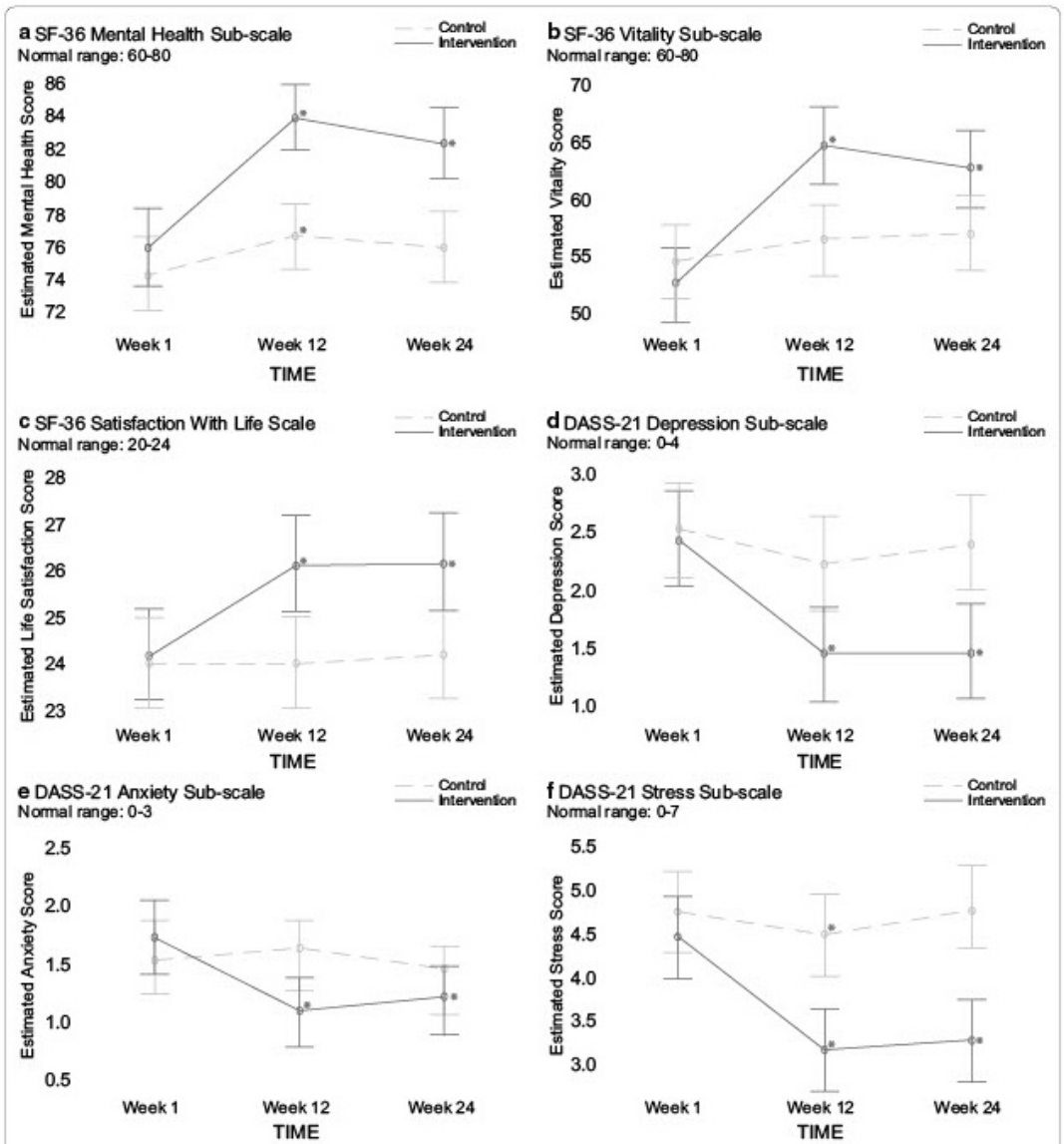


Fig. 2 Mean scores on the outcomes measured using the SF-36 and SWLS (positive affect) and DASS-21 (negative affect) scales across time (Week 1, Week 12 and Week 24), showing 95% confidence levels. * Indicates a significant difference compared to Week 1

time in all outcome measures (interactions between condition and time): mental health ($F(319)=7.326$, $p=0.007$), vitality ($F(319)=9.445$, $p=0.002$), depression ($F(319)=7.841$, $p=0.005$), anxiety ($F(319)=4.440$, $p=0.360$), stress ($F(319)=12.494$, $p=<0.001$) and life satisfaction ($F(319)=8.731$, $p=0.003$). Post hoc analyses using independent samples t-tests indicated that the intervention group experienced significantly greater changes from Week 1 to Week 12 in all outcome measures: mental health ($t(357)=-3.958$, $p<0.001$,

dz = 0.42), vitality (t(357) = − 4.279, $p < 0.001$, dz = 0.45), depression (t(357) = 3.195, $p = 0.002$, dz = 0.34), anxiety (t(357) = 4.325, $p < 0.001$, dz = 0.46), stress (t(357) = 3.508, $p = 0.001$, dz = 0.37) and life satisfaction (t(357) = − 4.702, $p < 0.001$, dz = 0.50). The improvements experienced by the intervention group remained significantly greater than the wait-list control at Week 24 compared to Week 1: mental health (t(319) = − 2.707, $p = 0.007$, dz = 0.30), vitality (t(319) = − 3.073, $p = 0.002$, dz = 0.34), depression (t(319) = 2.800, $p = 0.005$, dz = 0.31), anxiety (t(319) = 2.113, $p = 0.035$, dz = 0.24), stress (t(319) = 3.545, $p < 0.001$, dz = 0.40) and life satisfaction (t(319) = − 2.958, $p = 0.003$, dz = 0.33).

Within the intervention group, significant improvements were observed from Week 1 to 12 in all outcome measures: mental health (10%, t(167) = − 6.423), $p < 0.001$, dz = 0.50), and vitality (22%, t(167) = − 7.043, $p < 0.001$, dz = 0.54), depression (− 41%, t(167) = 6.189, $p < 0.001$, dz = 0.48), anxiety (− 38%, t(167) = 5.030, $p < 0.001$, dz = 0.39), stress (− 31%, t(167) = 6.702, $p < 0.001$, dz = 0.52), and life satisfaction (8%, t(167) = − 6.199, $p < 0.001$, dz = 0.48) as measured by SWLS (see Fig. 2 and Additional file 1). At Week 24, the changes in these measures from Week 1 remained significant for the intervention group: mental health (8%, t(158) = − 5.375, $p < 0.001$, dz = 0.43), vitality (19%, t(158) = − 5.997, $p < 0.001$, dz = 0.48), depression (− 40%, t(158) = 5.070, $p < 0.001$, dz = 0.40), anxiety (− 29%, t(158) = 4.211, $p < 0.001$, dz = 0.33), stress (− 26%, t(158) = 5.808, $p < 0.001$, dz = 0.46) and life satisfaction (8%, t(158) = − 5.875, $p < 0.001$, dz = 0.47).

In contrast, the wait-list control group experienced significant improvements from Week 1 to Week 12 only in mental health (2%, t(190) = − 2.210, $p = 0.028$, dz = 0.16) and stress (− 9%, t(190) = 2.092, $p = 0.038$, dz = 0.15), but not in vitality (4%, t(190) = − 1.710, $p = 0.089$, dz = 0.12), depression (17%, t(190) = 1.596, $p = 0.112$, dz = 0.12), anxiety (5%, t(190) = − 0.796, $p = 0.427$, dz = 0.05) or life satisfaction (0%, t(190) = 0.161, $p = 0.872$, dz = 0.14) (see Fig. 2 and Additional file 1). All measures for the wait-list control were similar at Week 24 to those at Week 1: mental health (2%, t(161) = − 1.382, $p = 0.169$, dz = 0.11), vitality (5%, t(161) = − 1.357, $p = 0.177$, dz = 0.11), depression (− 5%, t(161) = 0.598, $p = 0.551$, d = 0.05), anxiety (− 5%, t(161) = 0.444, $p = 0.657$, d = 0.03), stress (1%, t(161) = − 0.112, $p = 0.991$, dz = 0.01) and life satisfaction (1%, t(161) = − 0.365, $p = 0.715$, dz = 0.03).

At Week 24, the attrition rate was 24% for this study. There were no significant differences between the completors and dropouts in the following characteristics: age ($p = 0.510$), sex ($p = 0.511$), ethnicity ($p = 0.081$) and education ($p = 0.307$). Comparisons were made between those analysed (defined as those who undertook the intervention and all three assessments, n = 321) and the dropouts (defined as those who completed the baseline questionnaire but did not progress to completing the 12 weeks post-intervention questionnaire, n = 104). The data showed that the dropouts had significantly poorer scores for several of the mental health metrics including: mental health (75.4 ± 14.5 vs 59.1 ± 22.4, t(424) = 6.438, $p < 0.001$), depression (2.5 ± 2.6 vs 3.8 ± 4.1, t(424) = − 2.936, $p = 0.004$), anxiety (1.7 ± 1.9 vs 2.5 ± 2.7, t(424) = − 2.636, $p = 0.010$) and life satisfaction (23.8 ± 6.5 vs 22.2 ± 7.9, t(424) = 1.977, $p = 0.49$).

Harms

There were no reported harms that arose through the trial. No harms were anticipated given that the cohort was a subclinical population and the strategies implemented were positive lifestyle and psychological behaviours.

Discussion

To our knowledge, this is the first randomized controlled trial to examine the effectiveness of an interdisciplinary online intervention combining an array of strategies from Lifestyle Medicine and Positive Psychology on mental health and emotional wellness amongst a subclinical population. Hence, interventions such as those employed in this study may provide a response to the repeated calls for lifestyle interventions, psychological strategies, and education programs for the promotion of mental health and primary prevention of common mental health disorders [5, 8–11].

Targeting mental health promotion and prevention through interventions such as that used in the present study may provide a protective 'buffer' for individuals. For example, enhanced positive emotion may increase an individual's ability to cope when faced with adversity [13], and hence increase their resilience. The broaden-and-build theory asserts that the experiences of positive emotions may strengthen an individual's personal, social and psychological resources, sparking upward spirals in their emotional wellbeing [63]. In turn, this may have a moderating impact on stress, anxiety and depressive symptoms [64].

A unique aspect of the intervention used in this study was its multicomponent approach. To date, numerous studies have investigated the effectiveness of Positive Psychology techniques for improving mental health, including expressing gratitude, practising forgiveness, positive thinking and engaging in service activities [38, 39]; however, these strategies are often used in isolation. Similarly, while lifestyle factors such as diet [32] and exercise [28, 33, 65] are increasingly used as management and

treatment modalities for mental illness, they are infrequently combined with psychological strategies.

It is notable that the effect sizes observed in this study are relatively greater than those reported in two meta-analyses of randomized controlled trials, however, the studies in the meta-analyses were of a significantly smaller sample size and predominantly employed single-modality psychological strategies for the primary prevention of mental health [14, 58–66]. Further research is required to understand the underlying mechanisms of the larger effect sizes observed in the present study and if the multicomponent approach resulted in a compounding effect. Encouragingly, within Positive Psychology greater attention is being given to combining an array of psychological strategies [67], however, other evidence-based lifestyle factors, such as physical activity and nutrition, are typically not integrated into these interventions.

Over the past decade, wellness interventions focusing on mental health have increasingly moved online, as compared to the conventional face-to-face mode of delivery [60–62]. Online interventions have been shown to be efficacious and may yield several advantages over face-to-face delivery, including cost-effectiveness, ease of delivery and scalability [68].

Interestingly, the outcomes observed in this study are generally comparable to those observed in a cohort study that utilised the same intervention delivered face-to-face as part of a mandatory class for tertiary students [47]. However, there are several confounders in comparing the results of the cohort study to the present study, namely the participants in the present study were self-selected, of a broader age range and were generally healthier. There is a need to further explore the relative outcomes of mental health interventions when delivered online as compared to face-to-face.

Notably, the attrition rate in this study (24% at Week 24) was relatively low compared to that typically reported in online interventions that do not involve the support of a health professional (often as high as 45%) [39, 69]. A number of factors may have contributed to the low attrition rates observed in this study including the experiential pedagogical framework of the intervention and its interactive components, which are known to be key contributors to creating engagement in online interventions [26].

The observation that those participants who dropped out had poorer mental health scores than those who completed the intervention is notable. There is evidence to suggest that poor mental health and negative emotional states are linked with poor lifestyle choices [70, 71]. Conversely, better mental health is associated with healthy lifestyle choices [72] and according to the "upward spiral" theory, positive affect can aid long-term adherence to positive health behaviours [73]. Indeed, there is a reciprocal relationship between mental health and physical health outcomes because of the behavioural implications of poor mental health [74]. The implication of this observation is that while individuals with poorer mental health might have the greatest need of, and stand to benefit most from mental health interventions, it may be more difficult for them to engage and take positive steps. Certainly, this presents as an important area for further investigation.

Strengths and limitations

A strength of this study was that it involved participants from a broad age range (18 to 88 years) and geographically diverse regions. Another strength of the study is that the intervention used an e-learning management system that was not reliant upon follow-up support from a healthcare professional. This suggests that such interventions might represent a scalable, low-cost method for the promotion of mental health and emotional wellness on a population-level.

A limitation of this study is that the participants where self-selected and drawn from the same faith-based organization that funded the study, so they may have entered the intervention with a higher readiness for change than that of the general population, thus limiting the generalizability of the findings. Secondly, as commonly seen when participants self-select into a Positive Psychology intervention, the sex balance was skewed towards females, which may limit the generalizability of the intervention to male cohorts. Notably, studies of Positive Psychology interventions have not shown the mental health outcomes to be sex specific [14, 39, 41]. Thirdly, a limitation of this study was that it was registered retrospectively with the clinical trial registry, however, the full protocol for the study as documented in this publication was presented at an academic conference prior to data collection. Fourthly, as the study targeted mental health promotion, it does not inform the effectiveness of the intervention among a clinical population with a confirmed diagnosis. As discussed previously, this warrants further investigation given that a previous cohort study has indicated that individuals with lower levels of mental health reported the greatest benefits from the intervention [46].

Implications

This study has important implications for research and practice. Firstly, an early intervention based on an interdisciplinary approach, incorporating Lifestyle Medicine and Positive Psychology strategies, can be used to achieve significant improvements in mental health and emotional wellness. Hence, Clinicians should consider

promoting lifestyle medicine strategies and their benefits to improve mental health. Secondly, while the positive mental health outcomes are encouraging, future studies are required to investigate the relative contribution of the various evidenced-based strategies incorporated into the intervention, as well as who responds best to the intervention (i.e. age and sex effects). Thirdly, further research is required to explore the potential for a compounding effect, whereby combining a broad array of evidence-based approaches for improving mental health and emotional wellness may result in greater benefits than a single-modality approach. Lastly, online modes of delivery may present a low-cost and scalable opportunity for mental health promotion to improve mental health and emotional wellness.

Conclusion

Online interdisciplinary interventions may be a cost-effective and scalable method of mental health promotion. There is a need for future studies to examine the impact of online interdisciplinary interventions on at-risk and clinical populations to assess their potential role in secondary and tertiary prevention.

Abbreviations

SF-36: Short Form Survey (36 items); DASS-21: Depression, Anxiety and Stress Scale (21-Items); SWLS: Satisfaction With Life Scale; TPB: Theory of planned behaviour; LETS: Learn, experience, think and share; GLM: General linear modelling.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40359-021-00577-8.

Additional file 1: Supplementary Table 1. Changes in the outcome measures across time.

Additional file 2: Supplementary Table 2. Correlations between the outcome measures.

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Authors' contributions

GP, DM, LK and PB designed the study. GP & DM developed the intervention. GP drafted the manuscript, coordinated the trial and analysed the data. DM & LK provided supervision in the coordination of the trial and analysing the data. DM, LK & JM were major contributors in providing supervision in writing the manuscript. DM, JM, LK, JH, MR provided critical revision of the article. All authors read and approved the final manuscript.

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Availability of data and materials

The data that support the findings of this study are available from Adventist Health through the Seventh-day Adventist Church (SPD) Ltd, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Seventh-day Adventist Church (SPD) Ltd.

Declarations

Ethics approval and consent to participate

This study was approved by Avondale Human Research Ethics Committee [project number 2017:13]. The trial protocol is registered at The Australian New Zealand Clinical Trials Registry (ACTRN12619000993190). Registered on 12 July 2019 (Retrospectively registered). All participants provided online informed consent before screening took place.

Consent for publication

Not applicable.

Competing interests

GP is a Health Strategist employed by the Seventh-day Adventist Church (SPD) Ltd that promotes a version of the intervention used in this study through the faith-based organisation's network and community.

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CHAPTER FIVE: PUBLICATION 3–AN INTERDISCIPLINARY MENTAL WELLBEING INTERVENTION FOR INCREASING FLOURISHING: TWO EXPERIMENTAL STUDIES

5.1 Chapter Overview

This chapter addresses the first objective of this thesis: "Can a digital multicomponent interdisciplinary intervention improve the mental health and wellbeing of an Australasian nonclinical cohort?". The chapter is presented as a manuscript titled "An interdisciplinary mental wellbeing intervention for increasing flourishing: Two experimental studies" (refer to Section 5.2), published in *The Journal of Positive Psychology,* a Q1 ranked journal with an impact factor of 4.2. The objective of the study was to investigate whether two experimental studies could increase the proportion of participants flourishing through a ten-week digital interdisciplinary intervention that combined strategies from positive psychology and lifestyle medicine. There is a paucity of literature examining the effectiveness of digital multicomponent positive psychology or lifestyle medicine interventions on flourishing. The study contributed to the literature as it was the first interdisciplinary mental wellbeing intervention to increase flourishing using the Huppert and So conceptual framework. The results of the publication are discussed in this chapter.

5.2 Co-Author Statement

I attest that Research Higher Degree candidate Geraldine Lynn Chang Przybylko contributed to the paper/publication entitled: **An interdisciplinary mental wellbeing intervention for increasing flourishing: Two experimental studies.**

By:

- Contributing to the conception and design of the study and the intervention.
- Contributing to the development of the digital platform and eLMS.
- Leading the randomized controlled trial.
- Contributing to the measures used.
- Leading the data analysis and interpretation of the data.
- Leading the writing of the manuscript.
- Submitting the manuscript for review.
- Addressing reviewers' comments.

Signature of Candidate:



Name of Candidate: Geraldine Lynn Chang Przybylko

Date: 16 December 2021

Signature of Principal Supervisor:



Name of Principal Supervisor: Associate Professor Darren Morton

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An interdisciplinary mental wellbeing intervention for increasing flourishing: two experimental studies

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ABSTRACT

Positive Psychology Interventions (PPIs) have been shown to improve mental health, but little is known about their impact on the quantifiable experience of flourishing. Two experimental studies investigated whether the proportion of participants flourishing, assessed using the Huppert and So conceptual framework, could be increased through a 10-week online interdisciplinary intervention that combined strategies from positive psychology and lifestyle medicine. In Study 1 ($n = 421$), flourishing was significantly increased ($p < 0.001$) in the intervention but not the control group and was sustained at 12 weeks post-intervention. Study 2 ($n = 458$) showed that the addition of human support to the online intervention did not further improve its effectiveness at increasing flourishing. These studies demonstrate that online interdisciplinary interventions that incorporate positive psychology and lifestyle medicine strategies can increase human flourishing, irrespective of the addition of human support.

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Flourishing; positive psychology; lifestyle medicine; interdisciplinary; online; multicomponent; randomized controlled trial; mental wellbeing

Background

Over the past two decades, the positive psychology literature has progressed understanding of pathways to higher levels of mental health and functioning, commonly referred to as 'flourishing'. Human flourishing contrasts with the historical 'deficit' focus of psychology, which has long been concerned with stress, depression, and dysfunctional attitudes and behaviors. The associated benefits of flourishing include increased productivity, learning, creativity and longevity (Schotanus-Dijkstra et al., 2017; VanderWeele, 2017). By contrast, the antithesis of flourishing, referred to as 'languishing' (Keyes, 2007), is characterised by low levels of positive emotion and life satisfaction, high levels of distress, increased risk of chronic disease and higher rates of all-cause mortality (Diener & Chan, 2011; Keyes & Simoes, 2012).

Several definitions of 'flourishing' have been presented in the literature but to date theorists have not arrived at a consensus. Seligman (2011) defined flourishing as a multi-dimensional construct that integrates the presence of positive emotions (hedonic wellbeing) with high levels of psychological functioning (eudemonic wellbeing). Diener (2012) argued that flourishing includes important components such as prosperity (Ryff, 1989), social capital (Helliwell et al., 2009), good social relationships that also provide support to others (Brown et al., 2003), and purpose in life (Steger et al., 2008). Huppert and So (2013) defined flourishing as the combination of feeling good and functioning effectively to achieve high levels of mental wellbeing – the experience of life going well.

Despite the lack of consensus about what constitutes flourishing, and how it should be measured, it has been referred to as the 'gold standard of measuring wellbeing' (Seligman, 2011, p. 13). Accordingly, it is gaining attention from governments, policy makers, researchers and the general public as an important construct (Seligman, 2019; Forsman et al., 2015).

Quantifying flourishing

The construct of 'flourishing' is still in its infancy, with no consistent standard to conceptualize and measure the term (Huppert, 2009). While the concept continues to be developed and reimagined (Węziak-białowolska et al., 2018), Hone, Jarden, Schofield et al. (2014) reviewed four frameworks for the measurement of flourishing and applied these on a large sample of ten thousand adults from New Zealand. Significant variation in the prevalence of flourishing was recorded between the frameworks, with the Huppert and So conceptual framework indicating the lowest levels of flourishing among the cohort [Huppert and So (24%), MHC-SF (39%), Flourishing scale (41%) and PERMA model (47%)].

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The mental health continuum short form (MHC-SF)

The MHC-SF, developed by Keyes (2005) is a 14-item self-reported assessment derived by identifying the opposite of each symptom of depression listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM–III–R; American Psychiatric Association, 1987). The assessment contains three items relating to emotional wellbeing, six items relating to psychological wellbeing and five items relating to social wellbeing. A 6-point Likert scale ('never', 'once or twice', 'about one a week', '2–3 times a week', 'almost every day' or 'every day') is used to assess the individual's experience over the past month. Perugini and colleagues (2017) reported a high internal consistency for the MH-SF scale (Cronbach's alpha = 0.89) while Orpana et al. (2017) reported Cronbach's alphas of 0.82 for both emotional and psychological well-being subscales and 0.77 for social wellbeing.

Flourishing scale

The Flourishing scale was developed by Diener et al. (2010), and involves eight items that relate to purpose and meaning, positive relationships, engagement, social contribution, competence, self-respect, optimism and social relationships. Each item utilizes a 7-point Likert scale ('strongly disagree', 'disagree', 'slightly disagree', 'mixed or neither agree or disagree', 'slightly agree', 'agree' and 'strongly agree') that when cumulated provides a score out of 56. The Flourishing scale has a high internal consistency (Cronbach's alpha = 0.89) (Hone, Jarden, Schofield et al., 2014).

PERMA model

Seligman (2011) proposed a flourishing model represented by the acronym PERMA: Positive emotion, Engagement, Relationships, Meaning and Achievement. A 15-item instrument was subsequently developed that included three items for each pillar in the acronym. Each item is based on a 11-point Likert scale (from 0–10, 'never' to 'always; or 0–10, 'not at all' to 'completely'). The PERMA Profiler has demonstrated high internal consistency (Cronbach alpha = 0.93) (Ryan et al., 2019).

Huppert and so conceptual framework

The Huppert and So conceptual framework was deemed by Hone, Jarden, Schofield et al. (2014) to be the most stringent conceptualisation of flourishing, and was found to have the highest internal consistency amongst the four frameworks (Cronbach alpha = 0.83). Therefore, the Huppert and So conceptual framework was utilized in the present study. The definition of flourishing conceptualized by Huppert and So (2013) was developed using internationally agreed criteria derived from the Diagnostic and Statistical Disorders (DSM-IV) of the American Psychiatric Association (1994) and the International Classification of Diseases (ICD-10) of the World Health Organization (1993). As the majority of common mental health disorders belong to two key diagnostic categories – Major Depressive Episode (DSM-IV)/Depressive Episode (ICD-10) and Generalised Anxiety Disorder – these categories were systematically examined and the mirror opposite symptoms associated with these disorders were determined.

Huppert and So subsequently developed a 10-item assessment of flourishing determined as meeting the following criteria: 1. A high level of 'positive emotion', as indicated by a score of 8 or above on a scale from 0 ('extremely unhappy') to 10 ('extremely happy'), 2. A high 'positive characteristics' rating, determined by the individual reporting in the highest two rankings on a 4-point Likert scale for four out of five positive characteristics (emotional stability, vitality, optimism, resilience, and self-esteem), and 3. A high 'positive functioning' rating, indicated by the individual reporting in the highest two rankings on a 4-point Likert scale for three out of four items relating to positive functioning (competence, engagement, meaning and positive relationships). Positive rankings in the 'positive emotion' and 'positive characteristics' domains assessed hedonic wellbeing while the 'positive functioning' domain captured expressions of eudemonic wellbeing.

To test their conceptual and operational definition of flourishing, Huppert and So utilized data from the European Social Survey, which included a representative sample of 43,000 individuals aged 15 and older from 23 countries. A wide variation of the prevalence of flourishing was found across European countries from a low of 10% in Slovakia, Russia and Portugal to a high of 41% in Denmark. These results concurred with other studies that have shown Nordic countries consistently rate the highest in happiness and life satisfaction (Biswas-Diener et al., 2010; Böhnke, 2005). Inter-item Spearman correlations were significant ($p < 0.001$) and positively correlated for all items ranging from 0.10 (engagement and emotional stability) to 0.49 (self-esteem and optimism).

To date, the Huppert and So conceptual framework has been applied in two epidemiological studies (Hone et al., 2015; Huppert & So, 2013), however, this conceptual framework has not been used for empirical investigations to measure the effect of interventions on the levels of flourishing amongst a cohort.

Interdisciplinary interventions to increase mental wellbeing

Over the past two decades there has been an increasing interest in a variety of psychological-based strategies for fostering positive psychological states and overall

mental wellbeing. These strategies, commonly referred to as Positive Psychology Interventions (PPIs) include fostering optimism, gratitude, hope, acts of kindness, and positive thinking. Whilst numerous studies have shown PPIs to significantly improve components of mental wellbeing, only three studies have investigated the influence of PPIs on flourishing, and no studies have used the Huppert and So conceptual framework. Firstly, Feicht et al. (2013) conducted a randomized controlled trial (n = 147) and reported significant improvements in flourishing scores using the Flourishing Scale (scored out of a maximum of 56 points) from 43 at baseline to 46 at four-week post-intervention ($p = 0.002$). The intervention involved a seven-week web-based multicomponent PPI applied in an occupational health setting. Secondly, Schotanus-Dijkstra et al. (2017) observed in a randomized controlled study (n = 275) involving a multicomponent PPI a significant increase in the percentage of individuals categorised as flourishing (from 7 to 34%, $p < 0.001$), assessed using the MHC-SF. Most recently, in a RCT involving 654 university students, Bendtsen et al. (2020) observed an 8.5 point increase in the median MHC-SF flourishing score among the intervention group in response to an online multicomponent PPI.

While PPIs are increasingly used and studied, the benefits of positive lifestyle behaviors represent a potential contributor to flourishing. Emerging work by (VanderWeele et al., 2019) has urged the inclusion of physical health into the flourishing construct. Historically, the discipline of 'Lifestyle Medicine' has focused on the prevention, management and reversal of chronic diseases, such as heart disease and diabetes, through the application of positive lifestyle behaviors including physical activity, diet, sleep, smoking cessation and minimizing alcohol consumption (Egger et al., 2011; Morton et al., 2016; Wright et al., 2017). However, there is growing literature demonstrating that the tenants of lifestyle medicine also benefit mental health and wellbeing (Firth et al., 2020; Firth et al., 2019; Jacka et al., 2017; Morton, 2018).

While extensive literature shows the connection between physical activity and physical health, the literature is scant examining the connection between physical activity and mental health and flourishing. In a longitudinal study of US adults (n = 5,789), Leibow et al. (2021) reported a bidirectional association between mental health and physical activity. The authors concluded that physical activity could improve mental health and those who had better mood and psychosocial functioning were more likely to improve their physical activity levels over time.

There is also clear evidence that physical activity is an effective method for preventing mental health disorders. In a prospective study involving Korean adults (n = 107,901), Kim et al. (2019) found that an active lifestyle reduced the incidence of depressive symptoms, regardless of sex, at one year follow up. Further, a meta-analysis of 49 prospective cohort studies (n = 266,939) observed that higher physical activity levels were associated with decreased odds ratios for developing depression, and the protective effect persisted across age, sex and geographical region (Schuch et al., 2018).

In the past decade, the benefits of regular physical activity for improving depression has been a topic of considerable research, culminating in three meta-analyses of randomized controlled trials (Josefsson et al., 2014; Krogh et al., 2011; Kvam et al., 2016). Further, physical activity is well-established as an intervention for depression, with results being comparable to antidepressant medications (Cooney et al., 2013; Kvam et al., 2016).

Similarly, there is limited but a growing body of evidence showing the link between nutrition and mental wellbeing (Akbaraly et al., 2009; McMartin et al., 2013). In a micro-longitudinal study on young adults (n = 403), Conner et al. (2015) observed that in early adulthood fruit and vegetable consumption may be associated with a wide range of well-being states indicative of flourishing. Johnson et al. (2017) implemented a 12-week community-based lifestyle intervention (n = 421) and found physical activity and healthy eating education significantly ($p < 0.001$) improved mental wellbeing at 3-month follow up (observed a 5-point increase in the median). In examining the food diaries of approximately 12,835 Australian adults, Mujcic and Oswald (2016) found that increased fruit and vegetable consumption was predictive of increased happiness, life satisfaction and wellbeing. Notably, consuming eight serves of fruit and vegetables a day was associated with psychological gains equivalent to moving from unemployment to employment. Further, the benefits of healthy eating on happiness preceded improvements in physical health.

There is also growing evidence that improving diet can reduce depressive symptoms (Jacka et al., 2014). In a meta-analysis of 21 studies (n = 117,229), Li et al. (2017) concluded that the Western-style eating patterns, consisting of high intakes of red and/or processed meat, refined grains, sweets and high fat dairy products, are associated with a higher risk of depression. Conversely a healthy diet, consisting of high intakes of vegetables, fruits, wholegrains, soy, fish and low-fat dairy, was found to be associated with a lower risk of depression.

A proliferation of sleep studies have also shown a strong connection between poor sleep hygiene and an increased risk of mental distress, including depression and anxiety (Mason & Harvey, 2014; Neckelmann et al., 2007). In a meta-analysis of 49 randomized controlled trials (n = 5,908), Gee et al. (2019) concluded that non-

mental wellbeing. These strategies, commonly referred to as Positive Psychology Interventions (PPIs) include fostering optimism, gratitude, hope, acts of kindness, and positive thinking. Whilst numerous studies have shown PPIs to significantly improve components of mental wellbeing, only three studies have investigated the influence of PPIs on flourishing, and no studies have used the Huppert and So conceptual framework. Firstly, Feicht et al. (2013) conducted a randomized controlled trial (n = 147) and reported significant improvements in flourishing scores using the Flourishing Scale (scored out of a maximum of 56 points) from 43 at baseline to 46 at four-week post-intervention ($p = 0.002$). The intervention involved a seven-week web-based multicomponent PPI applied in an occupational health setting. Secondly, Schotanus-Dijkstra et al. (2017) observed in a randomized controlled study (n = 275) involving a multicomponent PPI a significant increase in the percentage of individuals categorised as flourishing (from 7 to 34%, $p < 0.001$), assessed using the MHC-SF. Most recently, in a RCT involving 654 university students, Bendtsen et al. (2020) observed an 8.5 point increase in the median MHC-SF flourishing score among the intervention group in response to an online multicomponent PPI.

While PPIs are increasingly used and studied, the benefits of positive lifestyle behaviors represent a potential contributor to flourishing. Emerging work by (VanderWeele et al., 2019) has urged the inclusion of physical health into the flourishing construct. Historically, the discipline of 'Lifestyle Medicine' has focused on the prevention, management and reversal of chronic diseases, such as heart disease and diabetes, through the application of positive lifestyle behaviors including physical activity, diet, sleep, smoking cessation and minimizing alcohol consumption (Egger et al., 2011; Morton et al., 2016; Wright et al., 2017). However, there is growing literature demonstrating that the tenants of lifestyle medicine also benefit mental health and wellbeing (Firth et al., 2020; Firth et al., 2019; Jacka et al., 2017; Morton, 2018).

While extensive literature shows the connection between physical activity and physical health, the literature is scant examining the connection between physical activity and mental health and flourishing. In a longitudinal study of US adults (n = 5,789), Leibow et al. (2021) reported a bidirectional association between mental health and physical activity. The authors concluded that physical activity could improve mental health and those who had better mood and psychosocial functioning were more likely to improve their physical activity levels over time.

There is also clear evidence that physical activity is an effective method for preventing mental health disorders. In a prospective study involving Korean adults (n = 107,901), Kim et al. (2019) found that an active lifestyle reduced the incidence of depressive symptoms, regardless of sex, at one year follow up. Further, a meta-analysis of 49 prospective cohort studies (n = 266,939) observed that higher physical activity levels were associated with decreased odds ratios for developing depression, and the protective effect persisted across age, sex and geographical region (Schuch et al., 2018).

In the past decade, the benefits of regular physical activity for improving depression has been a topic of considerable research, culminating in three meta-analyses of randomized controlled trials (Josefsson et al., 2014; Krogh et al., 2011; Kvam et al., 2016). Further, physical activity is well-established as an intervention for depression, with results being comparable to antidepressant medications (Cooney et al., 2013; Kvam et al., 2016).

Similarly, there is limited but a growing body of evidence showing the link between nutrition and mental wellbeing (Akbaraly et al., 2009; McMartin et al., 2013). In a micro-longitudinal study on young adults (n = 403), Conner et al. (2015) observed that in early adulthood fruit and vegetable consumption may be associated with a wide range of well-being states indicative of flourishing. Johnson et al. (2017) implemented a 12-week community-based lifestyle intervention (n = 421) and found physical activity and healthy eating education significantly ($p < 0.001$) improved mental wellbeing at 3-month follow up (observed a 5-point increase in the median). In examining the food diaries of approximately 12,835 Australian adults, Mujcic and Oswald (2016) found that increased fruit and vegetable consumption was predictive of increased happiness, life satisfaction and wellbeing. Notably, consuming eight serves of fruit and vegetables a day was associated with psychological gains equivalent to moving from unemployment to employment. Further, the benefits of healthy eating on happiness preceded improvements in physical health.

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pharmacological interventions designed to improve sleep had a positive impact on depressive symptoms.

Further, in a cross-sectional study of Lithuanian adults (n = 6,497 aged 45–72), Sapranaviciute-Zabazlajeva et al. (2017) found that healthy lifestyle factors such as physical activity and healthy eating increased the probability of higher psychological wellbeing. The authors also concluded that higher psychological wellbeing was positively associated with the consumption of fruit and vegetables and physical activity for both genders. Whilst the literature is sparse with regards to the influence of lifestyle interventions on the construct of flourishing, clearly lifestyle behaviours are linked to components of the flourishing assessment such as positive emotion.

An integrative approach

Positive psychology and lifestyle medicine strategies have demonstrated efficacy in improving metrics of mental wellbeing, however, they are rarely used together. In previous studies we have examined the effectiveness of an online multicomponent intervention that integrated positive psychology and lifestyle medicine strategies on metrics of mental health, including depression and anxiety (Morton et al., 2020; Renfrew et al., 2020). Notably, the change in effect size observed in our studies were relatively larger than those reported in two meta-analyses of PPIs that predominantly used a single-modality approach (Bolier et al., 2013; Sin & Lyubomirsky, 2009; White et al., 2019). This highlights the potential value of multicomponent interventions.

Online interventions

Online interventions are becoming increasingly well used due to their accessibility, scalability and cost-effectiveness. There are conflicting reports regarding the addition of human support (through personalised SMS, videoconferencing, telehealth, etc) on the outcomes of online wellbeing interventions. For example, a systematic review and meta-analysis of online and computer-based stress interventions observed that the effect size of guided studies were almost double that of unsupported studies (Heber et al., 2017). Conversely, a number of studies have found no significant differences between supported and unsupported interventions (Aardoom et al., 2016; Renfrew et al., 2020).

The present studies

Two studies were conducted to test the hypothesis that a 10-week online mental wellbeing intervention, that integrated strategies from positive psychology and lifestyle medicine, could affect the prevalence of flourishing. Study 1 was a randomised controlled trial that included a 12-week follow-up. Study 2 was a three-arm randomised comparative study in which the influence of adding modes of human support to the intervention was examined.

Method

Intervention

The present studies both used an intervention referred to as 'The Live More Project' or 'The Lift Project' (Morton et al., 2017; Renfrew et al., 2020). The intervention is a 10-week program that integrated evidence-based strategies from positive psychology and lifestyle medicine for improving mental wellbeing (see Table 1).

The intervention used an experiential pedagogical framework of Learn, Experience, Think, and Share (LETS), facilitated through an e-learning management system (Morton et al., 2020). In each one-hour weekly session, the participants viewed a themed educational video that presented an evidence-based strategy for promoting mental wellbeing. The aim of the

Table 1. An overview of weekly topics and challenges for the intervention.

Week/Topic	Daily Challenge	Weekly Challenge
1. Speak positively	Offer a genuine compliment.	Memorise an inspirational text or saying.
2. Move dynamically	Spend 30 minutes of moderate exercise or 10,000 steps.	20 minutes of guided resistance exercises.
3. Immerse in an uplifting natural environment	Spend 30 minutes in an uplifting natural environment.	Experience a sunrise.
4. Immerse in a positive social environment	Do something intentional to show you care.	Forgive someone who has hurt you.
5. Look to the positive	Spend 15 minutes to reflect on three things that went well.	Write a letter of gratitude to someone and share it with them.
6. Eat nutritiously	Eat eight serves of plant-based food.	Prepare a high-fibre, plant-based meal with one or more friends.
7. Rest – sleep	Spend eight hours in bed without a device.	Spend an evening by firelight.
8. Rest – from stress	Spend 15 minutes in a quiet place, relaxing and being mindful of surroundings.	Take a day off work and a digital Sabbath (going 'off-line' for 24 hours to recharge).
9. Serving others	Perform a random act of kindness.	Use signature strength to perform an act of service.
10. What does it take to flourish?	Continue challenges found to be helpful.	Continue challenges found to be helpful.

intervention was to promote positive behaviour change through education by encouraging participants to apply what they had learnt through involvement in daily and weekly challenges (see Table 1). A gamification element was added to the intervention through 'challenge points' that the participants were awarded for engaging in the challenges. Points were recorded on an e-learning management system and the participants were ranked on a leaderboard. A maximum of 100 challenge points could be earned each week (i.e. maximum of 1,000 points for the 10-week intervention). Participants were also given the opportunity to interact with each other on a social forum for encouragement and accountability. Participants were able to post photos and comments relating to the challenges and access an e-book to expand their knowledge on the content presented in the videos. An e-workbook was also made available for journaling.

Study 1

Study 1 was an unblinded, randomized controlled trial (RCT) with an intervention and a wait-list control group. All procedures involving human subjects were approved by the Avondale Human Research Ethics Committee [project number 2017:13]. The trial protocol, which was registered at the Australian New Zealand Clinical Trials Registry (ACTRN12619000993190), commenced in September 2017 and concluded in February 2018. The wait-list control group had the opportunity to participate in the intervention free of charge at the completion of the study.

Randomization

The participants were randomized into the intervention or control group by a non-member of the research team using computer random number generation. Participants were then notified of their group allocation and provided online informed consent before screening took place.

Participants

Five hundred and ten individuals from a faith-based organization across Australasia self-selected to participate in the study (see Figure 1). The intervention was advertised as a mental wellbeing program in the faith-based organization's internal communication channels such as bulletins, periodicals and magazines.

As shown in Figure 1, of the 510 individuals who applied to participate in the study, only two did not meet the inclusion criteria which included: 18 years and older; fluent in English; having email and internet access; and were an Australian or New Zealand resident. The subjects agreed to participate in either arm of the study before randomization. A total of 421 individuals then completed the baseline assessment and entered the study (210 intervention, 211 control). A total of 366 (86.9%) participants completed the post-intervention questionnaire (169 intervention, 197 control participants) and 324 (77.0%) completed the 12 weeks post-intervention questionnaire (164 intervention, 160 control).

The baseline characteristics of the groups are shown in Table 2. There was no significant difference between the groups in any of the demographic measures, and both groups were equally distributed for age and gender. Combined, the 421 participants had a mean age of 47.3 ± 14.6 years and were predominantly female (70.8%), of a white/Caucasian background and tertiary educated.

Outcomes and measures

As shown in Figure 1, a self-reported wellness questionnaire that included questions about the participants' sociodemographic characteristics (age, gender, ethnicity, marriage status, level of education, and country of birth) and the ten-item Huppert and So conceptual framework was used to measure flourishing (Huppert & So, 2013). As explained in the introduction to this paper, participants were rated as flourishing if they reported 'positive emotion' (one item) and strong endorsements of 'positive characteristics' (four out of five items) and 'positive functioning' (three out of four items). The questionnaire was administered at baseline (Week 1), post-intervention (Week 12) and 12 weeks post-intervention (Week 24). The wait-list control group undertook the same measurements in the same weeks as the intervention group.

Sample size

Published pilot data (Morton et al., 2020) were used for the sample size calculation, based on the following: equal allocation of participants to each group; a 20% increase in the treatment group; a 40% attrition rate, based on reported levels of attrition in other online interventions (Gander et al., 2016); and 80% power and a significance level of 0.05 (95% confidence interval).

Statistical analyses

Data were analyzed using IBM SPSS Statistics (version 25). Descriptive statistics, involving frequencies, means, standard deviations and confidence intervals were used to present the data. An exact McNemar's test was

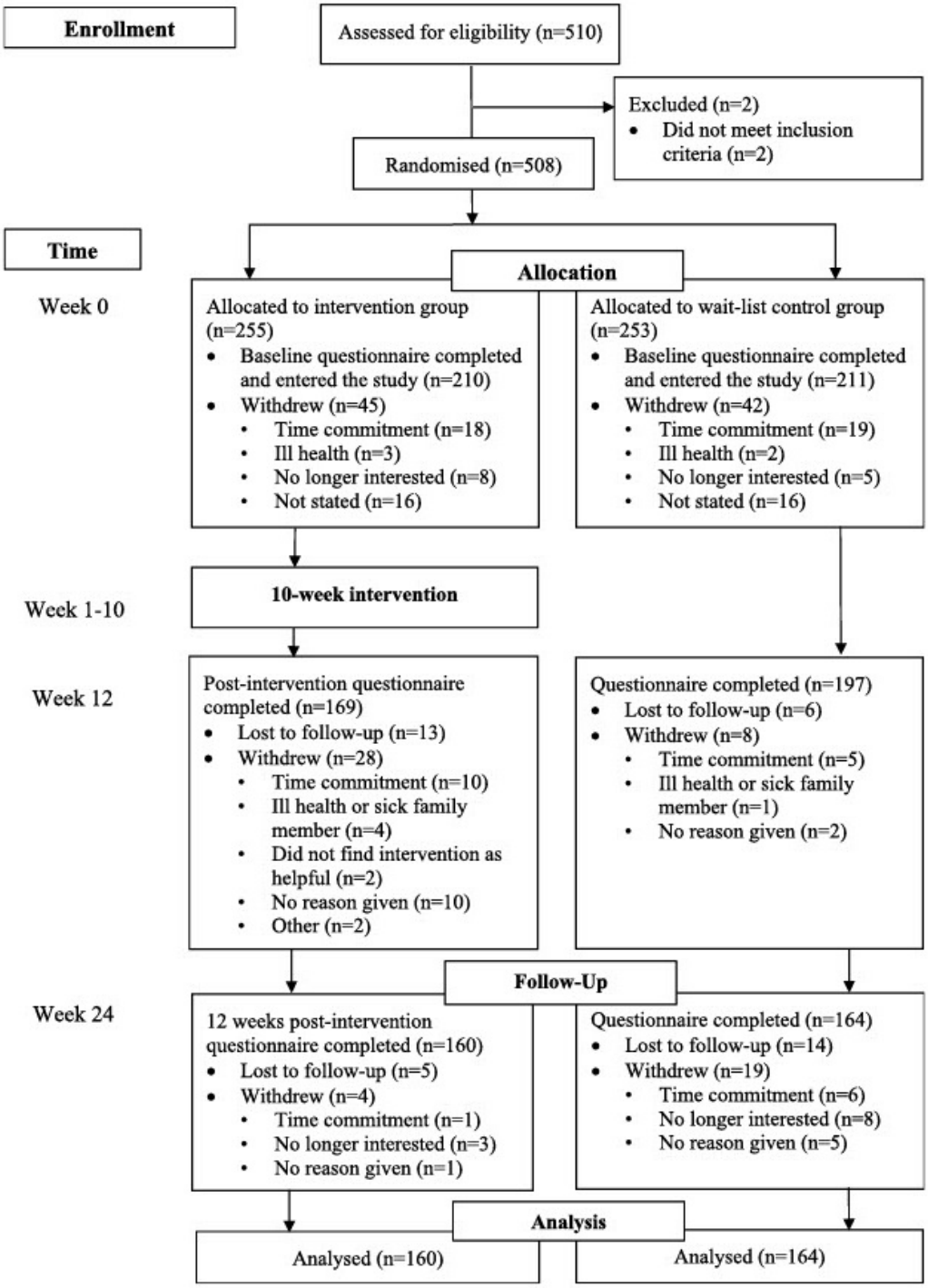


Figure 1. Study 1 CONSORT diagram.

Table 2. Study 1 Participant baseline characteristics.

Baseline characteristics	Intervention (n = 210)	Control (n = 211)
Age, mean (s.d.)	47.9 (15.0)	46.7 (14.4)
Gender, n (%)		
Men	59 (28.1)	64 (30.3)
Women	151 (71.9)	147 (69.7)
Ethnicity, n (%)		
White/Caucasian	177 (84.3)	168 (79.6)
Asian	10 (4.8)	10 (4.7)
Pacific Islander	2 (1.0)	17 (8.1)
Spanish/Hispanic/Latino	2 (1.0)	6 (2.8)
Indigenous	3 (1.4)	0 (0.0)
Black/African American	7 (3.3)	5 (2.4)
Other	9 (4.3)	5 (2.4)
Education status, n (%)		
Primary/Elementary	1 (0.5)	1 (0.5)
Secondary/High School	21 (9.8)	38 (18.0)
Tertiary/University Undergraduate	100 (47.7)	90 (42.7)
Tertiary/University Postgraduate	88 (42.0)	82 (38.9)

performed to analyse the changes in the proportion of participants flourishing from baseline to post-intervention and 12 weeks post-intervention.

Results

As shown in Figure 2, the intervention group observed a 17.2 percentage point increase (30.3 to 47.5%, $p < 0.001$) in those reporting 'flourishing' from baseline to post-intervention, while only a 1.3 percentage point increase (29.8% to 31.1%, $p = 0.360$) was observed in the control group. At 12-weeks post-intervention, the intervention group sustained a significant increase in the prevalence of flourishing from baseline levels (30.3 to 48.8%, $p < 0.001$), while the control group experienced a 1.8 percentage point reduction compared to baseline (29.8 to 28.0%, $p = 0.883$).

Discussion

Study 1 revealed two key findings. First, to the authors knowledge, this is the first RCT to show that an online interdisciplinary intervention, integrating strategies from both positive psychology and lifestyle medicine, can improve the prevalence of flourishing. Second, the outcomes of the intervention were sustained at 12 weeks post-intervention. Given the scalability of online interventions such as the one used in the present study, these findings are important as even modest improvements in wellbeing may confer large benefits in the prevention of mental illness at a population-level (Huppert, 2009; Schotanus-Dijkstra et al., 2016).

Study 2

The study was a multi-arm, unblinded randomized comparative design in which participants were allocated to three groups, differing in the mode of human support offered in addition to the standard online intervention. All procedures involving human subjects were approved by the Avondale Human Research Ethics Committee [project number 2018:09]. The trial, which was registered at the Australian New Zealand Clinical Trials Registry (ACTRN12619001009101), was conducted from July to December 2018.

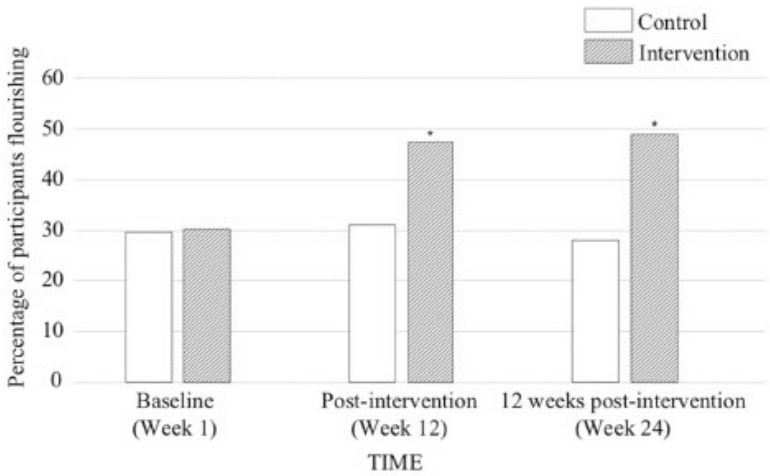


Figure 2. Changes in the percentage of participants utilizing the Huppert and So conceptual framework.
* denotes significant change from baseline ($p<0.001$).

Randomization

Utilising the same procedure as Study 1, the participants were randomized into one of the three groups:

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

Participants

As shown in Figure 3, 605 individuals self-selected to participate and met the inclusion criteria: 18 years and over, mobile phone with SMS capability, email and internet access, fluent in English, and were an Australian or New Zealand resident. The participants were then randomized into three groups: S (n = 202), S+ pSMS (n = 202) and S+ VCS (n = 201). A total of 458 completed the baseline questionnaire and entered the study (S = 157, S+ pSMS = 163, S+ VCS = 138). At 12 weeks, 320 (69.9%) participants completed the post-intervention questionnaire (S = 103, S+ pSMS = 114, S + VCS = 103). Advertising was conducted from July to September 2018 for this mental wellbeing program using internal communication channels, online marketing, social media and email strategies.

The baseline characteristics of the group are shown in Table 3. the 458 participants had a mean age of 47.3 ± 14.6 years and were predominantly female (77.1%), of a white/Caucasian background and tertiary educated.

Sample size, outcome measures and statistical analyses

The same assumptions for sample size calculation were based on the same assumptions as used in Study 1 and the same outcome measures were captured.

Results

As shown in Figure 4, all modes of human support groups observed a significant ($p < 0.001$) within-group improvement in those reporting 'flourishing' from baseline to post-intervention (percentage point increase of: S = 15.5, S+ pSMS = 20.2, S+ VCS = 22.3, and Combined = 19.4). A one-way analysis of variance (ANOVA) indicated no significant ($p = 0.651$) between-group differences. The attendance of the video conference support sessions (VCSSs) in the S+ VCs group was 2.8 out of 10 and 35.9% did not attend any session.

Discussion

Building on the findings of Study 1, this randomized comparative design investigated the efficacy of the intervention using three modes of human support. Significant improvements in the proportion of participants flourishing was observed in all groups, and the results were comparable to those observed in Study 1. Interestingly, Study 2 found that the mode of human support had no effect, however, attendance of the video support sessions was very low, and hence this group was operationally similar to the standard online delivery group (S).

Participant characteristics and change in flourishing status

The data from Studies 1 and 2 were combined to examine whether characteristics of the participants related to change in flourishing status from baseline to post-intervention. Presented in Table 4 are the age, gender, ethnicity and education profiles of those who were: flourishing at baseline but not at post-intervention (Regressed); not flourishing at either baseline nor post-intervention (Not Flourishing – No Change); not flourishing at baseline but were at post-intervention (Improved Flourishing); flourishing at both baseline and post-intervention (Flourishing – No Change). ANOVA indicated that there was a small but significant age difference between the groups ($F = 6.203$, $df = 3$, $p < 0.001$) with the post hoc analysis indicating that those who improved their flourishing status trended towards being younger than those who regressed ($p = 0.052$). Over four times more males improved their flourishing status as compared to those who regressed, which compared favourably to less than 3 times for the females ($\chi^2 = 14.854$, $df = 3$, $p = 0.002$). Ethnicity had no effect on change in flourishing status ($\chi^2 = 17.782$, $df = 18$ $p = 0.470$), however, a shift towards flourishing was more evident among those with lower education levels ($\chi^2 = 21.612$, $df = 9$, $p = 0.010$).

Analysis of the data from Study 1 indicated that change in flourishing status from baseline to 12 weeks post-intervention was not related to age ($F = 0.200$, $df = 3$, $p = 0.896$), gender ($\chi^2 = 1.813$, $df = 3$, $p = 0.612$), ethnicity ($\chi^2 = 19.671$, $df = 18$, $p = 0.352$) or education level ($\chi^2 = 7.793$, $df = 9$, $p = 0.555$).

General discussion

The two studies described support the hypothesis that a 10-week online interdisciplinary mental wellbeing intervention, that combined strategies from positive

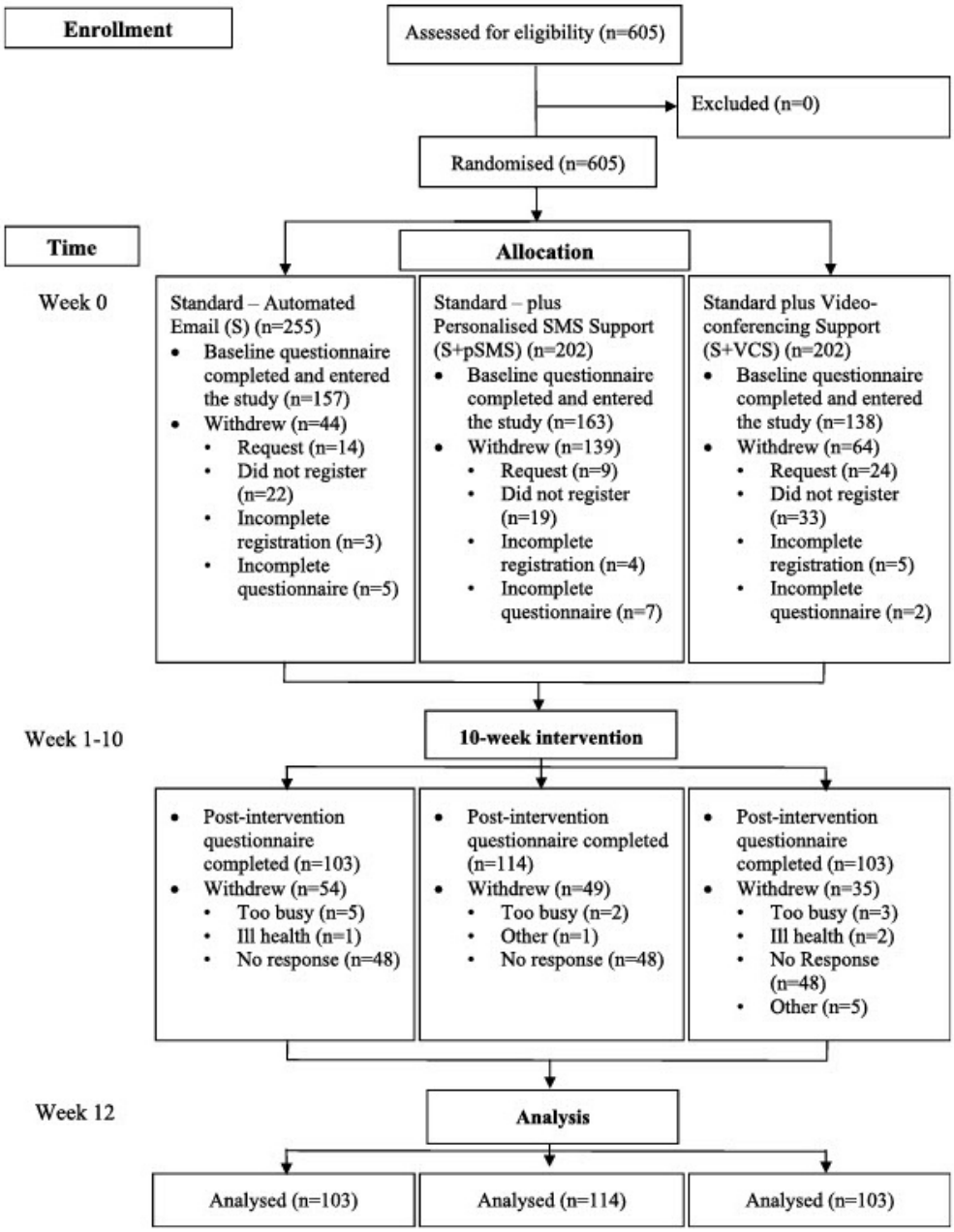


Figure 3. Study 2 CONSORT diagram.

psychology and lifestyle medicine, can increase human flourishing, as quantified by the Huppert and So conceptualization. These findings are notable as the promotion of flourishing can significantly reduce the prevalence of mental disorders (Grant et al., 2013), as well as provide a buffer against mental illness. Interestingly, despite the female bias in the participation of the intervention, which is typically found in PPIs

Table 3. Study 2 participant baseline characteristics.

Baseline characteristics	Group 1 S	Group 2 S+ pSMS	Group 3 S+ VCS	Combined
Age, mean (s.d.)	45.6 (13.9)	46.5 (13.4)	44.3 (13.9)	45.5 (13.7)
Gender, n (%)				
Men	33 (21.0)	37 (22.7)	31 (22.5)	101 (22.1)
Women	124 (79.0)	126 (77.3)	106 (76.8)	356 (77.1)
Other	0	0	0	1 (0.2)
Ethnicity, n (%)				
White/Caucasian	124 (79.0)	118 (72.4)	110 (79.7)	352 (76.9)
Asian	5 (3.2)	11 (6.7)	2 (1.4)	18 (3.9)
Pacific Islander	12 (7.6)	16 (9.8)	7 (5.1)	35 (7.6)
Spanish/Hispanic/Latino	5 (3.2)	3 (1.8)	4 (2.9)	12 (2.6)
Indigenous	0	0	1 (0.7)	1 (0.2)
Black/African American	4 (2.5)	3 (1.8)	3 (2.2)	10 (2.2)
Other	7 (4.5)	12 (7.5)	11 (8.0)	30 (6.6)
Education status, n (%)				
Primary/Elementary	0	2 (1.2)	0	2 (0.4)
Secondary/High School	36 (22.9)	39 (23.9)	24 (17.4)	99 (21.6)
Tertiary/University Undergraduate	74 (47.2)	65 (39.9)	75 (54.3)	214 (46.7)
Tertiary/University Postgraduate	47 (29.9)	57 (35)	39 (28.3)	143 (31.3)

(Gander et al., 2016), there was a trend for males to perform better than females with regards to improving and maintaining their flourishing status. Further investigation is warranted to understand the gender influence on mental wellbeing interventions.

To date, only three studies have investigated the effect of a RCT on flourishing, and in each case the interventions only employed psychological strategies, as compared to an interdisciplinary approach, and they did not use the Huppert and So conceptual framework for assessing flourishing (Bendtsen et al., 2020; Feicht et al., 2013; Schotanus-Dijkstra et al., 2017). Prior to the present studies, the Huppert and So conceptual framework was only applied from an epidemiological perspective (Hone, Jarden, Schofield et al., 2014; Huppert & So, 2013). Hence, the approach adopted in the present studies, using the Huppert and So flourishing construct as a measure of the effectiveness of an intervention, is novel.

While the positive outcomes observed in these studies are encouraging, further work needs to be done to

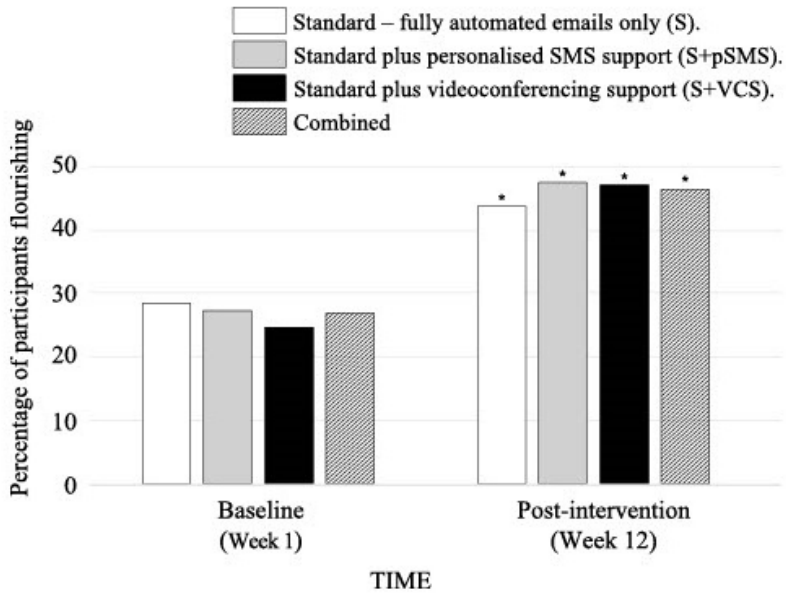


Figure 4. Changes in the percentage of participants utilizing the huppert and so conceptual framework.

Table 4. Participant characteristics and the change in flourishing status.

Baseline characteristics	Regressed	Not Flourishing – No Change	Improved Flourishing	Flourishing – No Change
Age, mean (s.d.)	51.3 (13.1)	44.8 (13.5)	46.7 (14.2)	51.4 (14.9)
Gender, n (%)				
Men (n = 110)	8 (7.3)	36 (22.7)	34 (30.9)	32 (29.1)
Women (n = 380)	38 (10.0)	182 (47.9)	103 (27.1)	57(15.0)
Ethnicity, n (%)				
White/Caucasian	36 (8.9)	180 (44.6)	112 (27.7)	76 (18.8)
Asian	5 (22.7)	7 (31.8)	8 (36.4)	2 (9.1)
Pacific Islander	2 (12.5)	7 (43.8)	4 (25.0)	3 (18.8)
Spanish/Hispanic/Latino	1 (12.5)	5 (62.5)	1 (12.5)	1 (12.5)
Indigenous	1 (33.3)	2 (66.7)	0	0
Black/African American	1 (9.1)	7 (63.6)	2 (19.2)	1 (9.1)
Other	0	10 (38.5)	10 (38.5)	6 (23.1)
Education status, n (%)				
Primary/Elementary	0	0	0	2 (100.0)
Secondary/High School	3(4.0)	36 (48.0)	24 (32.0)	12 (16.0)
Tertiary/University Undergraduate	24 (10.1)	112 (47.1)	70 (29.4)	32 (13.4)
Tertiary/University Postgraduate	19 (10.9)	70 (40.0)	43(24.6)	43 (24.6)

investigate the generalizability of the findings beyond the cohorts used, which consisted of mostly females from a faith-based organization. It is notable that the prevalence of flourishing observed at baseline in Study 1 (29.8% control, 30.3% intervention) and Study 2 (S = 28.3%, S+ pSMS = 27.3%, S+ VCS = 24.3%, and Combined = 26.6%) were comparable to previous findings on a broader New Zealand population (24%) that also used the Huppert and So conceptual framework (Hone, Jarden, Schofield et al., 2014), suggesting that the cohorts were somewhat representative of the broader population in terms of the proportion of those flourishing. However, the low attrition rates observed in the studies indicates a high level of motivation, which might be related to unique characteristics of the cohorts and that the participants were self-selected. Certainly, further investigations involving different demographics and people groups are needed.

A unique aspect of the present studies was the interdisciplinary nature of the intervention employed, which integrated strategies from both positive psychology and lifestyle medicine. As discussed previously, there have been three PPIs using a multicomponent approach to increase flourishing (Bendtsen et al., 2020; Feicht et al., 2013; Schotanus-Dijkstra et al., 2017). However, none have incorporated lifestyle medicine practices such as nutrition, physical activity, sleep and exposure to natural environments that were incorporated in the present studies. In his seminal paper, Walsh (2011) identified eight lifestyle-based contributors to mental health and wellbeing: exercise; nutrition and diet; nature; relationships; recreation and enjoyable activities; relaxation and stress management; religious and spiritual involvement, and contribution and service. To optimise the effectiveness of mental wellbeing interventions it is prudent that an interdisciplinary approach, incorporating several or all of these contributors, be considered and adopted. To date, most wellbeing interventions operate from a lifestyle medicine or psychological framework. However, there is a need for a more collaborative approach as greater benefits may be realized.

In a recent article, VanderWeele et al. (2020) surmised the recommendations of an interdisciplinary workshop on the measurements of wellbeing and identified that existing flourishing scales tended to include only psychological factors. Indeed, this is the case in the scales utilised and appraised by Hone, Jarden, Schofield et al. (2014). The authors asserted that there is no model that fits all scenarios, and hence the measurement of flourishing will depend on the purpose and context of the wellbeing measurement. Further, the inclusion of lifestyle factors and markers of physical health should be considered in flourishing scales moving forward.

Interest in online mental health and wellbeing interventions has increased over the past decade due to technological advances (Deady et al., 2017) and they may present a scalable, low-cost solution to alleviating the growing mental health burden. While online interventions have many benefits and can overcome barriers of face-to-face interventions, such as anonymity and lack of motivation to attend a venue (Richards et al., 2015), it is important to consider design aspects when developing these interventions to optimise engagement and outcomes. The intervention used in the present studies adopted elements that have been shown to increase online engagement such as gamification (leaderboards, badges and points) (Looyestyn et al., 2017) and access to an e-learning management system (including lessons, videos, and an e-workbook), and these may have contributed to the impressive outcomes observed in the present studies. Certainly, further research is required to better inform the design of online interdisciplinary mental

wellbeing interventions to optimise engagement. Counterintuitively, Study 2 found that the provision of videoconferencing might not be well received by many individuals participating in an online intervention. Further elucidating the factors that may or may not contribute to participants' engagement in an online mental wellbeing intervention, and the associated effectiveness of the intervention, is important moving forward.

Strengths

The present studies make a number of contributions to the literature on flourishing. To our knowledge, they are the first to demonstrate that an online multicomponent intervention that integrates strategies from the fields of positive psychology and lifestyle medicine can significantly increase the number of participants flourishing within an experimental cohort, using the most stringent criteria for flourishing (Hone, Jarden, Schofield et al., 2014). Hence, online mental wellbeing interventions might provide a viable strategy for reducing the prevalence of mental illnesses. Secondly, both studies used a high-powered design and involved a larger sample size than most of the previous interventions focused on flourishing (Feicht et al., 2013; Schotanus-Dijkstra et al., 2017), as well as those reviewed in a recent meta-analyses of PPIs (White et al., 2019). Thirdly, the broad distribution in the participants' age, ranging from 18 to 88 years old, across a geographically diverse area can be considered a strength of the study. Finally, the study had a relatively low attrition rate (Study 1 = 20.4% at 12-weeks post-intervention, Study 2 = 30.1% at post-intervention) compared to 45% typically observed in PPI's (Gander et al., 2016), which may be attributed to the pedagogical framework used in the intervention and the engaging interactive components included.

Limitations

There are a number of limitations to the study that mostly relate to the generalizability of the findings. Firstly, the participants were self-selected and hence may have had greater motivation and higher readiness for change than the general population. Secondly, unique characteristics of the study cohorts (i.e. female biased and faith-based) may diminish the transferability of the outcomes to different populations. Finally, the intervention targeted a subclinical population and therefore does not inform the effectiveness of the intervention on a clinical cohort. However, the results of the present studies broadly align with the findings of Schotanus-Dijkstra et al. (2017) who did target a clinical population, but this is an important area for future research.

Practical implications and future research

The results from the present studies have important implications for the literature on flourishing as well as mental health practice as they contribute to the limited knowledge of how to increase flourishing within the general population. Additionally, Study 1 was the first RCT to combine evidence-based positive psychology and lifestyle medicine strategies in an interdisciplinary design to improve flourishing scores. The present studies suggest that online interventions may be a viable low-cost and scalable option for mental health promotion.

Future research is needed in four key areas. Firstly, further investigation is needed to determine the effectiveness of online multicomponent interventions incorporating strategies from positive psychology and lifestyle medicine, such as that used in this study, on clinical populations. Secondly, additional research is warranted to understand the gender responsiveness to mental wellbeing interventions. Thirdly, the influence of various factors such as human support and gamification on the up-take and responsiveness to online mental wellbeing interventions warrants further exploration, as well as the relative impact these have on the outcomes of the intervention. Lastly, healthy lifestyle behaviours are not commonly emphasised in the promotion of mental wellbeing, however, future studies could investigate the contribution that changes in physical health, mediated through lifestyle behavioural change, makes to the measurement of flourishing.

Conclusion

The two studies reported in this article demonstrate that online interdisciplinary mental wellbeing interventions that combine strategies from positive psychology and lifestyle medicine, can increase flourishing. The findings of these studies are relevant to governments, policy makers, researchers, and clinicians as it suggests that an interdisciplinary online multicomponent approach using gamification, e-learning management system and social forum can significantly improve flourishing and potentially provide a low-cost scalable solution at a population-level.

Abbreviations

ANOVA: Analysis of Variance
DSM-IV: Diagnostic and Statistical Disorders
ICD-10: International Classification of Diseases
MHC-SF: Mental Health Continuum Short Form
PPI: Positive Psychology Intervention
RCT: Randomized Controlled Trial

Diener, E., Wirtz, D., Tov, W., Kim-Prieto, C., Choi, D. W., Oishi, S., & Biswas-Diener, R. (2010). New well-being measures: Short scales to assess flourishing and positive and negative feelings. *Social Indicators Research*, *97*(2), 143–156. https://doi.org/10.1007/s11205-009-9493-y

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S: Standard group
S+VCS: Standard plus videoconferencing support
S+pSMS: Standard plus personalised short message service group
LETS: Learn, Experience, Think and Share

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Author's contribution

GP, DM, & JM designed the study. GP & DM developed the intervention. GP drafted the manuscript and coordinated the trial. GP & MR collected the data. GP analyzed the data. DM & JM provided supervision in the coordination of the trial and analyzing the data. DM & JM were major contributors in providing supervision in writing the manuscript. DM, JM, JH, MR provided critical revision of the article. All authors read and approved the final manuscript.

Consent for publication

Not applicable.

Disclosure statement

The authors declare that they have no competing interests to declare. GP is Executive Director of ELIA Wellness that promotes a version of the intervention used in this study through the faith-based organisation's network and community.

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Data availability

The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

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CHAPTER SIX: PUBLICATION 4 - THE INFLUENCE OF GENDER AND AGE ON THE OUTCOMES OF AND ADHERENCE TO AN INTERDISCIPLINARY DIGITAL MENTAL HEALTH PROMOTION INTERVENTION IN AN AUSTRALASIAN NONCLINICAL SETTING: A COHORT STUDY

6.1 Chapter Overview

This chapter addresses the second research question of the thesis: "What is the influence of gender and age on the outcomes of and adherence to a digital multicomponent interdisciplinary mental wellbeing intervention amongst an Australasian nonclinical cohort?" The chapter is presented as a manuscript titled, "The influence of gender and age on the outcomes of and adherence to an interdisciplinary digital mental health promotion intervention in an Australasian nonclinical setting: A cohort study" (refer to section 6.2), published in the *Journal of Medical Internet Research,* a Q1 ranked journal with an impact factor of 4.39. The objective of this study was to determine the influence of gender and age on the outcomes of and adherence to a ten-week digital interdisciplinary mental health promotion intervention that integrates strategies from positive psychology and lifestyle medicine and utilises persuasive systems design (PSD) principles.

Digital mental health promotion interventions can be effective tools for enhancing the mental health and wellbeing of nonclinical cohorts. This study adds to the body of knowledge as it is the first to investigate the influence of gender and age

on the responsiveness to a digital interdisciplinary mental health promotion intervention in a nonclinical setting. The results of the study are further discussed in this chapter.

6.2 Co-Author Statement

I attest that Research Higher Degree candidate Geraldine Lynn Chang Przybylko contributed to the paper/publication entitled: **The Influence of Gender and Age on the outcomes of and adherence to an Interdisciplinary Digital Mental Health Promotion Intervention in an Australasian Nonclinical Setting: A Cohort Study.**

By:

- Contributing to the conception and design of the study and intervention.
- Contributing to the development of the digital platform and eLMS.
- Leading the randomized controlled trial.
- Contributing to the measures used.
- Leading the data analysis and interpretation of the data.
- Leading the writing of the manuscript.
- Submitting the manuscript for review.
- Addressing reviewers' comments.

Signature of Candidate:



Name of Candidate: Geraldine Lynn Chang Przybylko

Date: 16 December 2021

Signature of Principal Supervisor:



Name of Principal Supervisor: Associate Professor Darren Morton

Date: 16 December 2021

Original Paper

The Influence of Gender and Age on the Outcomes of and Adherence to a Digital Interdisciplinary Mental Health Promotion Intervention in an Australasian Nonclinical Setting: Cohort Study

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Abstract

Background: The global prevalence of mental health disorders is at a crisis point, particularly in the wake of COVID-19, prompting calls for the development of digital interdisciplinary mental health promotion interventions (MHPIs) for nonclinical cohorts. However, the influence of gender and age on the outcomes of and adherence to MHPIs is not well understood.

Objective: The aim of this study was to determine the influence of gender and age on the outcomes of and adherence to a 10-week digital interdisciplinary MHPI that integrates strategies from positive psychology and lifestyle medicine and utilizes persuasive systems design (PSD) principles in a nonclinical setting.

Methods: This study involved 488 participants who completed the digital interdisciplinary MHPI. Participants completed a pre and postintervention questionnaire that used: (1) the "mental health" and "vitality" subscales from the Short Form 36 (SF-36) Health Survey; (2) the Depression, Anxiety and Stress Scale (DASS-21); and (3) Satisfaction With Life Scale (SWL). Adherence to the digital interdisciplinary MHPI was measured by the number of educational videos the participants viewed and the extent to which they engaged in experiential challenge activities offered as part of the program.

Results: On average, the participants (N=488; mean age 47.1 years, SD 14.1; 77.5% women) demonstrated statistically significant improvements in all mental health and well-being outcome measures, and a significant gender and age interaction was observed. Women tended to experience greater improvements than men in the mental health and well-being measures, and older men experienced greater improvements than younger men in the mental health and vitality subscales. Multiple analysis of variance results of the adherence measures indicated a significant difference for age but not gender. No statistically significant interaction between gender and age was observed for adherence measures.

Conclusions: Digital interdisciplinary MHPIs that utilize PSD principles can improve the mental health and well-being of nonclinical cohorts, regardless of gender or age. Hence, there may be a benefit in utilizing PSD principles to develop universal MHPIs such as that employed in this study, which can be used across gender and age groups. Future research should examine which PSD principles optimize universal digital interdisciplinary MHPIs.

Trial Registration: Australian New Zealand Clinical Trials Registry ACTRN12619000993190; http://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=377889 and Australian New Zealand Clinical Trials Registry ACTRN12619001009101; http://www.anzctr.org.au/ACTRN12619001009101.aspx

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KEYWORDS

age; gender; adherence; digital health; interdisciplinary; mental health; promotion; intervention; lifestyle medicine; positive psychology; multicomponent; lifestyle; outcome; cohort study

Introduction

Background

The global prevalence of depression and anxiety prior to the COVID-19 pandemic was estimated at 586 million people [1]. In Australia, 1 in 5 individuals reported a mental or behavioral condition in 2017-2018 [2], with the prevalence being higher among women (22%) than men (18%) and in the 15-24 years age range (26%). Recent population-based surveys indicate that mental health has further deteriorated since COVID-19 [3,4]. In response, there is a need for accessible and scalable mental health and well-being interventions that not only support individuals suffering from mental distress but that also promote the mental health and psychological resilience of nonclinical cohorts [5-7].

Emerging literature has shown that digital mental health promotion interventions (MHPIs) can improve mental health [8,9] and prevent the onset of mental health disorders [10,11]. Research suggests several advantages of digital MHPIs, including the potential to target individuals before they reach a diagnostic threshold [12], being more economical than face-to-face interventions [13], increased acceptability, and having the potential to disseminate on a wider scale [10]. The use of mobile apps and texting for self-guided care may help to improve physical health while reducing anxiety, stress, and depression [14]. Conversely, the literature also identifies several disadvantages of digital MHPIs, including the resources spent on individuals who do not develop adverse outcomes [13], higher dropout rates [15], and the smaller effect sizes compared with those of clinical interventions [10]. Digital interventions targeting clinical cohorts have been found to be beneficial for the treatment of acute depression, and a meta-analysis concluded that gender and age are not moderating factors of the outcomes [16]. Digital MHPIs have also been shown to be effective tools for enhancing the mental health and well-being of nonclinical cohorts, although little is known about the influence of gender and age on the responsiveness to these interventions in this context [17].

Influence of Gender on MHPIs

There is a paucity of research examining the influence of gender on the outcomes of and adherence to digital interdisciplinary MHPIs when delivered in nonclinical settings. It is well established that men and women experience mental health issues and distress differently. For example, women are more likely to talk to someone, seek professional health care, protect themselves and their offspring, and continue engaging with their social networks [18]. In contrast, men typically build up their emotions over time, which may develop into adverse behaviors such as anger, violence, and hostility that in turn can compound the mental health issue [19].

Studies also show that men are typically more hesitant than women to seek help or treatment for mental health concerns [20]. Notably, women tend to rate MHPIs as more important than men [21] and self-selected mental health interventions typically have a bias toward female participation [15,22-27]. Numerous strategies such as role models, incorporating problem-solving tasks, and portraying positive male traits have been proposed for improving the outcomes of MHPIs when targeting men [28]. The use of MHPIs in male-dominated industries has been reported to improve mental health literacy and knowledge, increase social support, provide access to treatment, and reduce absenteeism [29].

Further, men may require more encouragement than women to engage in, and adhere to, digital interventions, thus requiring better implementation of programs [30]. Promoting enjoyable activities and creating sustainable cultures that facilitate group comradery are also deemed positive strategies for MHPIs [31] as they encourage trust, reduce stigma, and normalize engagement [32]. Interestingly, an Australian Football League themed app using young male role models, psychoeducation, social connection, and applied games to target men reported 60-day improvements in flourishing and a sense of connection to the intervention community regardless of gender [33]. However, there is limited understanding of the influence of gender on the outcomes of and adherence to digital interdisciplinary MHPIs, which was the main objective of this study.

Influence of Age on MHPIs

The literature is also sparse regarding the influence of age on the outcomes of and adherence to digital interdisciplinary MHPIs in a nonclinical setting. Although young adults are commonly termed "digital natives" [34,35], this does not necessarily equate to interest and engagement with digital MHPIs and services. For example, a large web-based survey on university students revealed that those with psychological distress (26.14%, 1577/6034) reported a low utilization rate of 2.98% (47/1577) for online mental health services, despite 59.99% (946/1577) reporting a willingness to use the services [36]. Regardless, digital mental health interventions have been found to be effective for improving depression, anxiety, and psychological well-being among college students. However, further investigations are required to understand the key factors to optimize such interventions [37].

Little is known on the efficacy of digital MHPIs for older adults in a nonclinical setting. New technologies are promising tools to alleviate loneliness and social isolation [38]. Novel interventions such as virtual reality interventions have been found to improve psychological well-being in older adults in a nonclinical setting, and have the potential to foster environmental mastery, personal growth, and autonomy [39]. In addition, animatronic pets provide a promising opportunity to support healthy older adults in reducing loneliness, increasing quality of life, and improving psychological well-being [40].

A key challenge is the ability to develop user-driven, action-based mental health interventions for younger men that

shift behavior, stigma, and leverage the influence of their peers [41]. Social influences are more prominent in the adoption of mobile health services among young to middle-aged adults compared with older adults [42].

A key factor affecting adherence to digital mental health interventions among older adults is whether their expectations of the potential outcomes are realistic [43]. Managing expectations reduces the likelihood of older adults deeming the intervention to be a "waste of time" and hence increases adherence, which contributes to improved outcomes of the intervention. Interestingly, mental health interventions are rarely designed with the novice digital user in mind or in accordance with the digital guidelines of older participants [44]. In fact, an "innovativeness-needs paradox" seems to exist where the people in most need of the digital MHPI are those at the highest risk of having the least access, training, skills, adoption rates, and adherence to the intervention, therefore increasing health care inequalities [45]. Digital MHPIs have the potential to reduce the gap in health care provision for older adults as many patients have long wait times for mental health providers, need help in the prevention and management of a multitude of chronic diseases, and have limited access to mental health providers as they are unable to travel long distances [45].

Persuasive Systems Design

It is well recognized that adherence is problematic in digital MHPIs. Two decades ago, Fogg [46] coined the term "interactive technology" as the design to leverage social influence and motivate and persuade humans to change their attitudes and behaviors. Interactive technology involves features that reward people with positive feedback, model a target behavior or attitude, and provide social support. Oinas-Kukkonen and Harjumaa [47] progressed the work of Fogg by proposing persuasive systems that incorporate information software or systems that are devised to reinforce, change, or formulate attitudes and/or behaviors. In addition, the persuasive systems design (PSD) model was developed specifically to optimize engagement with digital interventions [47]. The PSD model incorporates four categories of persuasion principles: Primary Task Support, Dialogue Support, System Credibility Support, and Social Support. Each category includes 7 distinct persuasion principles, including reduction, tunneling, tailoring, self-monitoring, rewards, reminders, liking, trustworthiness, expertise, surface credibility, social learning, social comparison, and normative influence and completion. Studies have also demonstrated that PSD principles can improve the outcomes of and adherence to digitally delivered interventions [48-52].

Game-based digital mental health interventions were particularly found to increase the participants' engagement and adherence over the long term [53]. Although gaming is typically used by the younger male demographics, gender and age were not associated with frequency of play [53]. In contrast, a systematic review reported no evidence that the use of gamification was associated with increased adherence to the protocol of the program [54]. However, this may be due to most studies utilizing only one feature of gamification (eg, goal-setting, progress, feedback reward, or story/theme).

Common reasons reported for nonadherence include lack of time, disinterest in the intervention, treatment no longer needed, hardware or technical issues, perceived ineffectiveness of the intervention, life events, chose not to proceed as participants felt better after undertaking a few modules, discontent with the group assignment, holiday, work commitments, poor health, and no longer wished to participate [52].

Study Objectives

Mental health promotion is crucial for improving population-level mental health. Despite the emerging literature supporting the effectiveness of digital MHPIs [23,25], there is a paucity of research investigating the influence of gender and age in nonclinical cohorts. In this study, we aimed to investigate the influence of gender and age on the outcomes of and adherence to a digital interdisciplinary MHPI in a nonclinical cohort.

Methods

Study Design

We previously reported that a randomized controlled trial (RCT) using an MHPI, referred to as the "Live More Project" or "The Lift Project," showed significant improvements (P<.001) in all outcome measures for an intervention group, whereas no changes were observed in the control group regardless of gender and age [25]. The focus of this study was to examine the influence of gender and age on the outcomes of and adherence to a digital MHPI among a larger cohort.

Study Participants

This study combined the data of two cohorts from two independent studies that utilized the same intervention in an Australasian nonclinical setting (see Table 1), creating a total study population of 488 participants. The participants were recruited voluntarily through a faith-based organization. The study was advertised as an "emotional wellness" program through the faith-based organization's internal communications channels, including bulletins and magazines.

Cohort 1 was the treatment arm (n=168) from an unblinded RCT. The Avondale University Human Research Ethics Committee approved all procedures involving human subjects for the RCT (project number 2017:13). The trial protocol was registered at the Australian New Zealand Clinical Trials Registry (ACTRN12619000993190). For more information about the study design and intervention, refer to Przybylko et al [25].

Table 1. Overview of weekly topics and challenges for the intervention.

Week	Topic	Daily challenge	Weekly challenge
1	Speak positively	Offer a genuine compliment	Memorize an inspirational text or saying
2	Move dynamically	Spend 30 minutes of moderate exercise or 10,000 steps	20 minutes of guided resistance exercises
3	Immerse in an uplifting natural environment	Spend 30 minutes in an uplifting natural environment	Experience a sunrise
4	Immerse in a positive social environment	Do something intentional to show you care	Forgive someone who has hurt you
5	Look to the positive	Spend 15 minutes to reflect on three things that went well	Write a letter of gratitude to someone and share it with them
6	Eat nutritiously	Eat eight servings of plant-based food	Prepare a high-fiber, plant-based meal with one or more friends
7	Rest: sleep	Spend 8 hours in bed without a device	Spend an evening by firelight
8	Rest from stress	Spend 15 minutes in a quiet place, relaxing, and being mindful of surroundings	Take a day off work and a digital Sabbath (going "offline" for 24 hours to recharge)
9	Serving others	Perform a random act of kindness	Use signature strength to perform an act of service
10	What does it take to flourish?	Continue challenges found to be helpful	Continue challenges found to be helpful

Cohort 2 involved a three-arm (n=320) randomized comparative study that examined the influence of different modes of human support on the intervention. The Avondale University Human Research Ethics Committee approved the conduct of the study (project number 2018:09) and the trial was registered at the Australian New Zealand Clinical Trials Registry (ACTRN12619001009101); refer to Renfrew et al [23] for a detailed explanation of the study. The study indicated that the intervention improved the mean scores for all mental health metrics, regardless of the addition of human support. Further, the mode of human support offered in addition to the intervention had no influence on the outcomes of the intervention [55]. Hence, as the mental health outcomes were similar for all arms in the study, all participants were pooled to form Cohort 2.

Intervention

Both cohorts participated in an intervention referred to as the "The Live More Project" or "The Lift Project" [56,57]. The 10-week digital interdisciplinary MHPI used evidenced-based strategies from the disciplines of lifestyle medicine and positive psychology for improving mental health and well-being, as detailed in Table 1.

The intervention was based on Ajzen's [58] Theory of Planned Behavior and employed an experiential pedagogical framework of "Learn, Experience, Think, Share," which was accessed through an electronic learning management system. Weekly 30-minute video sessions were aimed to educate and empower participants to make positive behavior changes. Daily and weekly experiential challenges provided practical application. The following PSD principles were used in the intervention to improve adherence: gamification to increase challenge points and badges by participating in the challenges; a social forum to comment, post photos, and encourage interaction between the participants to provide accountability; and provision of reminders to watch the videos and log challenges. Refer to Multimedia Appendix 1 for website and app screenshots. An electronic book and electronic workbook were also provided to expand the participants' knowledge and to journal their experience during the intervention.

Measurements

Mental Health Outcomes

All participants in each cohort completed a self-reported questionnaire at preintervention (Week 1) and postintervention (Week 12). The questionnaire included sociodemographic characteristics such as age, gender, ethnicity, level of education, country of birth, and three validated instruments. An outline of the instruments used in the questionnaire are detailed below.

Short Form 36-Item Health Survey

The Short Form 36-item (SF-36) Health Survey is a self-reported health questionnaire appropriate for use among a general population [59]. This survey consists of 36 items that assess eight scales: general health, mental health, vitality, social function, physical function, role limitations due to physical health, role limitations due to emotional problems, and bodily pain. These subscales can be used separately; the two subscales measuring positive affect (ie, "mental health" and "vitality") [60] were used in this study. The "mental health" subscale assesses emotional well-being (5 items) and the "vitality" subscale assesses energy and fatigue (4 items) [61]. Both subscales generate a score between 0 and 100, with a higher score representing a higher level of mental health and vitality. Although exact cut-off scores have not been established for the two subscales, studies have indicated that a mental health score less than 56 is indicative of major depression [62] and a score less than 45 on the vitality subscale was classified as fatigued [63]. This study observed a Cronbach α of .86 for mental health and .88 for vitality, indicating good internal consistency.

Depression, Anxiety and Stress Scale

The 21-item Depression, Anxiety and Stress Scale (DASS-21) is a well-used assessment to measure the negative affect of

emotional states—depression, anxiety, and stress (7 items per subscale)—on both clinical and nonclinical populations [64]. The questionnaire generates a score between 0 and 21, with a higher score representing increasing levels of mental distress [65]. Individuals were considered "symptomatic" if they reached the threshold of greater than 4 for depression, greater than 3 for anxiety, and greater than 7 for stress. This study observed good internal consistency with a Cronbach α of .87 for depression, .70 for anxiety, .83 for stress, and .90 for the overall score for the 3 domains.

Satisfaction With Life Scale

The 5-item Satisfaction With Life Scale (SWLS) assesses global life satisfaction [66] and is used in numerous settings [67]. The questionnaire generates a score between 5 and 35, with a higher score representing increasing levels of life satisfaction. A score of 19 indicates an average life satisfaction. This study observed a Cronbach α of .88, indicating good internal consistency.

Measurements

Adherence

This study used the following adherence measures for the intervention that have been established previously [55].

Videos Viewed

Each week the participants were introduced to a weekly topic (see Table 1) that was presented using an educational video. The total number of weekly videos viewed was used to measure primary adherence and was measured out of a total of 10. A video was marked as "viewed" when 80% or more of the presentation had been played.

Experiential Challenge Activities

Participants were encouraged to put what they had learned each week into action by participating in experiential challenge activities. Adherence to challenges was calculated through the total weekly challenge score and the total number of weeks that the participants had completed the challenge. The daily challenge was awarded 10 points with a maximum of 70 points per week, and weekly challenges were allocated 30 points. Hence, participants had the opportunity to achieve 100 points per week, for a total of 1000 points at the end of the 10-week intervention.

Statistical Analysis

The data were analyzed using SPSS Statistics (version 25). The χ^2 test was used to examine the difference in the baseline characteristics. Descriptive statistics, involving frequencies, means, SDs, and 95% CIs, are used to present the mental health and well-being outcomes, as well as the adherence measures.

Multivariate analysis of variance (MANOVA) was used for comparisons as there were several categorical independent variables and continuous dependent variables. Data were prescreened and cleaned to ensure the robustness of the MANOVA, which was also aided by the large sample size. MANOVA, using the general linear modeling (GLM) function in SPSS, was used to test for time effects (pre to postintervention), gender and age effects, and their interactions. When significant, Bonferroni post hoc analyses were utilized to determine significant changes from pre to postintervention to compare gender and age differences, and to explore significant interactions. Pearson correlation analysis was used to evaluate the relationship between the mental health or well-being outcomes and adherence measures. Analysis of variance was used to compare differences in the outcomes and adherence measures between the age categories. Paired and independent sample *t* tests were used to explore gender differences in the mental health and well-being outcome measures. Missing data for age (n=4) were replaced with the mean age and missing data (n=14) for mental health outcomes were removed from the analysis.

Results

Participant Baseline Characteristics

A total of 488 participants completed the preintervention questionnaire (week 1) and postintervention questionnaire (week 12).

Cohorts 1 and 2 differed with regard to age (mean 49.3 years, SD 14.1 and 45.9 years, SD 14.0, respectively; P=.01), gender balance (women: 69.1%, 116/168 and 81.9%, 262/320, respectively; P=.002), and ethnic representation (White: 89.3%, 150/168 and 81.8%, 262/320, respectively; P=.05). Although a statistically significant difference was observed between the cohorts in these demographic variables, it is notable that in both cohorts there was a bias toward White women in the 35-54–year age category. No statistically significant difference was found between Cohorts 1 and 2 in the highest education obtained (tertiary education: 89.3% and 81.8%, respectively; P=.52).

There was a difference between Cohorts 1 and 2 in all baseline mental health measures except life satisfaction; however, the mean scores for both cohorts were in the nonclinical range for all measures. The baseline mental health measures for the two cohorts were as follows: mental health (75.5 and 66.2, P<.001), vitality (52.5 and 60.2, P<.001), depression (2.5 and 3.5, P=.001), anxiety (1.8 and 2.3, P=.02), stress (4.5 and 5.7, P=.001), and life satisfaction (23.9 and 23.1, P=.08). Combining these two cohorts increased the heterogeneity of the total sample, which in turn increased the generalizability of the study.

The combined cohort (N=488), which formed the population for this study, had a mean age of 47.1 years (SD 14.1) and were mostly women (77.9%, 380/488). The ethnicity of the population was largely White (83.4%, 407/488), followed by Other (5.3%, 26/488), Asian (4.5%, 22/488), Maori/Pacific Islander (3.3%, 16/488), Black/African American (2.3%, 11/488), Spanish/Hispanic/Latino (0.6%, 3/488), and Indigenous (0.6%, 3/488). The highest level of education achieved was tertiary education (84.4%, 413/488), followed by secondary/high school (15.2%, 75/488) and primary/elementary (0.4%, 2/488).

In the absence of standardized or universally accepted age categorization, the authors determined three age categories based on the age grouping system of the World Health Organization [68]: 18-34 years (younger adults: 21.7%, 106/488), 34-54 years (middle-aged adults: 47.1%, 230/488), and ≥55 years (older adults: 31.1%, 152/488). However, the World Health

Organization acknowledges that there is no conceptual justification for selecting one age standard over another [68].

There was no statistically significant difference between men and women (χ^2_{487}=1.42, *P*=.70) or the age categories (F_{487}=0.30, *P*=.69) with regard to ethnic representation (F_{487}=0.03, *P*=.98) or highest level of education obtained (F_{487}=0.23, *P*=.59). However, statistically significant differences were found between genders and between age categories in some of the preintervention psychometric measures (see Table 2). At preintervention, women reported poorer mental health metrics than men for mental health (t_{487}=4.85, *P*<.001), vitality (t_{487}=3.94, *P*<.001), depression (t_{487}=–3.13, *P*=.002), anxiety (t_{487}=–3.05, *P*=.002), and stress (t_{487}=–4.14, *P*<.001), but not life satisfaction (t_{487}=1.09, *P*=.29). However, the mean scores were found to be in the nonclinical range. The ≥55 years age category had a significantly better score than the 18-34 (*P*<.001) and 34-54 (*P*=.002) age categories for mental health; the 18-34 (*P*<.001) and 34-54 (*P*<.001) categories for vitality; the 18-34 category for depression (*P*<.001) and anxiety (*P*=.002); and the 18-34 (*P*<.001) and 34-54 (*P*<.001) categories for stress. The 35-54 age category had a significantly higher score than the 18-34 age category for depression (*P*=.03) and anxiety (*P*=.03), but not for stress (*P*=.97).

Table 2. Pre to postintervention changes in each of the outcome measures defined by the gender and age categories.

Outcome measure	Preintervention (week 1), mean (SD)	Postintervention (week 12), mean (SD)	Difference, mean (%)	*t* test (*df*)	95% CI	*P* value	Effect size (*Cohen d*)
Mental health							
Overall	69.4 (16.4)	77.9 (14.9)	8.5 (12)	–13.306 (487)	–9.72 to –7.22	<.001	0.54
Gender							
Men	76.0 (14.4)	81.3 (16.2)	5.3 (7)	–3.227 (107)	–8.59 to –2.05	.002	0.35
Women	67.5[a] (16.5)	76.9 (14.4)	9.4 (14)[a]	–14.197 (379)	–10.69 to –8.09	<.001	0.61
Age category (years)							
18-34	64.1 (16.6)	71.3 (17.8)	7.2 (11)	–1.304 (105)	–10.66 to –3.83	<.001	0.42
35-54	68.5 (15.3)	77.0 (14.1)	8.4 (12)[b]	–9.695 (229)	–10.13 to –6.71	<.001	0.57
55+	74.3[b,c] (16.7)	83.7 (11.7)	9.5 (13)[b]	–9.182 (151)	–11.50 to –7.43	<.001	0.67
Vitality							
Overall	57.6 (18.2)	86.2 (17.6)	10.5 (18)	–14.018 (487)	–12.01 to –9.06	<.001	0.59
Gender							
Men	63.5 (16.7)	69.9 (19.9)	6.4 (10)	–3.416 (107)	–10.06 to –2.67	<.001	0.35
Women	55.9[a] (18.3)	67.7 (16.8)	11.8 (21)[a]	–14.772 (379)	–13.31 to –10.19	<.001	0.67
Age category (years)							
18-34	53.9 (15.7)	63.0 (19.0)	9.1 (17)	–4.737 (105)	–12.96 to –5.31	<.001	0.53
35-54	55.6 (18.7)	66.6 (17.3)	11.1 (20)[b]	–10.647 (229)	–13.14 to –9.04	<.001	0.62
55+	63.2[b,c] (17.8)	73.9 (15.4)	10.7 (17)	–8.475 (151)	–13.21 to –8.21	<.001	0.64
Depression							
Overall	3.2 (3.3)	1.9 (2.6)	–1.3 (–39)	10.575 (487)	1.02 to 1.49	<.001	0.43
Gender							
Men	2.3 (3.0)	1.5 (2.7)	–0.8 (–34)	3.464 (107)	0.34 to 1.26	.001	0.28
Women	3.4[a] (3.3)	2.0 (2.6)	–1.4 (–40)[a]	10.121 (379)	1.12 to 1.66	<.001	0.47
Age category (years)							
18-34	4.1 (3.5)	2.6 (3.3)	–1.6 (–38)	5.675 (105)	1.03 to 2.14	<.001	0.47
35-54	3.1 (3.1)	2.0 (2.6)	–1.1 (–35)	6.562 (229)	0.76 to 1.41	<.001	0.38
55+	2.7[b] (3.2)	1.4 (1.9)	–1.3 (–49)	6.095 (151)	0.88 to 1.72	<.001	0.50
Anxiety							
Overall	2.1 (2.3)	1.3 (1.8)	–0.8 (–38)	9.242 (487)	0.64 to 0.98	<.001	0.39
Gender							
Men	1.5 (1.9)	0.9 (1.7)	–0.6 (–42)	3.896 (107)	0.32 to 0.97	<.001	0.36
Women	2.3[a] (2.4)	1.5 (1.8)	–0.9 (–35)	8.382 (379)	0.65 to 1.05	<.001	0.40
Age category (years)							
18-34	2.8 (2.7)	1.6 (2.1)	–1.2 (–42)	4.886 (105)	0.70 to 1.67	<.001	0.49
35-54	2.1[b] (2.2)	1.3 (1.9)	–0.7 (–35)	6.574 (229)	0.51 to 0.94	<.001	0.35
55+	1.8[b] (2.1)	1.1 (1.4)	–0.7 (–39)	4.516 (151)	0.38 to 0.98	<.001	0.39
Stress							
Overall	5.3 (3.4)	3.8 (3.1)	–1.5 (–28)	11.313 (487)	1.24 to 1.76	<.001	0.47
Gender							

Outcome measure	Preintervention (week 1), mean (SD)	Postintervention (week 12), mean (SD)	Difference, mean (%)	*t* test (*df*)	95% CI	*P* value	Effect size (*Cohen d*)
Men	4.2 (2.8)	3.0 (3.2)	–1.2 (–28)	4.270 (107)	0.63 to 1.73	<.001	0.39
Women	5.7[a] (3.4)	4.1 (3.0)	–1.6 (–28)	10.554 (379)	1.30 to 1.89	<.001	0.50
Age category (years)							
18-34	6.4 (3.6)	4.9 (3.8)	–1.5 (–24)	4.812 (105)	0.90 to 2.17	<.001	0.42
35-54	5.5 (3.1)	4.1 (2.9)	–1.4 (–26)	7.909 (229)	1.08 to 1.79	<.001	0.48
55+	4.3[b,c] (3.4)	2.7 (2.3)	–1.6 (–37)	6.477 (151)	1.09 to 2.04	<.001	0.55
Life satisfaction							
Overall	23.4 (6.8)	25.8 (6.4)	2.4 (10)	–11.991 (487)	–2.85 to –2.04	<.001	0.37
Gender							
Men	24.0 (6.5)	26.2 (6.0)	2.2 (9)	–5.694 (107)	–3.02 to –1.46	<.001	0.35
Women	23.2 (6.8)	25.7 (6.5)	2.5 (11)	–10.562 (379)	–2.97 to –2.04	<.001	0.38
Age category (years)							
18-34	23.3 (7.2)	25.7 (6.7)	2.4 (10)	–5.114 (105)	–3.33 to –1.47	<.001	0.35
35-54	22.9 (7.0)	25.7 (6.6)	2.8 (12)	–9.206 (229)	–3.38 to –2.19	<.001	0.41
55+	24.0 (6.2)	26.0 (5.9)	2.0 (8)	–5.864 (151)	–2.63 to –1.30	<.001	0.33

[a]Significant gender difference.

[b]Significant difference from the 18-34 age category.

[c]Significant difference from the 35-54 age category.

Mental Health Outcomes

Overall Intervention Effect

MANOVA results of the changes in the mental health and well-being outcomes from pre to postintervention indicated a statistically significant difference for gender (F_{487}=2.81, P=.01, Wilks Λ=0.97, η^2=0.03) and age (F_{487}=2.46, P=.004; Wilks Λ=0.94, η^2=0.03). A significant gender and age interaction (F_{487}=2.14, P=.01; Wilks Λ=0.95, η^2=0.03) was observed, with younger females experiencing greater improvements than the older females in 5 out of 6 outcome measures. This trend was not evident among the males. Table 2 shows the changes in mental health and well-being outcomes from pre to postintervention, reported for gender and the age group categories. Statistically significant improvements in all mental health and well-being measures were observed.

Influence of Gender on Mental Health Outcomes

Although women reported lower levels of mental health (ie, higher emotional distress) at preintervention, they experienced a higher mean change than men in mental health (F_{487}=13.16, P<.001), vitality (F_{487}=11.90, P=.001), and depression (F_{487}=3.89, P=.05), as seen in Table 2. No significant differences were observed between men and women with respect to anxiety (F_{487}=0.87, P=.35), stress (F_{487}=0.88, P=.35), or life satisfaction (F_{487}=3.53, P=.06).

Influence of Age on Mental Health Outcomes

Although the ≥55-year age category had higher levels of mental health (ie, lower emotional distress) at preintervention, they experienced a significantly higher mean change in the mental health scale (F_{487}=5.15, P=.006) than the younger age categories. However, there were no statistically significant differences between the age categories for vitality (F_{487}=2.05, P=.13), depression (F_{487}=0.53, P=.58), anxiety (F_{487}=1.53, P=.22), stress (F_{487}=0.32, P=.73), or life satisfaction (F_{487}=2.15, P=.12). The pre to postintervention results indicated that the 18-34–year age category had a significantly lower mean change than the 35-54 (P=.009) and ≥55 (P=.002) age categories for mental health, and the 35-54 age category for vitality (P=.05). Despite the 18-34 age category achieving a higher score (ie, indicating higher emotional distress) at postintervention compared to the 35-54 age category for depression (P=.31), anxiety (P=.14), and stress (P=.54), no statistically significant differences were observed. There were also no statistically significant differences found between the 18-34 and 35-54 age categories for life satisfaction (P=.06), or between the 35-54 and ≥55 age categories for any outcome measures: mental health (P=.37), vitality (P=.80), depression (P=.65), anxiety (P=.67), stress (P=.50), and life satisfaction (P=.16). Every age category for both genders showed a statistically significant improvement (ie, lower emotional distress) in mental health and well-being metrics, except for the 18-34–year age category for mental health (P=.13) and vitality (P=.13), and the men in the ≥55-year age category for stress (P=.09).

Adherence

Overall Intervention Effect

MANOVA results of the adherence measures indicated a statistically significant difference for age (F_{487}=2.20, P=.04;

Wilks Λ=0.97, η^2=0.01), but not gender (F_{487}=1.25, P=.29; Wilks Λ=0.99, η^2=0.01). No statistically significant interaction between gender and age (F_{487}=0.75, P=.61; Wilks Λ=0.99, η^2=0.01) was observed.

Influence of Gender on Adherence

As shown in Table 3, there was no statistically significant gender difference in the number of videos watched (t_{487}=–0.52, P=.61), total challenge points achieved (t_{487}=–1.44, P=.15), or the number of weeks that challenges were engaged with (t_{487}=–1.72, P=.09). Although women recorded higher mean challenge points and a higher percentage watched all 10 videos, there was no significant difference between the genders.

Table 3. Adherence outcomes by gender.

Variable	Men (n=108)	Women (n=380)	Total (N=488)	Between-group difference, *P* value
Number of videos viewed (%)				N/A[a]
10	22	33	31	
8-9	5	3	3	
5-7	52	39	43	
1-4	16	20	19	
0	5	5	5	
Number of videos viewed, mean (SD)	6.4 (2.9)	6.6 (3.2)	6.55 (3.18)	.61
Challenge, mean (SD)				
Challenge points (out of 1000)	355.6 (370.6)	412.2 (361.2)	377.5 (354.0)	.15
Number of weeks challenge scores logged (out of 10)	4.4 (3.72)	5.1 (3.63	4.8 (3.6)	.09

[a]N/A: not applicable.

Influence of Age on Adherence

A statistically significant difference was observed between the age categories in the number of videos watched (F_{487}=5.99, P=.003); however, as shown in Table 4, there was no significant difference in the total challenge points (F_{487}=2.448, P=.09) or total number of weeks that challenges were recorded (F_{487}=2.563, P=.08). The age categories of 35-54 and ≥55 years recorded the same mean number of videos watched, which was higher than that for the 18-34 years age category. Both the mean challenge score and the number of weeks that challenge scores were logged showed improvements with age, although the difference was not statistically significant.

Table 4. Adherence outcomes between age categories.

Variable	18-34 years (n=106)	35-54 years (n=230)	≥55 years (n=152)	Total (N=488)	Between-group difference, *P* value
Number of videos viewed (%)					N/A[a]
10	25	33	31	89	
8-9	1	4	3	8	
5-7	38	42	45	125	
1-4	26	18	18	62	
0	10	3	4	17	
Number of videos viewed, mean (SD)	5.6 (3.51)	6.8 (3.06)	6.8 (2.99)	6.6 (3.17)	.01
Challenge, mean (SD)					
Challenge points (out of 1000)	340.8 (346.3)	398.7 (339.0)	442.9 (372.2)	400.3 (363.7)	.09
Number of weeks challenge scores logged (out of 10)	4.4 (3.64)	5.0 (3.65)	5.4 (3.62)	5.0 (3.65)	.08

[a]N/A: not applicable.

Discussion

Principal Results

The aim of this study was to investigate the influence of gender and age on the outcomes of and adherence to a digital interdisciplinary MHPI in a nonclinical cohort. To the authors' knowledge, this study is the first to investigate the effect of gender and age on the outcomes of a digital interdisciplinary MHPI that employed an array of strategies from the disciplines of lifestyle medicine and positive psychology in a nonclinical Australasian setting. Stratification by gender and age showed significant improvements in all mental health and well-being outcomes. Hence, digital interventions such as those employed in this study are useful across gender and age groups for mental health promotion and building psychological resilience.

A female bias was observed in this study, which is consistent with the literature of positive psychology interventions as mentioned previously. Despite the population scoring in the nonclinical range for mental health and well-being, women reported significantly lower mental health scores (ie, higher emotional distress) than men at baseline. However, the women experienced greater improvements than men in the mental health, vitality, depression, and life satisfaction measures. Notably, the women experienced twice the mean change increase in the mental health and vitality subscales compared with the change reported by men, resulting in similar outcome scores to the men at postintervention. This indicates that those scoring lower in the mental health and well-being outcomes can achieve higher mean changes, presumably as there is greater potential for improvement. This is consistent with the results of our previous study using the same intervention that reported higher levels of change were experienced by those with the lowest mental health score at preintervention [57].

This study observed small to medium effect sizes for gender and age on mental health outcomes of a digital interdisciplinary MHPI, which is consistent with the literature of universal digital mental health interventions [10]. However, Tan et al [69] asserts that the impact of small effect sizes can be large when translated to a population level. Hence, digital interdisciplinary MHPIs provide a potential strategy to deliver low-cost and scalable interventions to build the psychological resilience of an individual to help them cope with the adversities experienced in life [70].

This study showed that those aged ≥55 years achieved better mental health and well-being outcomes than the younger age categories in all mental health metrics from pre to postintervention, except for stress. In addition, older men experienced greater improvements than the younger men in the mental health and vitality subscales of the SF-36. These findings are consistent with a meta-analysis of positive psychology interventions, indicating that mental health benefits increased with age [71]. However, these finding are counterintuitive, as younger adults are more frequent users of the internet than older adults (ie, "digital natives"), which could be hypothesized to influence the outcomes of a digitally delivered program [72-74]. A modulating factor might be the time availability. In a previous qualitative study [75], we reported that "time" was perceived as a major barrier to adherence for many participants, although the older participants expressed that retirement provided them with more time to adhere to the intervention. Notably, outcomes of a digital mental health intervention were shown to be related to higher levels of adherence such as higher levels of time spent on the digital platform, number of sessions completed, percentage of the program viewed, and number of activities compared to the control group [76].

Moreover, this study found no significant differences in any adherence measures across gender and age, except for older adults who watched a significantly higher mean number of videos than younger adults. This is consistent with a meta-analysis showing that age was not a predictor of adherence in 13 out of 18 trials [77]. However, this contrasts with a systematic review that found gender to be a consistent predictor of adherence, with women having a higher probability to complete the intervention compared with men [78]. Nevertheless, the authors acknowledged that higher preintervention scores for depression and low scores in anxiety were also found to predict greater adherence.

Naslund et al [79] suggested that focusing digital technologies on early intervention for younger people is key for advancing global mental health. However, Forsman et al [17] argues that the implementation and innovation of mental health promotion for older adults must not be overlooked. Mental health promotion for older adults is of particular importance for three key reasons: there is a higher mental health burden of disease for older adults, digital mental health solutions can improve the mental health care of older adults, and it is well recognized that the mental health of young individuals is strongly influenced by the well-being of their older caregivers [72].

As this study observed improvements in the mental health outcomes of and adherence to a digital interdisciplinary MHPI regardless of gender and age, the authors challenge the concept of focusing solely on mental health promotion for younger or older adults. Instead, the authors encourage developers to be strategic and design digital interdisciplinary MHPIs for all adults (ie, universal). The intervention used in this study employed strategies to increase engagement and adherence among men (ie, using male role models, portraying positive male traits, promoting enjoyable activities, and facilitating peer involvement), younger adults (ie, action-based intervention and leverage the influence of peers), and older adults (ie, designing the intervention for the novice user and managing expectations of the intervention).

In addition, principles from the established PSD categories were incorporated into the intervention. First, from the Primary Task Support category, "reduction," "tunneling," and "self-monitoring" were used to aid adoption by novice users and older adults, and to increase adherence by encouraging behavioral change through participation in a variety of challenges (ie, enjoyable activities). Second, from the Dialogue Support category, the PSD principles of "rewards," "reminders," and "liking" were incorporated in the MHPI to increase adherence in the form of alerts and personalized reminders [32,49,54]. Third, from the System Credibility Support category, the PSD principles of "trustworthiness," "expertise," and

"real-world feel" were incorporated by using an internationally recognized male role model that provided credibility to the intervention to build trust and to portray positive male traits. Lastly, from the Social Support category, the PSD principles of "social learning," "social comparison," "social facilitation," and "competition" were employed to promote peer involvement through social interaction (ie, encourage participants to write comments and post pictures in relation to the challenges) and increase adherence and accountability through the use of gamification (ie, points, badges, and the leaderboard). The culmination of the design elements [31,43,80,81] incorporated in the intervention resulted in it being effective; however, further research should investigate which elements are most beneficial and for whom.

Strengths and Limitations

The strengths of this study are outlined below. First, this study is strengthened by a large number of participants (N=488) and vast age range (18-88 years old) across geographically diverse areas. The second main strength is the MHPI's novel interdisciplinary nature that utilized multicomponent, evidenced-based strategies from the disciplines of lifestyle medicine and positive psychology. Using multicomponent strategies, rather than employing a single tactic, is also deemed to be more efficacious [56,71,82]. Third, the use of PSD principles in the intervention were both gender-responsive and age-sensitive. Increasing the number of PSD principles does not necessarily lead to better outcomes [52]. Future studies could investigate which PSD principles best optimize universal MHPIs.

There are also several limitations of the study. First, the participants were self-selected and drawn from a faith-based population. Hence, they may have entered the study with higher motivation levels and readiness for change than the general population, which may accordingly limit the generalizability of the findings. Second, there was a female bias to the study—which is often observed in positive psychology interventions—and may limit the generalizability of the intervention to male participants. Future studies could explore the use of male-centric advertising and recruitment locations to increase the number of male participants. Third, the study observed small to medium effect sizes for gender and age, which is consistent with the literature. Lastly, as the intervention was promoted as a mental well-being intervention, the sample was in the "nonclinical range" for the mental health scores. Therefore, further research will need to be undertaken to investigate the influence of gender and age on the outcomes of and adherence to digital mental health interventions that integrate strategies from positive psychology and lifestyle medicine when dealing with clinical populations.

Conclusions

The findings of this study demonstrate that a digital interdisciplinary MHPI that employed multicomponent evidence-based strategies from the disciplines of lifestyle medicine and positive psychology using PSD principles can significantly improve mental health and well-being outcome measures across gender and age categories in a nonclinical setting. There may be a benefit in utilizing PSD principles to develop universal MHPIs such as that employed in this study, which can be used across gender and age groups. Future research should examine which PSD principles optimize a universal digital interdisciplinary MHPI.

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Authors' Contributions

GP, DM, and JM designed the study. GP and DM developed the intervention. GP drafted the manuscript and GP and MR coordinated the studies. GP and MR collected the data. GP analyzed the data. DM and JM provided supervision in the coordination of the study and analyzing the data. DM and JM were major contributors in providing supervision in writing the manuscript. JM, DM, and MR provided critical revision of the article. All authors read and approved the final manuscript.

Conflicts of Interest

DM operates a "profit-for-purpose" trust that administers the delivery of a version of the intervention; however, 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), 1621 KB-Multimedia Appendix 1]

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Abbreviations

DASS: Depression, Anxiety and Stress Scales
MANOVA: multivariate analysis of variance
MHPI: mental health promotion intervention
PSD: persuasive system design
RCT: randomized controlled trial
SF-36: Short Form 36 Health Survey
SWLS: Satisfaction With Life Scale

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Chapter Seven: Discussion, Conclusion and Future Directions

7.1 Chapter Overview

The impetus for this thesis came from the rising prevalence of mental health disorders (United Nations, 2020; Wilson & Nicolson, 2020), despite the increasing use of antidepressants over the past two decades (Brett et al., 2017; Stephenson et al., 2013; Wilkinson & Mulder, 2015). The current paradigm for addressing the mental health and wellbeing crisis is not working. This thesis responds to the multiple calls for novel lifestyle interventions that support individuals suffering mental distress and promote mental health and psychological resilience in a nonclinical setting. In addition, this thesis is particularly relevant due to the current COVID-19 pandemic, which has exacerbated the mental health and wellbeing crisis.

This thesis aimed to explore the effectiveness of a digital multicomponent interdisciplinary intervention on mental health and wellbeing. It further examined the influence of gender and age on the outcomes of and adherence to the intervention. In summary, this thesis has addressed the following:

- **Chapter One: The Introduction** provided the contextual background of the thesis, outlined the research aims and questions, and the significance of the thesis.
- **Chapter Two: Literature Review** outlined the mental health and wellbeing crisis and investigated the disciplines of lifestyle medicine and positive psychology in the context of improving mental health and wellbeing. The literature review culminated with Publication 1, published in Frontiers of Psychology, promoting digital interdisciplinary mental health and wellbeing

interventions as a potential strategy for improving the mental health of populations during and post-COVID-19 pandemic.

- **Chapter Three: Methodology** presented the research design and intervention utilised in the studies. In addition, the chapter explored the theoretical framework and principles underpinning the intervention.
- **Chapter Four: Publication 2** was published in BMC Psychology and examined the effectiveness of a digital interdisciplinary intervention on mental health and wellbeing.
- **Chapter Five: Publication 3** was published in the Journal of Positive Psychology and investigated the efficacy of a digital interdisciplinary intervention on flourishing.
- **Chapter Six: Publication 4** was published in JMIR Mental Health and examined the influence of gender and age on the outcomes of and adherence to a digital interdisciplinary mental wellbeing intervention.

The next section of this chapter summarises the major findings of the thesis, followed by a discussion of its key strengths and limitations, and its implications for research and practice. The chapter concludes with recommendations for future research.

7.2 Summary of Findings

7.2.1 Research Question 1: Can a digital multicomponent interdisciplinary intervention improve the mental health and wellbeing of an Australasian nonclinical cohort?

Research Question 1 was primarily addressed by Publication 2 (Chapter Four)–"The effectiveness of a digital interdisciplinary intervention for mental health promotion: A randomized controlled trial" and Publication 3 (Chapter Five)–"An interdisciplinary mental wellbeing intervention for increasing flourishing: Two experimental studies". Some learnings that occurred from Publication 4 (Chapter Six), were also addressed in Research question 1.

In Publications 2 and 3, a digital interdisciplinary intervention integrating lifestyle medicine and positive psychology strategies improved an Australasian population's mental health and wellbeing, and was sustained at 12 weeks post-intervention. Targeting mental health promotion to enhance mental wellbeing may provide a protective buffer for individuals against mental disorders (Arango et al., 2018). The broaden-and-build theory asserts that positive emotions can increase the ability of an individual to enhance their personal, social, and psychological resources, sparking upward spirals in high levels of mental wellbeing (Gloria & Steinhardt, 2016), also known as flourishing. The findings are consistent with previous research that showed flourishing could protect against adversity and mental illness and is associated with a lower prevalence of mental disorders (Keyes et al., 2020).

In addition, the findings from Studies 1 and 2 add to the existing literature and increase understanding of the complementary nature of lifestyle medicine and positive psychology to improve mental health and wellbeing. Although the literature has demonstrated that the disciplines of lifestyle medicine (Firth et al., 2020; Kvam et al., 2016) and positive psychology (Boiler et al., 2013; Chakhssi et al., 2018; Hendriks et al., 2019; Sin & Lyubomirsky, 2009) can enhance mental health and wellbeing, the disciplines are mainly used in isolation.

Awareness of the complementary nature between the two disciplines has emerged in recent years. For example, the PERMA wellbeing framework for flourishing emerged from the positive psychology literature (Seligman, 2011). Over the past few years, the PERMA model has developed to incorporate PERMA-H (Health) to recognise the contribution of lifestyle behaviours to mental health and wellbeing (Lai et al., 2018; Mayer, 2019). Similarly, within the lifestyle medicine discipline, the primary focus is on modifying health behaviours to improve health outcomes. However, emerging literature indicates that healthy lifestyle habits foster psychological and physiological health; hence, positive psychology is recommended to be part of routine health care (Lianov et al., 2020).

In Publications 2, 3 and 4, a unique aspect of the intervention was using a multicomponent interdisciplinary approach. A meta-analysis encouraged practitioners to recommend multiple positive psychology strategies in a shotgun approach as it may be deemed more efficacious for their clients rather than a single strategy (Sin & Lyubomirsky, 2009). Notably, there has been an increase in multicomponent lifestyle interventions in recent years to increase mental health and wellbeing (Gomez-Gomez et al., 2020); however, the interventions omit positive psychology strategies. Likewise, there has been an increase in multicomponent PPIs

(Hendriks et al., 2019) for improving mental health; however, the interventions exclude evidence-based lifestyle factors, such as physical activity, nutrition and sleep. In addition, relatively larger effective sizes were observed in Publication 2 and 4, compared with previous meta-analyses that predominantly employed single-modality interventions (White et al., 2019). This suggests that a multicomponent interdisciplinary approach may yield compounding benefits.

In Publication 3, the digital interdisciplinary mental wellbeing intervention significantly increased the flourishing status of the participants and sustained the results at 12 weeks post-intervention, using the Huppert and So conceptual framework. Previously, the framework was only used from an epidemiological perspective (Huppert et al., 2008; Huppert & So, 2013).

Publications 2 and 4 revealed that the digital mode of delivery of mental wellbeing interventions could increase mental health and wellbeing. The findings of the study support digital delivery becoming an essential augmentation of the provision of mental health promotion compared with the traditional mode of face-to-face delivery (Aboujaoude et al., 2020; Hill et al., 2017). The benefits of digital mental health and wellbeing interventions make them appealing due to their accessibility, scalability, and cost-effectiveness (Richards et al., 2015; Torous et al., 2020), which is related to not requiring support from a health professional. A recent rapid meta-review reported good evidence for usability, safety, acceptance, and satisfaction of digital mental health and wellbeing interventions (Rauschenberg et al., 2020). In addition, the interventions were deemed appropriate to alleviate COVID-19 psychosocial consequences at a population-level.

In Publication 2, participants who dropped out from the intervention had poorer mental health scores than those who completed the intervention. These findings are consistent with a previous study that reported that those who discontinued the intervention reported lower mental health metrics (Mak et al., 2017). Notably, poor mental health and negative emotional states are associated with poor lifestyle choices (Achraf Ammar et al., 2020; Velten et al., 2014). In contrast, better mental health is related to healthy lifestyle choices (Velten et al., 2018). Hence, a reciprocal relationship exists between mental health and physical health outcomes (Lianov & Fredrickson, 2019).

In summary, this thesis concluded that a digital multicomponent interdisciplinary intervention using various strategies from lifestyle medicine and positive psychology could improve mental health and wellbeing.

7.2.2 Research Question 2: What is the influence of gender and age on the outcomes of and adherence to a digital interdisciplinary mental health and wellbeing intervention amongst an Australasian nonclinical cohort?

Research Question 2 was primarily addressed by Publication 4 (Chapter Six)– "The influence of gender and age on the outcomes of and adherence to an interdisciplinary digital mental health promotion intervention in an Australasian nonclinical setting: A cohort study". Some learnings that occurred from Publications 2 and 3 also addressed Research Question 2.

Publication 4 demonstrated that a digital interdisciplinary MHPI that utilises PSD principles could improve the mental health and wellbeing of an Australasian nonclinical cohort, regardless of gender or age. Stratification by gender and age showed significant improvements in all mental health and wellbeing outcomes. A

multicomponent approach using lifestyle medicine and positive psychology strategies was beneficial for mental health promotion and psychological resilience across gender and age groups.

In Publication 4, females had significantly lower mental health scores (i.e., higher emotional distress) than males at baseline. However, females experienced greater improvements than males in the mental health, vitality, depression, and life satisfaction measures. Notably, females experienced twice the mean change increase in the mental health and vitality subscales compared with the change reported by men, resulting in comparable outcome scores to the men at post-intervention. This finding suggests that those scoring lower in mental health and wellbeing outcomes can realise higher mean changes as a greater opportunity for improvement exists. The finding is consistent with a previous study using the same intervention, which found that those with the lowest mental health score at baseline achieved the highest levels of change (Morton et al., 2020).

In Publication 3, males improved and maintained their flourishing status more than females. The study observed a female bias in participation, which is consistent with positive psychology interventions (Bendtsen et al., 2020; Feicht et al., 2013; Schotanus-Dijkstra et al., 2017). The findings are of significance, as it was the first study to examine the change in flourishing status between genders using a digital interdisciplinary multicomponent intervention.

Publication 4 revealed that older adults achieved better outcomes than younger adults in mental health and wellbeing measures, except for stress. Similarly, a meta-analysis of positive psychology interventions observed that the benefits tended to increase with age (Sin & Lyubomirsky, 2009). The finding is somewhat surprising as younger adults are often referred to as digital natives and have greater

internet access and usage than older adults (Australian Bureau of Statistics, 2020; König et al., 2018).

Digital mental health and wellbeing interventions are typically designed for those familiar with technology, resulting in barriers for novice users and older adults (Pywell et al., 2020). Older adults tend to have inadequate skills and training in technology (Kenny & Connolly, 2017), resulting in an *innovativeness-needs paradox*, where the people who need digital mental health and wellbeing interventions the most have the least access, adoption rates, and adherence (Seifert et al., 2019). In a previous qualitative study using the same intervention used in this thesis, time emerged as a key barrier to adherence for participants (Renfrew et al., 2021). However, the older adults indicated that retirement enabled more time to engage with and adhere to the intervention. Notably, the outcomes of the digital mental health intervention could be related to higher levels of adherence, such as higher levels of time spent on the digital platform, the number of sessions watched, the percentage of the program viewed, and the number of activities completed (Enrique et al., 2019). Gender and age did not influence the adherence to the intervention, although the older participants viewed a higher number of videos.

In Publications 2 and 4, low attrition rates were reported, which contrasts with the existing literature that typically finds adherence and attrition problematic (Gander et al., 2016; Mak et al., 2017; Renfrew et al., 2020). Factors that may have contributed to the low attrition rates are the experiential pedagogical framework and PSD principles, which successfully contribute to generating engagement in digital interventions. The follow-up conducted by email and text messages to prompt the participant to complete the questionnaire is also a potential contributor to the low attrition rates.

In summary, a digital interdisciplinary MHPI that utilises PSD principles can improve the mental health and wellbeing of an Australasian nonclinical cohort, regardless of gender or age.

7.3 Significance of the Study

The major findings of the thesis have important implications for research and practice. First, a digital mental health and wellbeing intervention based on an interdisciplinary approach, incorporating lifestyle medicine and positive psychology strategies, can produce significant improvements in mental health and wellbeing in a nonclinical setting. Second, the studies observed larger effect sizes than previous studies that utilised single-modality interventions, suggesting that a multicomponent interdisciplinary approach may yield compounding benefits.

Third, it was the first interdisciplinary mental wellbeing intervention to increase flourishing using the Huppert and So conceptual framework. Fourth, gender and age did not influence adherence to the intervention that employed PSD principles to improve mental health and wellbeing. Hence, digital mental health and wellbeing interventions can be designed for all adults (i.e., universal) utilising PSD principles that work effectively across gender and age categories.

Fifth, low attrition rates were observed compared with other studies reported in the existing literature, which typically finds adherence and attrition problematic for digital delivery. Last, digital mental wellbeing interventions may be a viable low-cost and scalable option for mental health promotion without the necessary support from a health professional. Therefore, it is recommended that policy-makers, governments, and researchers increase the investment in mental health promotion, prevention, and the advancement of digital technology to provide a whole systems approach model to health care.

7.4 Strengths and Limitations

7.4.1 Strengths

There are several key strengths of the studies in this thesis. Firstly, the studies involved a broad age demographic (18 to 88 years), and the participants were drawn from a geographically diverse region. Secondly, the studies involved a large sample size and used a RCT design and a randomized comparative design to minimise allocation bias. Thirdly, the studies used an e-LMS that did not require a health professional and hence represents a scalable, cost-effective method for promoting mental health and wellbeing on a population-level.

7.4.2 Limitations

The primary limitation of the studies in the thesis was the self-selected sample drawn from a faith-based population. Hence, the participants may have entered the study with higher motivation levels and readiness for change than the general population, limiting the generalisability of the findings. The second limitation of the study is the female bias of the participants, which is typical of PPIs but can diminish the outcomes transferability to different populations. The third limitation of the studies was the lack of prospective registration.

7.5 Recommendations for Future Research

The following recommendations for further research are outlined based on the thesis findings.

First, the literature is limited in understanding the benefits of using multicomponent interventions. Further research could explore the potential for a compounding effect, whereby combining a broad array of evidence-based

approaches for improving mental health and wellbeing may result in greater benefits than a single modality approach.

Second, healthy lifestyle behaviours are rarely used to promote mental health and wellbeing; however, future studies could investigate the contribution that changes in physical health, mediated through lifestyle behavioural change, can make to measuring flourishing.

Third, investigation of the influence of various PSD principles on the uptake and responsiveness to a digital mental wellbeing intervention warrants further exploration, and the relative impact these have on the outcomes of and adherence to the intervention.

Fourth, there is a need for further exploration of the potential use of interventions such as the one employed in this thesis to understand the reasons why people with poorer mental health and lifestyle choices benefited from the intervention or failed to engage in the intervention due to aspects such as motivation and greater severity requiring a more intense intervention.

Last, the study occurred in a nonclinical setting. Further research could examine the effectiveness of a digital multicomponent interdisciplinary intervention incorporating positive psychology and lifestyle medicine strategies on a clinical population.

7.6 Conclusion

The findings in this thesis demonstrate that a digital multicomponent interdisciplinary mental wellbeing intervention that combines lifestyle medicine and positive psychology can increase mental health and wellbeing, and sustain the outcomes 12 weeks post-intervention. Secondly, digital multicomponent interdisciplinary mental wellbeing interventions employing PSD principles can be

used across gender and age categories. During lockdowns and travel bans due to COVID-19, there is an urgent need for digital interdisciplinary mental health and wellbeing interventions that are cost-effective and scalable to support individuals suffering mental distress, promote mental health, and build psychological resilience at a population-level. In addition, there is a critical need for policy-makers, governments, and researchers to invest in the rollout of well-designed digital interdisciplinary mental health interventions such as the one employed in this study. This thesis informs a potential way forward to improve mental health and wellbeing on a population-level.

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Appendix

Appendix 1. Questionnaire

Please respond to the following questions.	
GENERAL QUESTIONS ABOUT YOU:	
1	What is your date of birth?
2	What is your gender?
3	What is your ethnicity?
4	What is your highest level of education?
5	What is your marital status?
QUESTIONS ABOUT YOUR PHYSICAL HEALTH:	
1	What is your height?
2	What is your weight?
3	Are you taking any medications for high cholesterol?
4	Are you taking any medications for high blood pressure?
5	Are you taking any medications for diabetes?
6	In general, would you say your health is:
7	Compared to one year ago, how would you rate your health in general now?
8	In the past week I had a lot of energy.
9	During the past 2 weeks, how many serves of vegetables (excluding potatoes) did you usually eat each day?
10	During the past 2 weeks, how many serves of fruit did you usually eat each day? (*one serve = 1 medium piece of fruit, 2 pieces of smaller fruit, 1 cup of diced pieces or 1 ½ tbsp sultanas).*
11	Which of the following best describes your usual diet?
12	On average, how many days a week do you perform moderate-intensity physical activity or exercise, where your heart is beating faster and your breathing is harder than normal (such as brisk walking)?
13	On average, how many total minutes of physical activity or exercise do you perform on those days?
14	On an average day, how many hours do you spend sitting (including work, leisure time, etc)?
15	During the *past month*, how many hours of actual sleep would you average a night?
16	During the *past month*, how would you rate your sleep quality overall?
17	How many cigarettes do you smoke each day?
18	During the last 12 months, how often did you usually have any kind of drink containing alcohol?
19	During the last 12 months, how often have you used recreational drugs?

QUESTIONS ABOUT YOUR LEVEL OF INTELLECTUAL STIMULATION:	
1	I love learning new things.
2	I like to read material that makes me think.
3	I like to listen to ideas different to mine.
4	I view learning as a life-long process.
5	I view mistakes as learning points.
6	I engage in intellectually engaging activities.
7	I am confident that I can learn new skills.

QUESTIONS ABOUT WORK, HOBBIES AND INTERESTS:	
1	I am engaged and interested in my daily activities
2	I am competent and capable in the activities that are important to me
3	Most days I feel a sense of accomplishment from what I do.
4	How often do you engage in activities that interest you such as hobbies, work, family activities, sports, etc?
5	How often do you engage in activities that give you a sense of satisfaction which may include hobbies, work, family activities, sports, etc?
6	How often do you participate in voluntary activities (ie. give you time and/or services)?
7	During the past 4 weeks, how would you rate your overall performance in the things you do each day?
8	Which one of the following categories best explains your employment status?
If you are employed, please respond to the following:	
9	How many hours do you work each week on average?
10	Do you have at least one day off each week from work?
11	Do you feel that you are fairly compensated for the work you do?
12	I am enthusiastic about my job
13	My job inspires me
14	I am proud of the work that I do
15	When I get up in the morning, I feel like going to work
16	I am immersed in my work

QUESTIONS ABOUT YOUR EMOTIONAL WELLBEING:	
1	Taking all things together, how happy would you say you are?
2	Are there any exceptional circumstances that have occurred in the ***past week*** that have given your happiness a significant boost?
3	Are there any exceptional circumstances that have occurred in the ***past week*** that have significantly taken away from your happiness?
How true are these questions about you?	
4	I'm generally aware of my emotions as I experience them.
5	I'm usually able to find ways to control my emotions when I want to.
6	When things go wrong in my life it generally takes me a long time to get back to normal.
7	On the whole, I'm a highly motivated person.
8	I'm normally able to "get into someone's shoes" and experience their emotions
9	I'm usually able to influence the way other people feel.
10	I am optimistic about my future
11	I am always optimistic about my future.
12	In general, I feel very positive about myself.
These questions are about how you feel and how things have been with you during the past 4 weeks.	
13	Did you feel full of pep?
14	Have you felt calm and peaceful?
15	Did you have a lot of energy?
16	Have you been a happy person?
17	Have you been a very nervous person?
18	Have you felt so down in the dumps that nothing could cheer you up?
19	Have you felt downhearted and blue?
20	Did you feel worn out?
21	Did you feel tired?
Please read each statement and indicate how much the statement applied to you over the *past week* . There are no right or wrong answers. Do not spend too much time on any statement.	
22	I found it hard to wind down
23	I was aware of dryness of my mouth
24	I couldn't seem to experience any positive feeling at all
25	I experienced breathing difficulty (eg, breathlessness in the absence of physical exertion)
26	I found it difficult to work up the initiative to do things
27	I tended to over-react to situations
28	I experienced trembling (eg, in the hands)
29	I felt that I was using a lot of nervous energy
30	I was worried about situations in which I might panic and make a fool of myself
31	I felt that I had nothing to look forward to
32	I found myself getting agitated
33	I found it difficult to relax
34	I felt down-hearted and blue
35	I was intolerant of anything that kept me from getting on with what I was doing
36	I felt I was close to panic
37	I was unable to become enthusiastic about anything
38	I felt I wasn't worth much as a person
39	I felt that I was rather touchy
40	I was aware of the action of my heart in the absence of physical exertion (eg, racing heart rate)
41	I felt scared without any good reason
42	I felt that life was meaningless
43	My personal finances are a significant source of stress for me

QUESTIONS ABOUT YOUR RELATIONSHIPS AND SOCIAL SUPPORT :	
1	There is a special person who is around when I am in need.
2	There is a special person with whom I can share my joys and sorrows.
3	My family really tries to help me.
4	I get the emotional help and support I need from my family.
5	I have a special person who is a real source of comfort to me.
6	My friends really try to help me.
7	I can count on my friends when things go wrong.
8	I can talk about my problems with my family.
9	I have friends with whom I can share my joys and sorrows.
10	There is a special person in my life who cares about my feelings.
11	My family is willing to help me make decisions.
12	I can talk about my problems with my friends.
13	People respect me.
14	My social relationships are supportive and rewarding.
15	There are people in my life who really care about me.
16	How many people do you have in your life that you could call at 3 am if you needed help?

QUESTIONS ABOUT YOUR SENSE OF MEANING AND PURPOSE:	
1	I lead a purposeful and meaningful life
2	I am a good person and live a good life
3	I consider myself to be a spiritual person.
4	I engage in self-reflection.
5	I engage in spiritual practices (eg. Prayer, meditation, bible study, etc)
6	I feel a connection to something larger than myself.
7	I seek out meaning in my life.
8	I generally feel that what I do in my life is valuable and worthwhile.
9	Do your personal beliefs give meaning to your life?
10	To what extent do you feel your life to be meanginful?
11	To what extent do your personal beliefs give you the strength to face difficulties?
12	To what extent do your personal beliefs help you to understand difficulties in life?

QUESTIONS ABOUT HOW YOU INTERACT WITH THE ENVIRONMENT:	
1	How often do you spend time in natural outdoor environments.
2	I enjoy and appreciate spending time outside in natural settings.
3	I practice recycling (glass, paper, plastic, etc.).
4	I consciously conserve energy (electricity, heat, light, water, etc.) in my place of residence.
5	I do not pollute the air, water or earth if I can avoid doing so.
6	I do my part to take care of the Earth by not littering.
7	I am working to decrease my environmental "footprint."

QUESTIONS ABOUT YOUR GENERAL LIFE SATISFACTION:	
1	In most ways my life is close to my ideal.
2	The conditions of my life are excellent.
3	I am satisfied with my life.
4	So far I have gotten the important things I want in life.
5	If I could live my life over, I would change almost nothing.

Appendix 2. Ethics Approval

Human Research Ethics Committee
Telephone: 02 4980 2121
Fax: 02 4980 2117
Email: research.ethics@avondale.edu.au

17 July 2017

Dr Darren Morton
Avondale College of Higher Education
582 Freemans Drive
COORANBONG NSW 2265

Dear Darren

Thank you for submitting an application for ethics approval to the Avondale Human Research Ethics Committee for your project entitled *The impact of a multimodal lifestyle intervention (the Live More Project) on the wellbeing of Seventh-day Adventist church members across Australasia.*

I am pleased to advise that final approval is granted for your project. Approval is granted for the duration of your project to 31/08/2020; project number 2017:13

Once final approval is granted, the following additional standard conditions apply:

1. That you notify the committee of any changes to circumstances or research design, which might require a review of the ethics approval.
2. That you provide an annual interim report of your progress to the committee, and a final report once this project is completed. The first report will be due twelve months from the date you commence the research.

We wish you well in this valuable research endeavour.

Sincerely

Kyllie Gow
Secretary
Avondale Human Research Ethics Committee

Avondale
COLLEGE OF HIGHER EDUCATION

Human Research Ethics Committee
Telephone: 02 4980 2121
Fax: 02 4980 2117
Email: research.ethics@avondale.edu.au

Dr Darren Morton
Avondale College of Higher Education
582 Freemans Drive
COORANBONG NSW 2265

17 July 2018

Dear Darren,

Thank you for submitting an application for ethics approval to the Avondale Human Research Ethics Committee for your project entitled: *The Influence of Human Support on Adherence to, and Outcomes of, an Online, Lifestyle-based Mental Health Intervention*.

I am pleased to advise that final approval is granted for your project. Approval is granted for the duration of your project to August 2020; project number 2018.09.

The following additional standard conditions apply:

1. That you notify the committee of any changes to circumstances or research design, which might require a review of the ethics approval.
2. That you provide an annual interim report of your progress to the committee, and a final report once this project is completed.

We wish you well in this valuable research endeavour.

Kind regards,

Nicole Meintjes
Secretary
Human Research Ethics Committee

Appendix 3. Participant Information Sheet and Consent Form



PROJECT TITLE: The impact of a multimodal lifestyle intervention (the Live More Project) on the wellbeing of Seventh-day Adventist church members across Australasia.

Research team: Associate Professor Darren Morton, Dr Lillian Kent, Geraldine Przybylko, Dr Peter Beamish, Jason Hinze.

INVITATION

You are invited to participate in this research project that is being conducted by researchers from Avondale College of Higher Education.

PURPOSE AND IMPORTANCE OF THIS RESEARCH

The purpose of this research project is to examine the impact of a ten-week wellbeing program called the "Live More Project" which is designed to increase participants' personal wellbeing. Happy people and those who report higher levels of wellbeing are known to not only have a higher quality of life, but also richer and fuller lives as well. If this program is effective, it might be useful for improving various peoples' wellbeing.

WHO IS BEING INVITED OR SELECTED TO PARTICIPATE?

To participate in the research project, you need to be: a member of the SDA church defined as someone who usually attends an SDA church two or more times a month); aged 18 years or older; living in Australia or New Zealand, able to access the internet; fluent in English; willing for your data to be anonymously and confidentially used for research purposes. Exclusion criteria for the study is the inability to participate in the moderate-intensity physical activity such as walking.

In addition, you need to be willing to be randomly assigned to participate in the Live More Project commencing either late September 2017 or February 2018. If you are randomly assigned to the February 2018 group, you will still complete a wellbeing assessment at the same time as the group who commences the project in September 2017 (as described in the next section below). You will not be expected to do anything else while the September 2017 group are undertaking the project.

WHAT DOES PARTICIPATION INVOLVE?

The Live More Project goes for ten weeks and involves watching a weekly 35-minute entertaining video in which you will learn fascinating ways to improve your wellbeing and socially interact online. Each week you will then be challenged to complete a daily activity arising from what you have learnt. The daily activities range from just a few minutes to 30 minutes. You will also be required to complete an online wellbeing assessment that will take approximately 15-20 minutes on three occasions (September 2017, December 2017, and February 2018).

POSSIBLE RISKS OR INCONVENIENCES

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

BENEFITS

In the Live More Project you will learn scientifically proven strategies for increasing your personal wellbeing, especially your emotional wellbeing. You should also find the results you receive from doing the Wellbeing Questionnaire interesting and informative.

CONFIDENTIALITY, ANONYMITY AND DISCLOSURE OF INFORMATION

Your data will be treated confidentially with only the researchers having access to it. Further, once your data has been entered into a computer your name will be removed from it so that your data is anonymous. 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 and/or professional conferences. The confidentiality of individual participants will be assured. In any publication, information will be provided in such a way that you cannot be identified.

FREEDOM OF CONSENT

Participation in this research is voluntary. It is completely up to you whether or not to 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 Geraldine Przybylko at GeraldinePrzybylko@adventist.org.au

This research project has been approved by the Avondale Human Research Ethics Committee (HREC). Avondale requires that all participants are informed that if they have any complaints 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

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: Associate Professor 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 randomized controlled trial in 2017 demonstrated that the Live More Project could improve the mental wellbeing 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 ten-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., video-conference) using a freely accessible application called 'Zoom'.

WHAT DOES PARTICIPATION INVOLVE?

The Live More Project is a ten-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 wellbeing. 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 wellbeing questionnaire that will take approximately 30 minutes, and this 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 wellbeing, especially your emotional wellbeing.

You will complete a questionnaire that measures seven dimensions of wellbeing: 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 and/or media reports. 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 and/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 Human Research Ethics Committee (HREC). Avondale requires that all participants are informed that if they have any complaints 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.

Appendix 4. Multimedia

These images portray features of the website e-learning management system and mobile app relating to the following article:

The Influence of Gender and Age on the Outcomes of, and Adherence to, a Digital Interdisciplinary Mental Health Promotion Intervention in an Australasian Nonclinical Setting: A Cohort Study

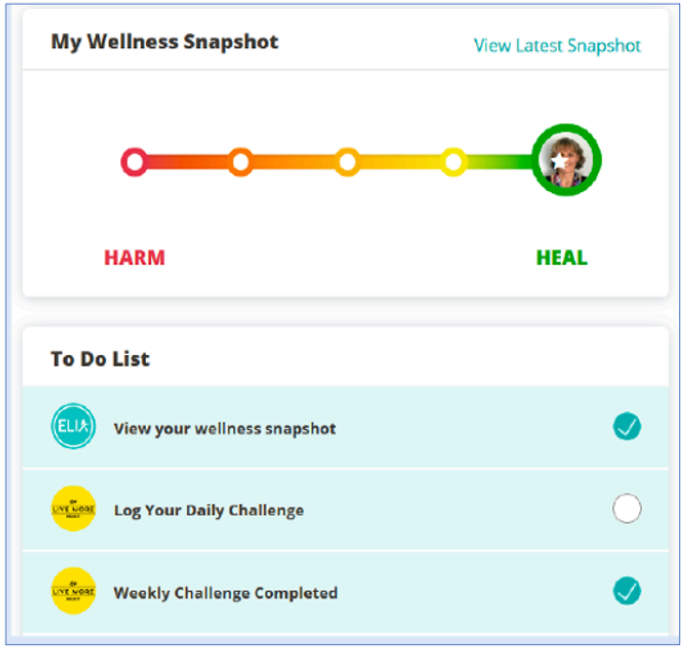
Authors: Przybylko G, Morton D, Morton J, Renfrew M

Section 1:

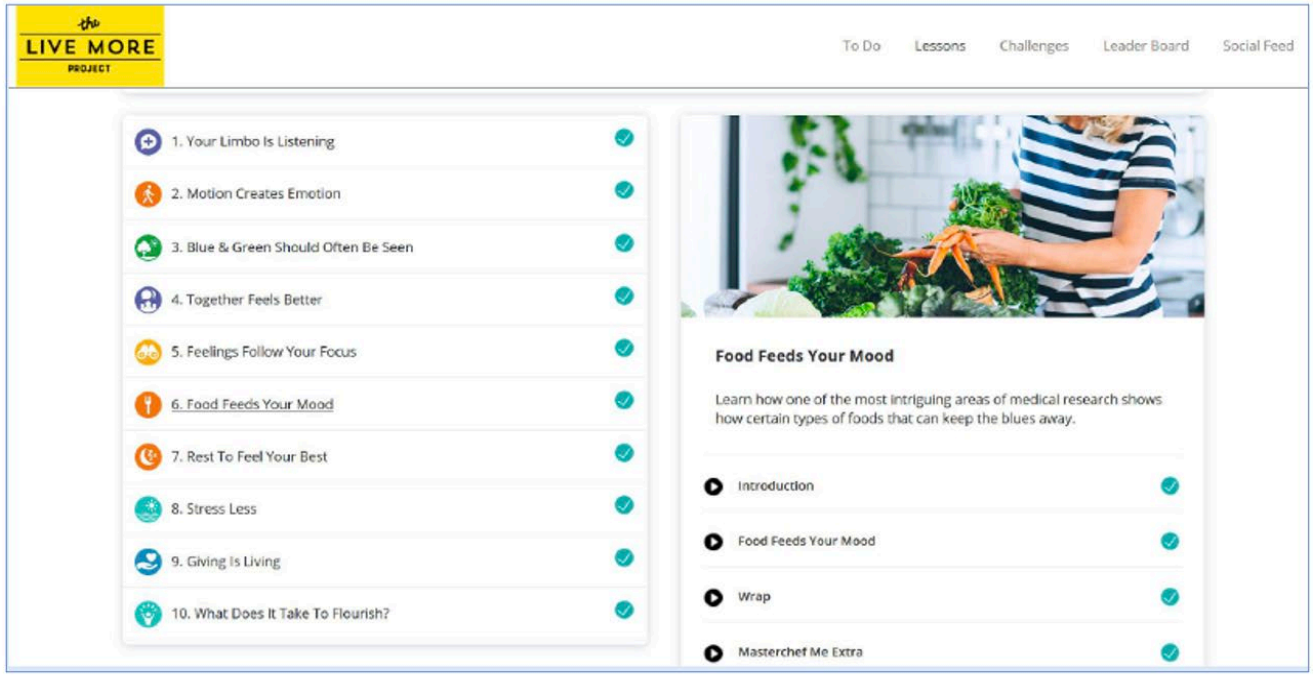
The Digital Platform

Images of the Digital Platform
(e-learning management system)

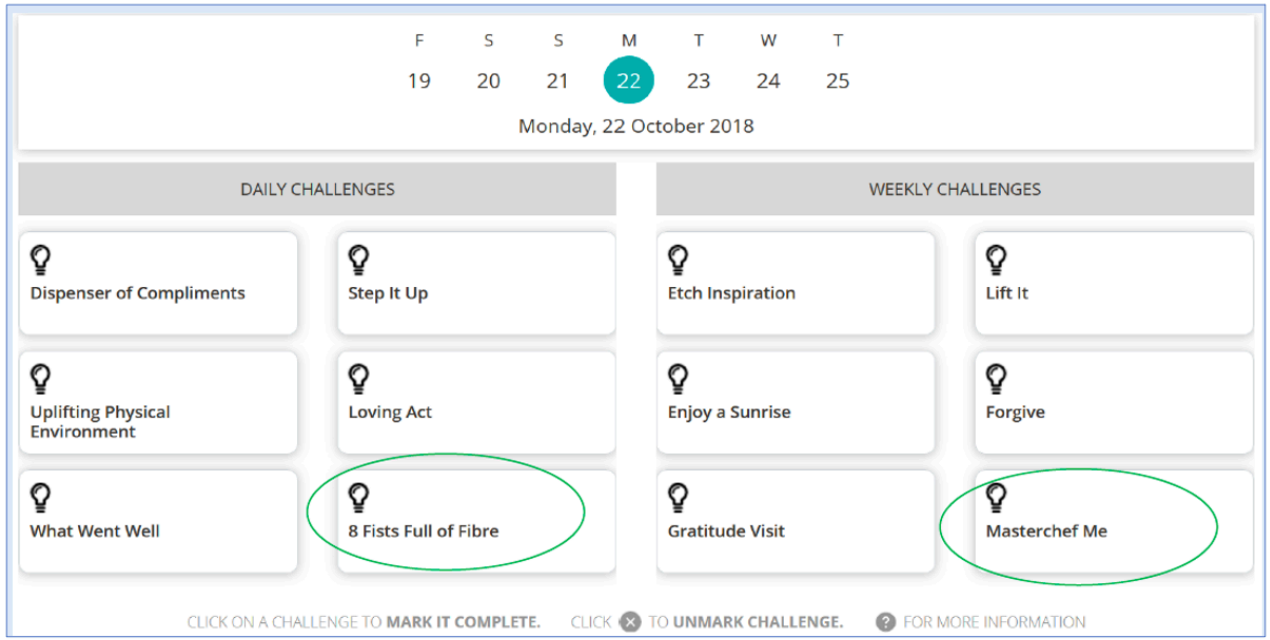
www.eliawellness.com



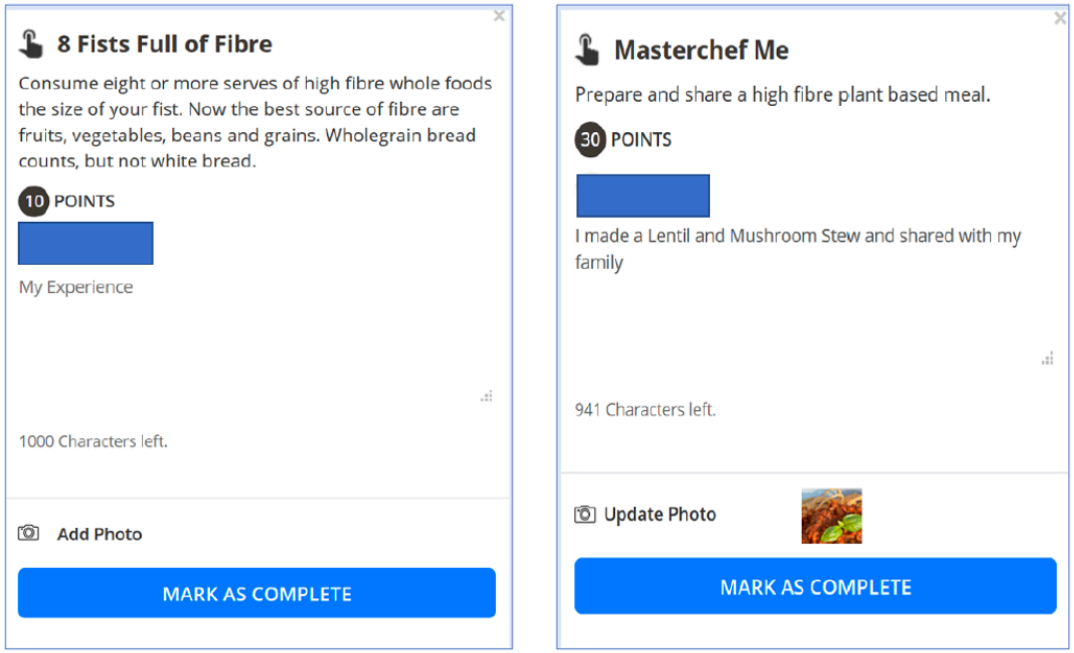
To Do List: A digital "To Do" list (available on each personal dashboard) provided easily accessible links to complete the various components. Note: the "Wellness snapshot" refers to the questionnaire administered at baseline, post-intervention, and 12 weeks post-intervention of the program.



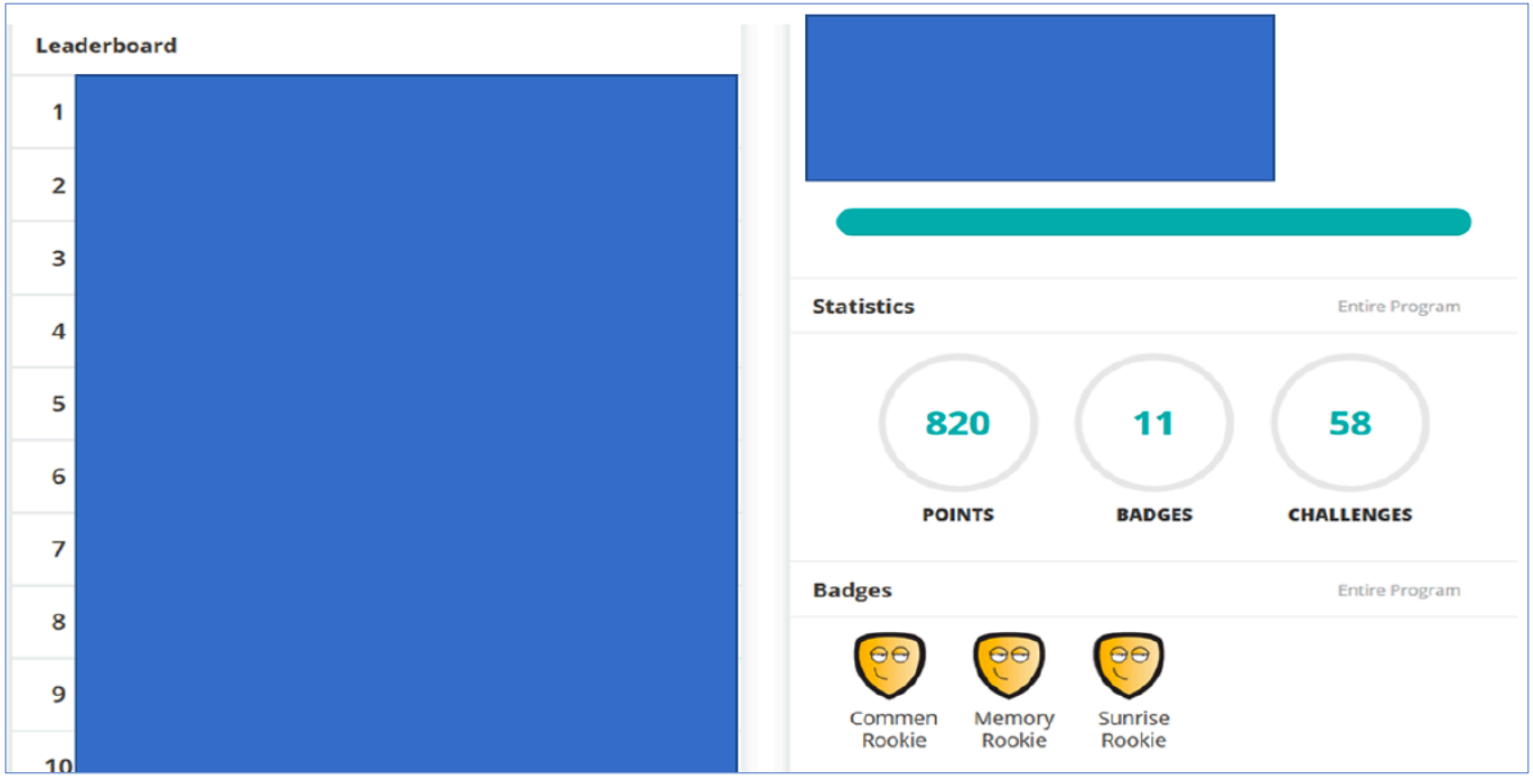
Sample View of Lesson 6 Content: Each lesson was divided into three to four short video presentations. Each new video segment was unlocked on completion of the previous video. Segments were ticked off automatically as they were viewed.



View of Challenge Icons for Lessons One to Six: After each lesson, participants are provided with daily and weekly challenges. For example, for lesson six, participants were challenged to eat "8 Fists Full of Fibre" daily and were asked to make one high-fibre plant-based meal for the "Masterchef Me" weekly challenge.



View of Lesson Six Log Pages: When participants clicked on the challenge icon (previous image) it opens 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.

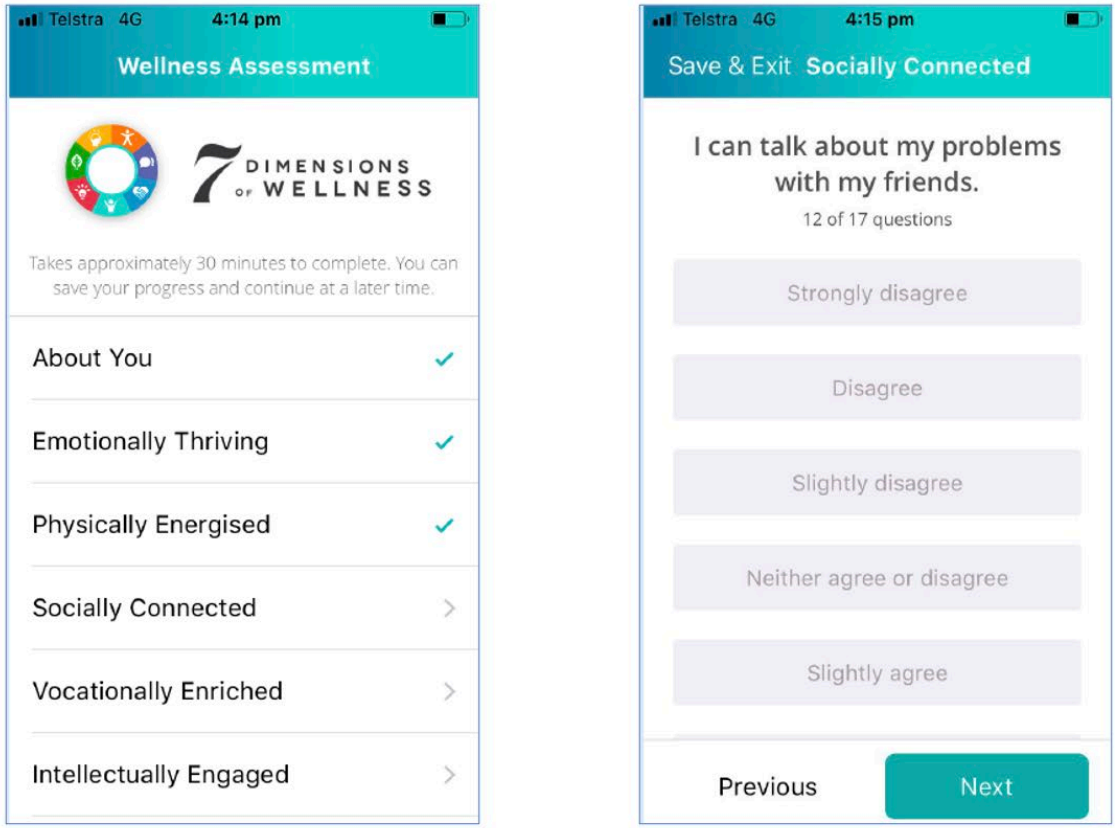


View of Leaderboard: Names and photos have been covered to protect privacy. Participants could compare their scores with others and earn badges for completing the activities.

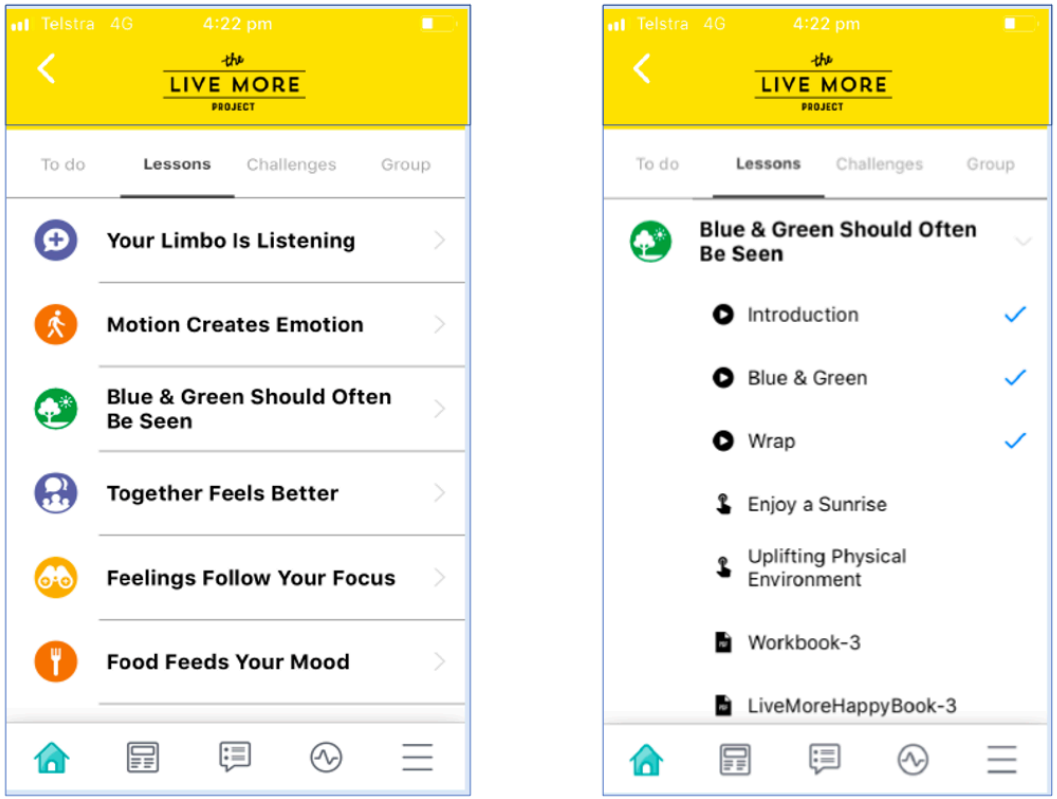
Section 2:

The Mobile App

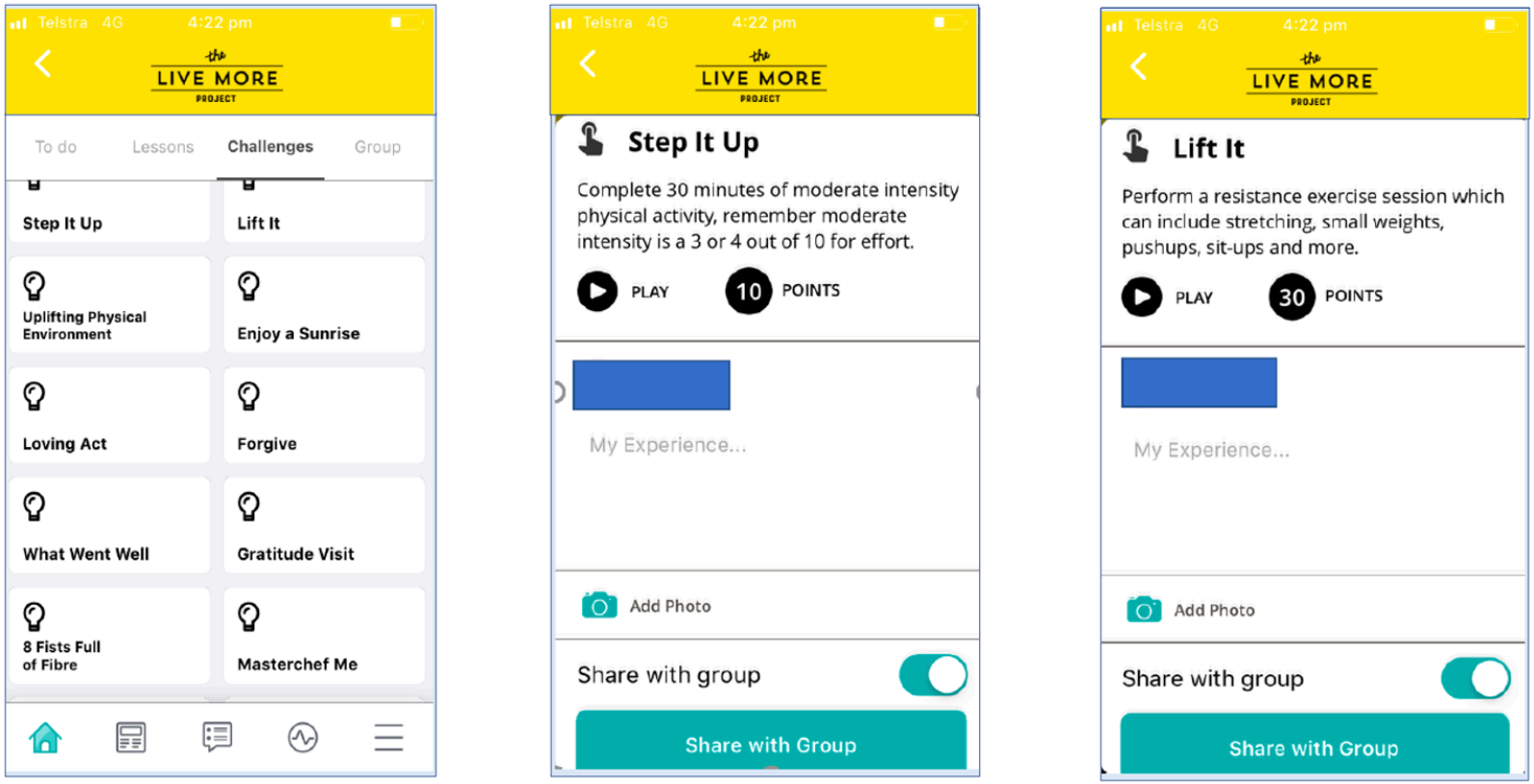
The following images are from the ELIA Wellness mobile app called “wellness”.



Questionnaire sample: Participants were asked to complete the questionnaire at baseline, post-intervention, and 12 weeks post-intervention

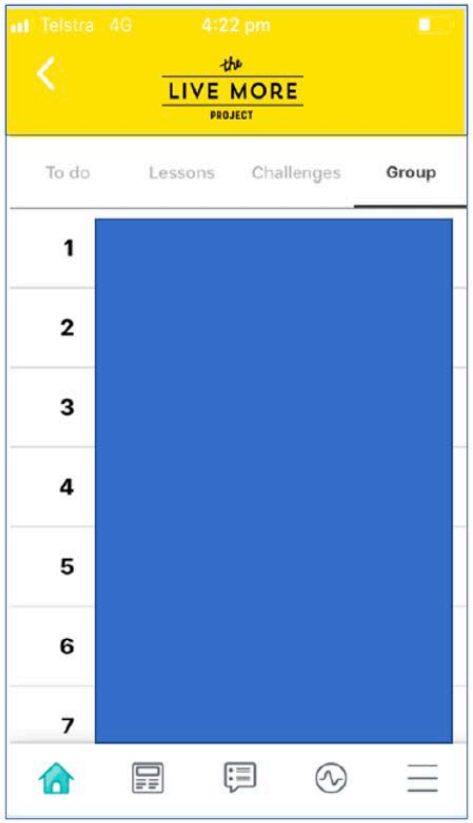


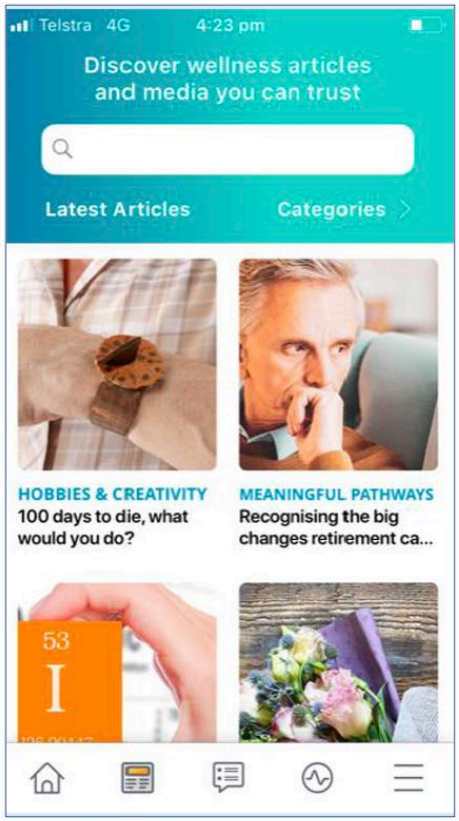
Video content on the mobile app: Participants watched the video content and could download a workbook and a chapter of the accompanying text-book called 'Live More Happy" (Moton, 2018) from the Lessons page on the app (or the website).



Challenges on the app: Participants could click on the icon and then record challenge activity.

The 'blue' box has been used to de-identify personal information.





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