How do young people use mobile applications (apps) to improve their wellbeing? Implications for engagement

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Abstract

As a community we are becoming more dependent on technology, this is particularly true for young people who nowadays rely on technology to make decisions, have relationships, schedule their time, and monitor their health. Good or bad, technology is here to stay. The unstoppable advancement and inevitable merging of technologies into peoples' lives has arguably been linked to as many drawbacks as benefits, so the need to understand it, harness it, and use its potential for benefit is pressing. This thesis represents an attempt to improve our understanding of how young Australians engage with readily accessible technology, specifically mobile applications (apps), to increase levels of wellbeing. Through four studies developed in the context of a larger research project called the Young and Well Cooperative Centre (Y&WCRC), this thesis contributes to knowledge about what determines a young person's engagement with wellbeing apps, guided by theoretical underpinnings of psychological strengths over deficits.

Study one (published) reported on a systematic literature review and Narrative Synthesis (Antezana et al., 2022b). Studies were drawn from the literature that were designed to improve wellbeing in a target population using apps to contrast users' characteristics across participation and engagement. Several observations arose from this analysis including the research participants' expectations of reward, the duration of the studies, and the specificity of the interventions. Most importantly though, it was found that interventions with significant identity components were in fact more likely to recruit and retain participants.

Study two (published) examined behaviour change techniques (BCT'S) contained within popular wellbeing apps (Antezana et al., 2020). Thirty popular wellbeing apps were selected and analysed in three categories: sleep, eating behaviour and physical activity. The Behaviour Change Techniques Taxonomy 1 (BCTTv1) (Michie et al., 2013) was used and apps were selected from the AppStore™ and GooglePlay™. Results showed that commercially designed apps have low levels of BCT's in general, which in turn raised the question of the relationship of BCT's and engagement. Engagement involves users interacting actively with apps in a sustained and

meaningful way; the results of this study showed that relying only on evidence-based techniques is not enough; this was investigated further in the subsequent studies.

Following from the findings of the BCT study, study three (published) aimed to understand whether characteristics of the individual using the apps were related to their engagement with them (Antezana et al., 2022a). A binary regression analysis was used to assess individual characteristics of participants in an online study that sought to determine changes in wellbeing of those app users who accessed a self-recommendation service offering a curated list of available wellbeing apps. The self-recommendation service was called “The Toolbox” and was associated with a web portal called the “Online Wellbeing Centre” (OWC) (Antezana et al., 2015). Common characteristics among users were sought to help predict engagement or non-engagement with the apps. Qualitative interviews with users of the OWC were also conducted. Results highlighted psychological differences between males and females and suggested individual- identity driven perceptions may be behind engagement with apps.

Study four (under review) presented a qualitative study to understand a user’s perceptions of wellbeing apps. In depth interviews were used and thematic analysis conducted on 13 individuals from different backgrounds recruited from Flinders University, South Australia. Results indicated that identity elements including, privacy, preferences, user experience and most importantly personal values all contribute to engagement with wellbeing apps. This study is currently awaiting final acceptance for publications with the Journal of Child and Family Studies having already responded to reviewers’ initial comments.

The results of the combined program of research have several implications for the way ‘apps’ are designed from a human and psychological perspective, as opposed to only technical considerations or persuasive design. This research makes the case that user engagement with apps hinges on identity; as engagement requires personal investment, motivation, interest and ultimately meaning. All these factors are required to cover the gap between the app and its’ features, versus effective behaviour change and consequent increased wellbeing.

Declaration

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, contains no material that has been accepted for the award of any other degree or diploma of a university or other institute of higher learning, except where due acknowledgement is made in the body of the text. All work contained in the submission was initiated, undertaken, and prepared within the period of candidature. I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968. The author acknowledges that copyright of published works contained within this thesis (as listed below) resides with the copyright holder(s) of those works.

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Dedications

I dedicate this thesis to God, my maker, source of all knowledge and my strength.

To my parents, I am proud to be your son and I wish to honour you by following the same path of dedication and sacrifice you have always shown me.

To Maria Sol, Sara and Nicolas, the reason of my life.

Abbreviations

Y&WCRC	Young and Well Cooperative Research Centre
BCT's	Behaviour Change Techniques
BCTTv1	The Behaviour Change Techniques Taxonomy 1
OWC	Online Wellbeing Centre
mHealth	Mobile Health
CHSALHN	Country Health South Australia Local Health Network
PP	Positive Psychology
APPS	Mobile applications
Y&W TOWNS	Young and Well Towns
RCT	Randomised Controlled Trial
CBT	Cognitive Behavioral Therapy
CSM	Complete State of Model of Mental Health
SMS	Short Messaging Service
FOMO	Fear of Missing Out
SA	South Australia
MHC-SF	Mental Health Continuum- Short Form
EBP	Evidence Based Practice

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Chapter 1 - Introduction

Preamble

The technological advances fostered by the internet and the advent of smartphones have created a revolution in the way people live. It is not an exaggeration to say that practically every area of human experience has been impacted by technology and the internet to some degree, from social life and employment, down to day-to-day tasks and entertainment (Provazza, 2019). In that context mobile health (mHealth) has presented itself as a promising approach to support and facilitate health care (Byambasuren et al., 2018; Larkin, 2011; Milne-Ives et al., 2020), demonstrating its usefulness to reduce levels of high prevalence psychological disorders such as depression and anxiety (Berg & Perich, 2022; Garrido et al., 2019). However, within the last decade, a new area of research has started to investigate the promise of apps to promote wellbeing (McKay et al., 2019). This research has particularly focused on young people, defined as the period of life between the ages of 16 to 25 years (Australian Institute of Health & Welfare, 2020; Dovey-Pearce et al., 2005), given their natural tendency to use technology (Burns, 2017). The potential of using technology to increase wellbeing may be hindered though by a lack of user engagement (Bresnick, 2015). With this in mind the current program of research set out to understand the factors that influence young peoples' engagement with wellbeing apps using multiple and complementary approaches including a systematic literature review, content analysis, analysis of users' characteristics, and in-depth interviews with typical users.

Context of candidature

The program of research undertaken was developed in the context of a larger research project called the Young and Well Cooperative Centre (Y&WCRC) (Burns, 2013). This multi-institutional collaboration included more than 70 partner organisations from universities to government across Australia with the goal of investigating the interaction of mental health, technology, and youth. I was employed as a research officer in a sub-project

called Young and Well Towns co-sponsored by Y&WCRC, Flinders University and Country Health South Australia Local Health Network (CHSALHN). Many significant outcomes were produced by this cooperative research centre addressing issues as diverse as cyber bullying, alcohol use, engagement with mental health services, and gaming for wellbeing (Montague & Parker, 2014; Orlowski et al., 2015; Papinczak et al., 2015). Overall, the different studies sponsored by Y&WCRC supported the case of using technologies to improve the wellbeing of young people in Australia.

In contrast to traditional mental health approaches, the emphasis of the Y&WCRC was to invest in wellbeing rather than the treatment of pre-existing mental illness. Concurrent to the Y&WCRC being developed, South Australia was in the process of positioning itself as the first “State of Wellbeing” in Australia following the implementation of Positive Psychology (PP) across the educational and government sectors, guided by the states’ ‘thinker in residence’ at the time Dr Martin Seligman (*South Australia State of Wellbeing*, 2017). The ideas and research questions described in this thesis emerged from the larger project, keeping the focus on strengths over deficits and how young people interact with novel technologies.

Aims of Thesis

Statement of the problem

Youth mental health is a priority area in Australia given that 1 in 4 young people between the ages of 16 to 24 years are reported to struggle with at least one diagnosable mental health issue (Australian Institute of Health & Welfare, 2021c; Milnes et al., 2011), and only a fraction of young people who experience mental health issues access traditional mental health support services (Milnes et al., 2011; Orlowski et al., 2016). The commonly coined “mobile health revolution” promised new ways to reach people in more efficient and timely ways with higher accessibility (Bucci et al., 2019). In this context, technology continues to offer a solution to help overcome barriers such as distance, accessibility, cost,

stigma, , out-of-hours support, and the need for anonymity (Singh & Landman, 2017). However, the majority of existing mHealth interventions address only existing mental illness, with very few targeting wellbeing. If conceptualised and designed to target the improvement of positive symptoms of mental health (e.g., positive emotion, meaning, hope) to prevent and manage mental illness, innovative mHealth apps can be an effective strategy to improve wellbeing by harnessing young people's natural affinity with technology. But this all relies on engagement with these apps, something which is traditionally low (Aggarwal, 2016; Andrews et al., 2013) and impacts the effectiveness of interventions (Free et al., 2010). The focus of this program of research is to investigate the factors that determine engagement as a pre-condition for the use of technologies designed to increase wellbeing.

Gaps in the literature

Limited research on wellbeing using mobile health technologies

Although the areas of wellbeing and positive mental health have an extensive body of research (Abeele, 2020; Bolier et al., 2013; Cheng, 2020; Vella et al., 2018), specific studies on the interaction of wellbeing and mHealth are scarce. The lack of research in this area is arguably due to it being a nascent research area and due to the traditional emphasis given to interventions focusing on deficits and pre-existing clinical conditions. The present program of research addresses this gap by focusing solely on wellbeing apps, their content, design, and most importantly on how users engage with them.

Poor understanding on how young people view wellbeing and its impact on engagement

Being a concept that is relatively new in psychological terms (Carr et al., 2021; Seligman, 2018) wellbeing is still not clearly understood when compared to more popularised psychological terms such as stress or anxiety (Waters et al., 2022). This lack of common understanding is even more noticeable in young people, as they struggle to define wellbeing and what it means to them. Research conducted by the Y&WCRC

(Winsall et al., 2018) showed that young people think about their wellbeing in a diverse, contextualised way and mostly when it is negatively impacted. Understanding how young people conceptualise wellbeing can provide useful insights to explain how they interact with technologies designed to improve it.

What are the predictive engagement elements that need to be considered when designing / adopting technologies?

Most studies addressing engagement with mHealth apps focus on the technical aspects of the app and use statistics such as downloads, time spent in an app, number of sign-ins and others (Kulyk et al., 2015; Lewis et al., 2020; Oyebode et al., 2020). However very little research exists focusing on users' experiences, understanding, and meaning associated with the use of these apps. The current program of research addressed this gap by looking into users' characteristics reflected in existing relevant research as well as by consulting with users directly.

Aims

The aims of this program of research were to:

1. Analyse the composition of wellbeing apps from a behavioural change perspective to assess the levels of evidence based behavioural change techniques imbedded in their design.
2. Understand engagement from an individual psychological perspective opposite to focusing on number of downloads or persuasive design elements.
3. Analyse and individuals' personal motivations to use mobile apps focused on wellbeing, emphasising the characteristics that enable users to make significant use of wellbeing apps.
4. Propose ways of maximising engagement to enhance the effect of quality wellbeing apps. The recommendations arisen from this research should contribute to increasing wellbeing levels.

Chapter 2 –Theoretical Framework

Preamble

Divided into four sections, this chapter presents the theoretical concepts that guide this program of research. Initially an overview of the field of Digital Health will be presented, positive / negative aspects, challenges / opportunities, and its interaction with mHealth. Next the concepts of wellbeing and mental health will be examined, in line with the Complete Mental Health Model proposed by Keyes and Lopez (Keyes & Lopez, 2002), along with the importance of health behaviours as the main targets for mHealth interventions and their relationship with wellbeing as a whole. Finally, the wellbeing challenges faced by young people will be examined, with a focus on understanding the interaction and use habits of young people and technology, and the concepts of engagement and identity. The main theories that will be interwoven in the sections outlined above include the research of Sherry Turkle on the interaction of youth and technology (Turkle, 2011a); and the research on identity, imagination, and intimacy through the use of apps presented by Howard Gardner (Gardner & Davis, 2013).

Section 1: Digital Health, Mobile Health and their interaction with mental health

Introduction

Technological advances have driven the progress of our species through history (Dzau & Balatbat, 2018), sometimes this advance has been steady as in the middle ages and at other times it has happened in leaps and bounds, sparking real revolutions in the way people conceptualise and live their lives (Bird, 2012, 2014). From the nineteenth to the twenty first century technological progress has accelerated very rapidly; improvements in life expectancy (from 40 to 83 years), quality of life and overall wellbeing from the time of the Industrial Revolution until now have surpassed all expectations (Estes & Sirgy, 2019;

Wilmoth, 2000). Scientific knowledge and technology have traditionally advanced hand in hand, and in doing so overall health has also benefited from this (Thimbleby, 2013).

From a technology perspective we are currently experiencing a boom. The explosion of the internet and mobile technologies have brought to reality ideas only previously conceived in science fiction such as mobile phones, video calls and instant communication (Manafi Varkiani et al, 2022). According to the market and consumer website Statista, smartphone subscriptions worldwide currently surpass 6 billion, with an estimated 7.690 billion by 2027 (Statista Research Department, 2022). Mobile applications now exist not only to facilitate day to day tasks and entertainment such as: banking, retail, travel bookings, gaming etc., but also, and increasingly, for things like the monitoring and treatment of medical and health related conditions (Direito et al., 2015; Francis, 2018; Staiger et al., 2020). The possibilities of smartphones and related technologies are significant; however, academia is lagging as researchers try to understand the implications and reaches of this technological revolution (Kankanady, 2020). Smartphones have impacted virtually every area in our lives, they have changed the way we behave, communicate, connect, navigate our environment and in short even the way we conceptualise our reality and health (Provazza, 2019).

Digital Health

Aptly called “Digital Health”, this relatively new term describes several technologies that could be used to collect and manage an individual's health data in order to facilitate and deliver treatment; this may include sharing clinical records, using telehealth, mobile health, wearables, and even artificial intelligence (Aguilera, 2015; Australian Institute of Health & Welfare, 2022). Applications in the area of digital health can be seen in the treatment of chronic conditions such as diabetes (Cafazzo et al., 2012; Georgsson et al., 2019) and cancer (Kouroubali et al., 2019; Zheng et al., 2020), as well as in the management of health behaviours, for example, smoking cessation (Barroso-Hurtado et al., 2021;

Bricker et al., 2020), alcohol abuse (Hides et al., 2018; Tait et al., 2019) and even risk behaviours (Milne-Ives et al., 2020; Sherin et al., 2014).

Mobile Health

The term mobile health (mHealth) refers to the utilisation of mobile technologies including wearables, sensors and smartphones, for the delivery of health interventions, sharing of health-related information, access to relevant health information and communication with health providers (Larkin, 2011; Singh & Landman, 2017). Currently, in 2023, mHealth is seen as a revolution in health given the ubiquitous availability of smartphones and their ever-increasing capabilities (Manafi Varkiani & Chelaru, 2022; Novartis, 2014). Since its inception mHealth has had a positive impact, reportedly lowering costs and facilitating the interchange of information between patients and clinicians (Handel, 2011) (refer to Table 1). However, as mHealth is still a nascent field and as such is mostly guided by app developers and industry (Eapen & Peterson, 2015), there are still challenges faced by this field (refer to Table 2).

Table 1

The Suggested Benefits of Utilising mHealth

Accessibility	Abolishing the need to attend appointments physically, clients can access information immediately and communicate with their health professionals (Kim et al., 2019)
Reduced costs:	Removing costs associated with transportation and dedicated infrastructure (Hall et al., 2014; Kim et al., 2019)
Speed	Interventions can be delivered with little waiting time and asynchronously (Ganasegeran et al., 2017; Larkin, 2011)
Personalised and patient centred treatment	Interventions can be tailored to target an individual's specific symptomatology (Ganasegeran et al., 2017; WHO Global Observatory for eHealth, 2011)
The use of preventative interventions	Using behaviour management interventions (Allida et al., 2020)
Reducing the need for hospitalization	Decreasing cost of care and improving the patients' quality of life (Schmaderer et al., 2022; Stinson et al., 2014)
The advantage of patient-generated data	Data collected in real time and shared with practitioners to tailor the best course of treatment (Agnihothri et al., 2020; Kim et al., 2019)
Chronic conditions management	By improving health behaviours and tracking (Agnihothri et al., 2020)
Treatment of non-critical conditions	By improving the quality of life and the levels of wellbeing (Lucivero & Prainsack, 2015)

Table 2

The Challenges Faced by mHealth

Effectiveness	An overview of systematic reviews including 23 reports concluded that the evidence in favor of the effectiveness of mHealth apps is very low with only 11 studies reporting meaningful effects on health (Byambasuren et al., 2018)
Diffusion	The dissemination of mHealth apps is a challenge (Gallos & Mantas, 2017). mHealth apps suffer the tag of “serious” apps, lacking the entertainment value of most successful apps and requiring intense and sustained use (e.g., keeping diaries, several logs a day, etc.) (Giunti et al., 2018) as opposite to a transactional use of other utilitarian apps such banking or shopping apps (Patel et al., 2020)
Uptake and engagement	Engagement with mHealth resources is poor particularly from young people (Goodyear et al., 2019; McLean, 2018)
Privacy and confidentiality	The management of sensitive information and the implications of potential breaches are a significant barrier for the use and adoption of mHealth solutions. This is true for practitioners as much as for users (Atienza et al., 2015; Nurgalieva et al., 2020)

Mobile Phones

Mobile phones are a preferred medium for the delivery of mHealth interventions due to them being portable and accessible (Camacho et al., 2014). Mobile phones have evolved from only being capable to make and receive calls to becoming “smartphones” (Islam & Want, 2014). Smartphones are in effect miniaturised personal computers with an ever expanding range of capacity both in memory as well as in processing, enhanced by their connectivity to the internet and thus becoming an entire world of information (Islam & Want, 2014). Smartphones can reproduce and stream different types of media, navigate the internet, serve as personal assistants, and by utilising specialised programs called “apps” (for applications) perform an ever-expanding number of functions. As miniature computers, mobile phones work as access points to the internet, this again, has grown ever more

powerful and straight forward with the advent of 3G, 4G and now 5G technologies (“G” refers to technological generations, every generation constitutes an advancement in speed, processing capacity and features) (*5G Explained*, n.d.). As minicomputers, mobile phones can store, download, and process large amounts and types of information, from text to complex games and real time video communication in high fidelity; they become a hub for information and entertainment (Provazza, 2019). Mobile phones are affordable and have high levels of penetration, mobility and versatility making the experience of using mobile phones every time, everywhere and in every context, pervasive and ubiquitous (Provazza, 2019).

Mobile applications – Apps

Generally speaking, an app is a program, which is then specialised and designed to integrate with the capabilities already offered by the different models of smartphones (camaras, sensors, video software, etc.) (Jabangwe et al., 2018). Users can download apps from specialised “app stores”, with the principal two being the “App Store™ for Mac users and “Google Play™ for Android users. In the app stores, apps are organised in different categories, such as games, lifestyle, and health. The number of apps in existence is ever expanding with an estimated of 1.96 million in App Store and 2.87 million in Google Play in 2022 (*Mobile App Download Statistics & Usage Statistics*, 2021). The existence and use of apps have revolutionised the way users behave and live their lives, being used to aid in nearly every aspect of life: socialising, productivity, entertainment, finance, education, travel, health and lifestyle (Anderson, 2016; Seberger et al., 2021).

mHealth apps

mHealth apps exist for promoting and supporting health, with approx. 3.87 million people suggested to be using health or fitness apps on a monthly basis (Mobius, 2021). In the first quarter of 2022, it was reported 52,565 health related apps existed in Google play, with estimates setting the growth of the mHealth field at 11% per year (from 2022 to 2030)

with a current market value of USD$50.7 billion. (*MHealth Apps Market Size | Industry Report, 2021-2028*, n.d.). There are two types of mHealth apps: the apps that are designed to support health interventions and manage health (e.g., symptom checkers, self-monitoring, prescription, rehabilitation, and doctor-patient communication apps) (Boulos et al., 2014), and those designed to support wellbeing and manage lifestyle behaviours (e.g., fitness, physical activity, diet, and sleep trackers etc.) (Dennis, 2020). The current program of research focuses on the second type. Given the scarcity of apps specifically developed to target wellbeing, for the sake of the current research, health and lifestyle apps are viewed as equivalent since they target categories that are consistent with wellbeing theory as expounded in the Complete Mental Health model by Keyes and Lopez (Keyes & Lopez, 2002). With that in mind, the term *"wellbeing apps"* will be used to describe specific wellbeing apps as well as health and lifestyle apps included in this thesis.

Opportunities

In contrast with the challenges described above, mHealth also presents many more opportunities that are worth exploring while technologies keep evolving. According to research by Norris and colleagues (2009) at the start of the mHealth revolution, mHealth was conceptualised to address four key aspects of health care: (1) prevention, by creating public health and lifestyle awareness; (2) monitoring: pre-disease screening and assessment; (3) treatment, supporting the provision of efficient and effective care; and (4) support for patients and their carers. The four opportunities cited are compounded by the fact that mHealth also has the added potential of being consumer focused, or in other words "client-centred," by putting power back in the hands of the user to make their own decisions, at their own pace and in their own way (McCurdie et al., 2012; Orlowski et al., 2015).

mHealth and Mental Health

The literature demonstrates an increasing use of mHealth for the support and promotion of mental health from the perspective of treating mental illness (Aguilera, 2015;

Burns et al., 2016; Luxton et al., 2011). Examples of this abound with studies addressing common mental disorders such as depression, anxiety, psychosis and even personality disorders (Berg & Perich, 2022; BinDhim et al., 2015; Drissi et al., 2020; Steare et al., 2021).The principal arguments supporting the use of apps in the mental health field are common to those relating to mHealth in general: reduced costs, increased accessibility, greater flexibility, and most importantly reduced stigma, particularly relevant for young people (Burns et al., 2016).

In spite of the benefits of mHealth, dissenting voices see apps as ineffective or essentially dangerous, citing arguments related to the low quality of content, the risks associated with managing risk, confidentiality issues, poor self-management, unrestricted and unfiltered access to medical – health information leading to misinterpretations, and ultimately the ineffectiveness of the interventions (Borland, 2015; Dossey, 2015). Consistent with these dissenting views, some apps are seen by users as medical devices, trusting in the information obtained when using them as if it was as accurate as tested medical devices, which in turn has the potential of causing harm (Herron, 2016). The lack of scientific support in the design of mental health apps is also frequently cited (Neary & Schueller, 2018), as is the lack of meaningful engagement by the users (Asall-Payne, 2016); this last aspect is of particular importance as users tend to interrupt their treatment before the benefits of using health apps can be obtained. A review looking into 389 studies that used health apps determined that a lack of support features, technical difficulties, and lack of usefulness were contributing factors for the ubiquitous problem of user engagement (Amagai et al., 2022).

Section 2: Wellbeing and mental health

Mental Illness vs. Mental Health

Mental illness can be defined as the presence of diagnosable disorders, which in turn fall into categories of deficits and disfunction in one or more areas that influence behaviour, cognitive functioning and emotional regulation, with an associated impact on relational

capacity and contextual adaptation (Keyes, 2005). Mental health has traditionally been understood as the absence of mental illness (Keyes, 2005), this implies for example, that if someone does not meet diagnostic criteria for depression, it is assumed they are healthy. However, the rationale of defining health just by the absence of disease does not account for optimal functioning, this is particularly true for mental health, as just being free of mental illness does not account for personal growth, meaning, success, satisfaction or happiness (Keyes, 2002). In that context, the discipline of positive psychology (PP) attempts to address the totality of human experience by investigating those areas that reflect optimal functioning and the realisation of individual potentialities (Seligman, 2018; Seligman & Csikszentmihalyi, 2000). Psychologists Corey Keyes and Shane Lopez proposed the Complete State Model of Mental Health (CSM) (Keyes & Lopez, 2002). The CSM emphasises mental health as a complete state, not merely the absence of mental illness but also the presence of mental health. Keyes conceptualised mental illness and mental health as two different continua (Keyes, 2005). The two continua model of mental illness and mental health holds that as much as both concepts are related, they also reflect distinct dimensions: one continuum indicates the presence or absence of mental health and the other the presence or absence of mental illness. In this way the mental illness continuum covers diagnoses ranging from psychotic disorders to personality disorders and mood disorders, while the mental health continuum covers mental health on three levels: (1) languishing, which includes the absence of symptoms of mental health such as positive emotion, motivation, social engagement, self-acceptance, etc. but at the same time does not meet criteria for mental illness; (2) moderate mental health, which is diagnosed when symptoms of mental health are present but not significant; and finally (3) flourishing, which is the mental health diagnosis that includes optimal functioning in social, psychological and emotional areas (refer to Figure 1). In order to determine these mental health ranges, Keyes diagnosed their presence by assessing symptoms, indicators, frequency of behaviours, perceptions, and attitudes towards different circumstances in life that would impact functioning across four realms of wellbeing (Keyes, 2002) (refer to Table 3).

Figure 1

Complete State Model of Mental Health (Keyes & Lopez, 2002)

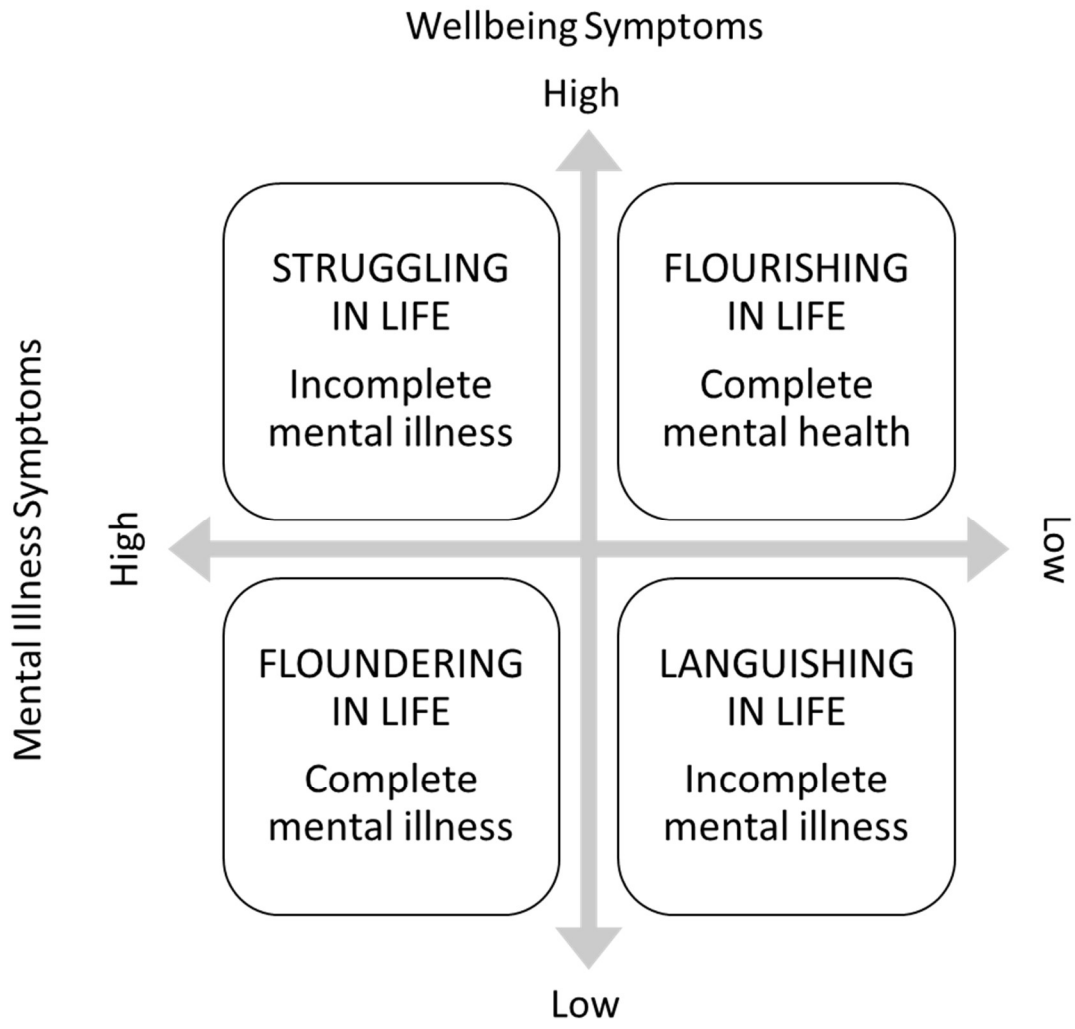

Table 3

Wellbeing areas according to the Complete State Model of Mental Health

Emotional wellbeing:	Emotional wellbeing comprises positive emotions in two dimensions: hedonic wellbeing, with emotions such as joy, happiness and hope, as well as Eudamonic emotions such as sense of peace, balance and contentment. Someone enjoying emotional wellbeing is capable of connecting with nature and engaging in activities that bring satisfaction: appreciation, calm, relaxation, living in the moment, achievement, purpose and feeling free.
Physical wellbeing:	Physical wellbeing comprises the practice of health behaviours such as a healthy diet, sleep, exercise and overall fitness.
Social wellbeing	Social wellbeing speaks of connectedness and positive adaptation to the social environment of the individual. As part of social wellbeing the model contemplates: - Contribution: Service, thinking of others, helping those in need, working, giving advice, participating in church - Social integration: beliefs, culture, history, community, teams, clubs, groups - Social actualisation: the belief that the community has potential and can evolve positively - Social acceptance: Loyalty, trust, treating people right, kindness - Social coherence: being able to make meaning of what is happening in society, contact with other cultures
Psychological wellbeing	Psychological wellbeing speaks to intra-personal elements such as - Self-acceptance: Believing in self, confidence, self-esteem, being authentic - Environmental mastery: Balanced lifestyle, embracing challenges, being outside of comfort zone, accepting defeat, resilience - Positive relations: Family and friends, socializing. - Personal growth: Studying, reading, travelling, discovering, experiencing, learning, taking risks; - Autonomy: Freedom, feeling free, independent - Purpose in life: Goals, creating a purpose, plan to achieve, being motivated

Complete mental health is a combination of high emotional, psychological, social and physical wellbeing, along with low mental illness; at the same time, this two continua model implies that efforts to increase positive emotions will not automatically result in decreased negative emotions, nor will decreased negative emotions necessarily result in increased positive emotion (Keyes, 2005). In contrast, according to the CSM, people can experience both negative symptoms of mental illness and positive symptoms of mental health simultaneously (e.g., anxiety and hope for the future), as they are not mutually exclusive. The complete mental health model seeks to bring attention to the mental health spectrum and by defining its symptomatology, to pursue interventions that can improve levels of mental health, and therefore wellbeing.

The ideal state of mental health is called flourishing and it is defined as functioning in an optimal state and reflects a mindset of growth, generativity and resilience; flourishing people have less issues in terms of physical disease, productivity and psychosocial functioning (Fredrickson & Losada, 2005; Keyes, 2002; Seligman, 2018). People who are functioning in less than optimal mental health levels are diagnosed as languishing according to the CSM. Languishing people are thought to struggle through life as much or even worse to those who present a mental illness diagnosis (Westerhof & Keyes, 2010). Increasing symptoms of mental health in young people can help to buffer against the onset of mental illness; the use of technology can potentially help in building mental health (Burns, 2013; Madden et al., 2020).

Health behaviours

Health behaviours refer to ways of ‘behaving’ that either support health or impair it (Havigerová et al., 2018). Positive health behaviours (e.g., health supporting) relate to things like regular physical exercise, appropriate diet, and a lifestyle that leads to mental health and wellbeing, whereas poor health behaviours (e.g., health impairing) relate to things like substance abuse, poor nutrition, lack of sleep and sedentary behaviour

(Havigerová et al., 2018; Lacombe et al., 2019). Several of the main causes of preventable death are non-communicable and related to health impairing behaviours (WHO, 2020).

From a mHealth perspective, both clinical interventions and health and lifestyle apps rely on modifying health behaviours (Fitzgerald & McClelland, 2017). Behaviour change Techniques (BCT's) are irreducible techniques and interventions aimed at modifying behaviours and originated in evidence-based behaviour change theories, they are observable and replicable (Michie et al., 2013), examples of BCT's include: goal setting, tracking, self-talk, repetitions, and others. Interventions aimed at improving health behaviours should be including behaviour change techniques (BCT's) (Fitzgerald & McClelland, 2017), however various studies show that wellbeing apps are not including appropriate BCT's consistently (Antezana et al., 2020; Eapen & Peterson, 2015).

Health behaviours involve preserving one's health even in absence of symptoms, and as such they demand a higher personal involvement and a clearer motivation (Havigerová et al., 2018). Personal engagement with interventions and technologies designed for this purpose is essential. Several health behaviour models exist attempting to explain the factors influencing their adoption (Chu & Liu, 2021).

- **Health Belief Model** (HBM) (Carpenter, 2010). The HBM is widely used to explain how people engage with health promotion interventions and app adoption (Alharbi et al., 2022), the training of positive health behaviours (Almutari & Orji, 2021), and even driving skills (Morowatisharifabad, 2009). The HBM is comprised of the following elements: (a) perceived susceptibility, related to the persons' assessment of becoming ill; (b) perceived severity, referring to the individual's assessment of the seriousness of their condition; (c) perceived barriers, things that are preventing the individual from behaving in a way that prevents illness; and (d) perceived benefits of engaging in positive health behaviours.

- **Social cognitive theory** (Bandura, 1989, 2009), explains how people's behaviours and attitudes are influenced by how other people act and how they perceive the outcomes of those behaviours. Social cognitive theory is comprised of (a) reciprocal determinism, describing the interaction of the individual with their environment and their behaviour aimed at achieving goals; (b) behavioural capability, referring to the capacity of the individual to perform a behaviour; (c) observational learning, referring to the capacity to imitate others' behaviours; (d) reinforcement, referring to the contingencies either internal or external that sustain behaviour; (e) expectations, referring to the anticipated outcomes of a behaviour; and (f) self-efficacy, referring to the level of a person's confidence in his or her ability to successfully perform a behaviour (Bandura, 2009). Social Cognitive Theory has been applied in areas such as health promotion (Bandura, 1998), increasing physical activity (Maberry, 2016), increasing motivation (Schunk & DiBenedetto, 2020) and even technology acceptance (Ratten, 2015).
- **Transtheoretical stages of change model** (Prochaska & Prochaska, 2019), this model considers the individual readiness to change in five levels: pre-contemplation, contemplation, preparation, action, and maintenance (Adams & White, 2003). These stages assume that people and organisations have different levels of motivation that ultimately determine their involvement in behaviour changing activities. Transtheoretical stages of change include individuals and different organisations (community) working together in planning for actions that would drive change through the different stages of the model. The transtheoretical stages of change model is frequently applied for health promotion, weight management, smoking cessation, depression, stress management and medication adherence amongst other (Adams & White, 2003; Liu et al., 2018; Tafticht & Csillik, 2013).

Section 3: Young people and wellbeing apps

Young people's mental health

In the scope of this research, we have adopted the most common definition of young people as it applies to most contexts, countries, and cultures. This definition focuses on age, usually locating this period of life between the ages of 16 to 25 years (Australian Institute of Health & Welfare, 2020; Dovey-Pearce et al., 2005). Traditionally it is understood that youth is a period of transition and profound transformation, this transition happens between adolescence to adulthood (Shek et al., 2019). Being a transitional period, adolescence and early adulthood imply instability and involves the exploration of different roles in society. Perhaps the most relevant aspect of the transformation undergone by young people in this stage of life is the search for their own identity (Crocetti, 2017). Identity in adolescence is multifaceted and complex, involving personal, social, and cultural dimensions (Becht et al., 2016). At a personal level, young people differentiate from their families of origin, starting with taking comparably opposing attitudes to their role models (usually their parents) and seeking validation from their peers (Jugert et al., 2020). The process of individuation demands that young people develop their personality in a dynamic process of comparison and validation (Topolewska-Siedzik & Cieciuch, 2018). In order to be successful in the process of individuation, young people have to master certain cognitive abilities such as hypothetical deductive thinking which allows them to use critical thinking at the moment of making decisions and assessing the value of the different elements that constitute their context (Lehalle, 2006). The advent of technology, internet, apps and social media has greatly impacted the socialisation patterns of young people, adding several layers of complexity that need to be considered both in its benefits as well as its challenges (Boonmongkon et al., 2013; Gardner & Davis, 2013; Rodogno, 2012).

Young people face several challenges to their development and wellbeing, one of the most important of which after the COVID19 pandemic has been unemployment. In Australia,

before the pandemic, youth unemployment rose from 12% in 2010 to 16% in 2020 (Australian Institute of Health & Welfare, 2021b). However, after the onset of the pandemic, this situation has worsened with young people accounting for 55% of all reported job losses (Littleton & Campbell, 2022). Employment issues pose significant challenges to a young people's mental health, as in the process of becoming adults, many young people define their identity through their work, with young people suffering common mental health disorders (e.g., anxiety and depression) when this area is affected (Bartelink et al., 2020). Young people also face the challenge of academic performance and study, this often constitutes a source of stress, with evidence showing that university students may be at higher risk of developing common mental health disorders and showing symptoms such as hopelessness, being overwhelmed, exhaustion and sadness (Pedrelli et al., 2015).

Youth mental health is a priority in Australia and around the world, given that half of mental health disorders present before the age of 14 years, and three quarters by age 24 years (Australian Institute of Health & Welfare, 2021c). Youth mental health prevalence, added to the propensity of young people to engage in high risk behaviours (e.g., consume illicit substances, engage in high risk sexual activity) makes them highly vulnerable to harm and disease (Australian Institute of Health & Welfare, 2021c). As of 2021, the Australian Institute of Health and Welfare (AIHW) estimated that 1 in every 4 young people in Australia suffer from a diagnosable mental health condition (Australian Institute of Health & Welfare, 2021c). The high prevalence of mental health disorders together with the cultural and societal transformations experienced in recent years highlight two needs: (1) find effective and adequate strategies to treat and support young people struggling with their mental health, and (2) invest in strategies to prevent and strengthen young people's mental health before they develop substantial problems (Colizzi et al., 2020).

The COVID-19 pandemic has affected young people in many ways, despite them not being classified in the high-risk population. Between July and August 2020, the Australian Institute of Health and Welfare estimates that due to COVID-19, up to 42% of young people

claimed disruption in their personal relationships, this was better than April where 70% of young people complained in this regard (Australian Institute of Health & Welfare, 2021a). Psychological distress as an effect of COVID-19 restrictions was also measured by the AIHW, with it being worse in 2020 and improving by the end of restrictions in 2021. Additional areas impacted included employment, education, and the worsening of living conditions such in the case of those suffering domestic violence (Australian Institute of Health & Welfare, 2021d). All these factors have an impact on the overall wellbeing of young people.

Young people and health behaviour

Young people represent the apex of development in physical activity, with peak physical performance usually happening between ages 19 to 26 years of age, and muscle tone decline starting at age 30 years of age (Santrock, 2020). Healthwise young people show fewer chronic problems that older individuals, however they are more prone to develop negative health behaviours such as substance abuse (nicotine, alcohol, drugs) and carry out high risk behaviours (Santrock, 2020). There is also a significant number of young people that don't engage in enough physical activity. According to the AIHM only 11% of young people aged 15 to 17 years were sufficiently active, this was significantly better for those aged 18 to 24 years at a 55%, but still low as just 1 in 3 were reported to meet recommended muscle strengthening guidelines (Australian Institute of Health & Welfare, 2015). Physical activity is essential to health and wellbeing, reducing sedentary behaviour in young people is a priority area as it relates to obesity and other systemic problems later in life (Blair & Morris, 2009).

Good health behaviours in the areas of sleep and nutrition are as important as physical activity for young people (Havigerová et al., 2018). Given that adolescence is a process of intense development, poor sleep and bad eating habits have a detrimental impact on cognition, emotional regulation, and mental health (Brand & Kirov, 2011;

Chaput & Dutil, 2016). Encouraging a balanced and active lifestyle is essential to maximise young people's opportunities to thrive (Blair & Morris, 2009). Wellbeing apps are designed to target health behaviours related to physical health such as exercise, sleep and nutrition (Milne-Ives et al., 2020) and increasingly also target emotional and psychological wellbeing (Bakker & Rickard, 2018).

How do young people understand wellbeing?

To understand if and how young people interact with wellbeing apps, it is important to consider the level of awareness and interest that young people have about their own wellbeing (Goodyear et al., 2019). It is suggested that being aware of their own wellbeing goes beyond being conscious of existing mental health issues, as these are disruptive by definition and therefore more likely to be addressed directly (Colizzi et al., 2020). Evidence suggests that young people in particular give little attention to thinking about their overall wellbeing, let alone at reflecting on the potential benefits of investing in it in order to prevent the impact of mental illness or other health conditions in the future (Winsall et al., 2018).

Specific research to understand young people perceptions of wellbeing is limited. A study by Winsall et al. (2018) found that wellbeing for young people is personally contextualised, mediated to individual experiences, and usually related to physical and mental health (refer to Table 4). While this research highlighted the importance of social elements such as family and friends, meaning, connectedness and purpose (consistent with the CSM model), most importantly it suggested young people only consider their wellbeing in times of stress. The implications of these findings are that investigations into how to young people can be engaged to build and maintain mental health need to be undertaken before it gets compromised, otherwise treating the distress at hand will always be the focus (Winsall et al., 2018). Although young people in Winsall's study were able to articulate complex understandings of wellbeing when prompted, they did not think about their wellbeing on a regular basis, let alone taking steps to strengthen it. Investigating young

people's understanding of their own wellbeing could then be another important and needed factor to be understood before we understand how they engage with wellbeing apps.

Use of and engagement with apps

From a research and clinical perspective, the first question asked in relation to understanding a user's engagement with health and wellbeing apps is if the use of these apps facilitate behaviour change. While the literature in this area suggests participants who adhere to study conditions do benefit from using health and wellbeing apps, as described in the mHealth section of this chapter (Fitzgerald & McClelland, 2017), it also suggests positive behaviour change could be enhanced by using multimodal interventions and not relying solely on mobile apps, SMS or the internet (Eapen & Peterson, 2015). The subsequent and more clinically relevant question is then whether young people maintain engagement with these type of apps / interventions for long enough for them to be effective. Poor engagement seems to be a common issue in mHealth, and it is considered to be an essential determinant to maximise the potential benefits and promise of these tools (Bresnick, 2015; Eapen & Peterson, 2015). Different approaches to improving young people's engagement with wellbeing apps have been investigated, ranging from purely technological design and persuasive technology (Kulyk et al., 2015) to psychological characteristics (Goodyear et al., 2019).

Table 4

Wellbeing Key Themes as Identified by Young People (Winsall et al., 2018)

Theme	Examples	
	Actions indicating or leading to wellbeing	**Things needed for wellbeing**
Positive emotions and enjoyable activities	feeling happy, smiling, laughing, making jokes, positive attitude, having fun, celebrating, shopping, reading, surfing, gaming	music, parties, karate, motorbikes, a good state of mind
Physical Wellness	healthy eating, exercising, swimming, running, sleeping, drinking water, de-stressing, relaxing	health, fitness, sport, massages, organic, vitamins, fruits and vegetables
Social connectedness & Altruism	talking, accepting others, getting together, loyalty, become part of teams/clubs, make new friends, be part of your community, fitting in, volunteering, respecting others, treat others well, responsibility for your friends, kindness, caring	a support network, friends and family, unconditional love
Autonomy and Control	protect yourself, in control of yourself, in control of your life, make good choices, rising above, being independent, clear your mind, let things go, work-life balance, 'normal' behaviour	safety, stable home life, long drives, freedom, money
Goals and Purpose	perseverance, being motivated, set goals, work towards something, planning, hope for the future, recognising your achievements	receiving awards and prizes, having purpose/purposeful lifestyle, having hobbies
Being Engaged and Challenged	learning, going to school, travelling, exploring, discovery, living in the moment, taking risks, learn from your past mistakes, being outside comfort zone, competition	a career
Self-esteem and Confidence	body language, believing in yourself, self-acceptance, be confident, be yourself, free of embarrassment, no judgement	.

In the realm of design, one of the main aspects considered when talking about technology use and adoption is usability (Wilks et al., 2021). Most research in the area of usability has focused on analysing engagement, or lack thereof, based on the features offered by the apps (Kolt et al., 2013). Elements such as data recollection, automatic tracking, accessibility, interfaces, goal setting, and other BCT's are commonly named in these studies (Oyebode et al., 2020; Ruijten, 2021). However, the conclusions regarding their engagement are limited and they do not account for users' motivation and long term use (Duncan et al., 2014; Neilsen, 2009; O'Reilly & Spruijt-Metz, 2013; Rabin & Bock, 2011). Moreover, while there is an increase in the number of people using wearables and downloading tracking apps (Deranek et al., 2021); it is counterintuitive to learn that it has been reported the longer someone has a tracker the less they use it, with most people leaving it within a month (Clawson et al., 2015).

The consensus seems to indicate that a combination of both persuasive design and personal factors need to be considered and included in the design of mHealth interventions, and by extension wellbeing apps in order to increase engagement (Goodyear et al., 2019; McLean, 2018). Persuasive design, is an area of practice that seeks to influence human behaviour using elements such as calls to action that emphasise goals achievement and personal improvement; rich imagery related to health, belonging to a team, audio reminders during and after workouts, and access to extensive content (blogs, communities, forums, etc.) (Antezana et al., 2020). Technical elements in the forms of features (e.g., reminders, alarms, diaries, etc.) are essential as they are the means to interact with the users and facilitate the interchange of information that makes up the intervention in itself (Gurupur & Wan, 2017), this is how BCT's get imbedded in the design of apps. Personal factors include the individuality of the users which guarantees that the meaning dimension of the intervention is not lost. It is suggested that users' individuality can be reflected in the implementation of personalised content and features that respond to deep motivations and values (McLean, 2018; Orlowski et al., 2015).

Section 4: Identity in the Context of Apps

Identity as a concept defines an individual's sense of self as being unique and separate from the others, and it relates to personal qualities, values, beliefs, and modes of being (Topolewska-Siedzik & Cieciuch, 2018). Identity relates to an environment and specific context, it gets moulded and validated by it and is transformed by its interaction with it (Jugert et al., 2020). It is not possible to talk of identity without also considering the importance of biological development and the capacity of the individual to interact with others and their environment (Topolewska-Siedzik & Cieciuch, 2018). Considering young peoples' developmental characteristics is essential when discussing how they form their identity.

Sherry Turkle and Identity in the virtual world

Research by Sherry Turkle recognizes the potential advantages of technology while at the same time highlighting the risks and psychological implications. As young people are considered the main users of technology in current times, Turkle's reflections on identity and the online world are relevant to understand how young people use and engage with technology. At the start of the nineties Turkle described how technology developers tried to enhance themselves by adapting technology to their bodies, by using first generation "wearables" (Turkle, 1999). Turkle emphasised that identity is not circumscribed by the boundaries of our physical bodies, but that it can transcend into artifacts and the spaces they create (Turkle, 1999). The idea of identity transcending boundaries in 2023 is truly evident now more than ever with the hyper connectivity offered by the internet and the use of smartphones (Rodogno, 2012). Specific technologies are designed to expand identities online, moving away from physical restrictions as well as from specific contexts, allowing people to participate simultaneously in a diversity of worlds, both virtual and physical (Turkle, 2011a). This level of interaction with technology is described by Turkle as a new

state of self (Turkle, 2011a). Turkle acknowledges the potential benefits of technology, but she also warns of potential risks explaining how hyper connectedness can actually be detrimental (Turkle, 2011a). Turkle explains that young people online develop a sense of continual co-presence in the real and in the virtual worlds, this involves mixing simultaneous roles that exist in a specific physical space but with different virtual presences. According to Turkle one can be too connected, at the point of losing privacy, so balance is important. The online world allows young people to experiment in a way that is removed from a face-to-face trial and error dynamic; most young people are experimenting with different roles, tools and tasks in a technology mediated manner. Turkle worries that this experimentation has now been transferred to technology in a way that reduces uncertainty, experimentation is “safe”, time works in a different way and the communication codes are altered (Turkle, 2011a).

An essential element of adolescent identity is validation by peers and is underpinned by connection and inclusion in distinct reference groups (Jugert et al., 2020; Santrock, 2020). Similarly, to experimentation, peer validation is now being played online with the mediation of technology allowing young people to edit, change and modify themselves in a protected and idealised self (Turkle, 2011b). The possibility of editing one’s personality may end up causing young people to develop several simultaneous identities; whereas before social contact needed to be actively sought, this could be seeing as a risk of continuously interacting online (Turkle, 2011b). Another risk raised by Turkle is that young people do not have an off time for being disconnected to collect themselves, with the self-reflection periods necessary to assimilate learning and emotional growth are fewer (Turkle, 2011b). Although Turkle’s reflections could be seen as unwarranted and somehow exaggerated, it is already a recognised problem that adolescents suffer significant emotional distress when they are not allowed to be tethered to their technology, an example of this is the FOMO (fear of missing out) syndrome (Dinh & Lee, 2021).

It is commonly said that people, mostly young users, are over reliant on their technology and are no longer able to navigate their way without “google maps,” remember

telephone numbers, or even do mental calculations without use of the calculator app. Even the level of general cultural knowledge has been suggested to have decreased given the immediate availability of google, with the term “to google” something becoming a de-facto verb with real clear meaning in today’s language (Feng et al., 2022). In this context Turkle concludes that young people have merged with their technology transforming it into an extension of themselves, almost as a prosthesis and removing a smartphone from a regular user is like taking away their hands (Turkle, 2011b). Considering the importance that interaction with technology has for young people, the importance of using it in a way that increases wellbeing is made even more evident.

Howard Gardner, “The App Generation”

In the 2013 book written by Howard Gardner called “the app generation” (Gardner & Davis, 2013), he looked deep into the interaction of young people and technology and how it influences the way users expand their imagination, intimacy, and identity online, through the use of the ever-evolving power of technology. From Gardner’s perspective, young people tend to gravitate towards technology as they use it to interact with objects that are shaped in a self-contained package that functions semi-autonomously and is available at the touch of a button (Gardner & Davis, 2013, p.61). Despite young people’s tendency to seek self-contained, autonomous ways of doing things through technology, Gardner also makes the case that apps allow users to expand themselves into the virtual world in an active way. Apps capable of enabling users to expand themselves in the virtual world facilitate behaviours, feed motivation, and facilitate self-expression (Gardner & Davis, 2013, p.91). Gardner proposes a distinction between apps that are enabling as those that facilitate and enhance intentions and behaviours, vs. apps that create dependence as those which take over an individual’s capacity to act independently. Gardner posits that similarly to a finger print, the apps in a person’s telephone are a unique reflection of their identity (Gardner & Davis, 2013, p.60); this is a telling statement as it alludes to apps working as projections of the users’ individuality, albeit the fact that apps in themselves are designed in a generic way,

the way they are used can indeed reflect the preferences, values and idiosyncrasies of the individual and therefore serve as extensions to their identity. Gardner also reports that the expression of individual identity by the use of apps is somehow constrained by the actual design and programming of the app, however this needs to be added to the multilayered levels of use as well as the interconnectivity of apps in the virtual world (Gardner & Davis, 2013, p.60).

Identity Summary

Forming a healthy identity in the era of the virtual world is a multifaceted and complex process (Afshar et al., 2015). Identity is a complex concept that is not circumscribed to an individual physical reality, but that expands into the interactions that each one of us has with the environment, regardless of the medium utilized (Turkle, 2011a). Nowadays, young people express their identities in a pragmatic way, with the focus on achieving discrete objectives; the world and the way we interact with it becomes a "superapp" (Gardner & Davis, p.169 2013).Young people focus their identities in a more individualised way, the tendency is on becoming an "influencer" and to have "followers" while at the same time accumulating "likes" that reinforce the need to publish online almost obsessively (Dinh & Lee, 2021). This in turn points to the fact that role-models are increasingly in the media and not at home (van Eldik et al., 2019). Identity expressed through the use of apps becomes almost a performance that requires a delicate balance between intimacy and the need to communicate and engage in order to be reinforced by others and validate the ego (Afshar et al., 2015; Turkle, 2011a). Theorists like Turkle (Turkle, 2011a) and Gardner (Gardner & Davis, 2013) fear that this new way of being and the ever available presence online, leaves young people with little time for the deep need of reflecting in themselves which is necessary for identity construction. In the context of identity being performed online and considering the challenges, this denotes the need to determine how young people engage with their wellbeing while the need becomes more pressing. It

does not seem possible or desirable to disconnect young people from the online world; wellbeing needs to be built using the technologies available including apps.

Chapter 3 – Exegesis and Methodological Framework

An exegesis is now presented prior to the four peer-reviewed papers that constitute this thesis. Three of these papers are published and one is currently under final consideration with a journal after an initial revision was completed and submitted. The exegesis is aimed at providing additional background and contextualising information related to the studies described in the papers. The exegesis also provides information relating to why decisions were made that were outside of the scope of the journal papers.

The origin of the thesis was in the context of my employment with Flinders University working on a project called the Young and Well Cooperative Research Centre (Y&WCRC) (Burns, 2013). The Y&WCRC united leaders in Australian industry and academia to research the interaction between young people and technology, primarily regarding their mental health and with a special emphasis on wellbeing. My association with the Y&WCRC was initially as a research project officer on a project called Young and Well Towns (Y&W Towns). The Y&W Towns project was led by Flinders University, South Australia (SA), and was tasked with investigating how young people living in rural and remote areas in SA used and engaged with technology to support their health and wellbeing. To do this, the Y&W Towns project sought to test a self-guided wellbeing website called ‘The Toolbox’ that offered a list of curated wellbeing apps to users which, when used, were expected to improve a young person’s wellbeing (Bidargaddi et al., 2017). The Toolbox was designed by Reachout.com (Collin et al., 2011) who acted as key partner with Y&W Towns together with Country Health SA (CHSALHN). To test the efficacy of “The Toolbox” in improving wellbeing of participants, an online Randomised Control Trial (RCT) was designed by Y&W Towns. Y&W Towns created a web-portal named “The Online Wellbeing Centre” (OWC) to recruit, randomise, direct and assess wellbeing in those young people who engaged with the study

(Antezana et al., 2015). Wellbeing was measured using the Mental Health Continuum-Short Form (MHC-SF) (Keyes, 2009) and participants were recruited from both rural and urban areas of SA (Antezana et al., 2015; Musiat et al., 2016). I was involved in the conception and design of the study, as well as in recruitment and implementation of the trial. Results from the RCT showed no effects in wellbeing scores of participants after using the recommended apps (Bidargaddi et al., 2017).

Although several aspects were discussed by the partners and investigators following these findings of the OWC, the main issue was identified as a lack of engagement, attrition at 4 weeks postrandomization was 45.1% in the control group (88/195) versus 55.2% in the active group. This was suggested to be one of the main reasons why the selected apps did not produce any wellbeing improvements, despite the apps well-documented potential (Stoyanov et al., 2015) and all the methodological considerations included in their selection (Antezana et al., 2015). Therefore, while understanding the beneficial effects of wellbeing apps on young people who used them, in line with the original RCT, which was my original motivation for this thesis, it subsequently became the lack of young people's engagement with apps despite their apparent affinity with potential benefits from use that was the critical question of interest I would pursue: Why did young people fail to engage with wellbeing apps? Why, if apps are part of their daily living, were they not using apps that offered benefits to their health? This question was heavily based on the assumption that engagement in health interventions is necessary to improve health (Cole-Lewis et al., 2019), and in this case, wellbeing. Engagement requires the participant's involvement in a voluntary and intentional way (Bresnick, 2015). Starting from this premise several lines of reflection were considered: Was it that young people found wellbeing apps not appealing enough? Was it that they were not as effective as they were purported to be? Were there any personal elements that needed to be considered that app developers were missing? It is these independent but related questions that formed the individual studies that comprise this thesis, using a mixed methodology framework and integrating both quantitative and

qualitative data. Following an overarching literature review (chapter 2) that considered the different aspects involved in the interaction between users (young people) and wellbeing apps, it was then decided to emphasise the individual as the focus of research over the technological elements, without disregarding the latter in the overall analysis. An exploratory program of research was therefore adopted that set out to understand young people as the users, and not only passive targets, of wellbeing applications. This research took one step back from an effectiveness rationale to investigate the antecedents that would explain users, their engagement and how they interacted.

Methodology, research design and underlying assumptions

The research design adopted was consistent with a mixed methods approach. Mixed methods seek to integrate qualitative and quantitative data in order to investigate a research question in depth (La et al., 2020). This approach enables different types of data to be combined to better explain behaviours and find commonalities in outcomes. The specific methodology that was used to frame the current program of research was a convergent design (Kuss et al., 2018). Convergent design builds from the results attained using quantitative and qualitative data by comparing results from both methodologies and merging findings in an interconnected whole. Mixed methods are particularly useful when exploring a new area of research (Shorten & Smith, 2017). The core of this thesis involves four peer-reviewed studies that addressed the research question from different but related perspectives using mixed methods. The four primary studies are presented in journal article form and then a synthesis of findings from this research trajectory is presented in the final chapter, as such they are presented independently as discreet peer reviewed and published journal articles; the results are then integrated in the final chapter.

The first paper, a Narrative Synthesis (Chapter 4), was undertaken to review the existing literature related to young people and wellbeing apps in depth. Results helped identify predictive elements for app engagement and shed some light onto which young

people are more likely to benefit from using wellbeing apps. A systematic review of 13 databases was undertaken and studies that focused on using apps to promote wellbeing in healthy young adults' populations were included; for example, this comprised purposely designed and freely available wellbeing apps as well as any lifestyle/commercial app focusing on wellbeing aspects. Both quantitative and qualitative papers were included. Excluded studies were those designed as clinical interventions for already existing conditions (e.g., depression, anxiety, obesity, smoke cessation, alcohol, diabetes, cancer); studies outside of the age range; primarily web-based programs rather than apps; study protocols; and studies with high levels of interaction with the researchers.

The second study analysed the content of apps (i.e., Behaviour Change Techniques (BCT's) (Chapter 5) to help better understand the composition of the app elements by coding their features using a comprehensive BCT taxonomy (Michie et al., 2013). Given the assumption that engaging with wellbeing apps is beneficial, at a lower level we are then assuming that the app's themselves are well designed and based on Evidence-Based Practice (EBP). Put another way, if the readily available and popular wellbeing apps are not based on EBP, then improvements in a young person's wellbeing cannot be expected regardless of their engagement with the app. This study endeavoured to understand the apps in their most basic make-up, that is the presence or absence of BCT's, and if this impacts on their usability, effectiveness and engagement. Apps that were highly ranked and freely available in the AppStore (*Apple Australia*, n.d.) and GooglePlay (*Android Apps on Google Play*, n.d.) were categorised into three main wellbeing areas: Physical activity, eating behaviour and sleep for their BCT's content. As previously mentioned, BCT's are defined as observable, replicable and irreducible active components or interventions derived from established theories aimed at changing behaviour (Michie et al., 2011).

The findings from this study raised questions regarding how increasing BCT's in apps may improve the underlying health behaviour change interventions within the apps, and in turn achieve higher engagement with the app from its users, or if these two elements

are related at all. For example, it may be suggested that apps could combine BCT categories such as ‘Social support’ and ‘Identity’ with techniques already in use such as ‘goals and planning’ and ‘feedback and monitoring’ to help young people expand their social networks and receive feedback on their behaviours by peers. To explore this further, the third study (Chapter 6) sought to identify participant characteristics that might help explain which sub-groups of young people were more likely to use wellbeing apps. This study focused on the participants in the original OWC-RCT project. Specifically, this study focused on identifying and understanding factors associated with the use of wellbeing apps by young people. A statistical model was built using data that included demographic information (e.g., age, gender and postcode), the Mental Health Continuum Short Form- MHC-SF (Keyes, 2009) and ecological momentary assessments (EMAs) to self-assess a participants energy, mood and reported sleep times as independent variables from the sample of the aforementioned OWC-RCT (Bidargaddi et al., 2017). Data obtained was analysed against a survey designed to identify if they had used any of the 46 apps included in The Toolbox during the previous month prior to signing into the study. A second aspect to the study included a qualitative survey in the form of individual interviews to follow up on participants. A total of 45 participants (71% female) participated in these interviews providing feedback on practical aspects of the OWC and Toolbox (e.g., site-access, usability, and design), as well as in motivational factors including personal interests and expectations.

The final study in the current program of research was a qualitative exploration to understand the motivations, perceptions, and characteristics of young people using wellbeing apps (Chapter 7). A convenience sample of young Australian app users were recruited from the OWC-RCT and University students in South Australia, in total 13 in-depth interviews were conducted and recorded over a 3-month period. Analysis was based on thematic analysis, and 11 codes were identified and grouped in four themes and three syntheses. Results reinforced the findings of the previous studies and provided a voice for

young app users. The integration of the results of all studies conducted and their implications are described in Chapter 8.

Further notes on papers

The plan for the current thesis was always to produce a body of work by publication, rather than publish after the thesis was written. This approach was determined to be the most efficient way for findings to be disseminated as soon as possible and a publication record to be established. Although the four papers that form the body of this thesis have been produced as independent studies, they are related and represent an accurate and honest reflection of my thinking process behind this thesis. The 'life' obstacles faced along the way meant that aspects of the research were completed out of sequence. The order presented, however, corresponds to my thinking at the time the studies were formulated. Details of any requested amendments from journal editors have not been outlined as these have been incorporated into the final papers. It is hoped that when the reader comes across different but largely interchangeable terms being used in the chapters, such as adolescents or young people, they understand this is the result of journal editors' preferences rather than an intentional inconsistency.

Chapter 4

Understanding What We Know so far About Young People's Engagement with Wellbeing Apps. A Scoping Review and Narrative Synthesis

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Statement of Contributions:

Mr Gaston Antezana (*Candidate*)

I was responsible for the conception and primary authorship of the paper. I conducted the data collection and analyses. I was the corresponding author and primarily responsible for responses to reviewers and revisions to the paper.

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Dr Venning, Ms Blake, Dr Smith, Mrs Winsall, Dr Orlowski, and Dr Bidargaddi (*Co-authors*)

We were the supervisors and co-researchers of the program of research that lead to this publication and there was ongoing collaboration between Mr. Antezana and us in refining the direction of the research. The realisation of the idea, collection of data, and analysis of data were the work of Mr. Antezana. Mr. Antezana was responsible for writing this paper; our role was to comment on drafts, make suggestions on the presentation of material in the paper, and to provide editorial input. We also provided advice on responding to comments by the journal reviewers and editor. We hereby give our permission for this paper to be incorporated in Mr. Antezana's submission for the degree of Doctor of Philosophy from Flinders University.

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Abstract

Background: Increased levels of wellbeing contribute to people being more productive, resilient, physically healthy and showing lower levels of mental illness. Using mobile apps to increase wellbeing in young people is becoming the method of choice. This study sought to critically appraise the current evidence base with regards to young people's (16 to 24 years of age) engagement with wellbeing *apps*.

Methods: A systematic review of the literature and narrative synthesis was conducted to investigate users' characteristics and other potential engagement elements. A total of 11,245 titles, 160 abstracts and 68 full-text articles published between 2002 to 2021 were screened, of which 22 studies were included.

Results: Main themes/findings indicated that a user's engagement with wellbeing *apps* was dependant on the presence of strong identity elements, including motivation, mood, and values; design elements such as meaningful rewards, short duration of studies, and seamless automatic delivery with low contact with researchers; and being innovative and contextualised. The majority of the studies did not report outcomes by social determinants such as ethnicity, education, and others.

Conclusion: This research reflects on the need to consider participants' individuality when designing *app* mediated wellbeing interventions.

Keywords: Apps, young people, wellbeing, identity, engagement.

Introduction

Young people face numerous challenges when it comes to their mental health, with high levels of depression, anxiety, suicide, and personality disorders reported (Liverpool et al., 2020; Rickwood et al., 2019). These conditions are aggravated by poor health behaviours including risk taking, drugs, alcohol, and lack of physical activity (Niedzwiedz et al., 2021), all heightened by the recent COVID-19 pandemic which has caused further mental health deterioration and risky behaviours in young people (Hawke et al., 2020). A novel way of addressing these issues developed over the last decade is using mobile health (mHealth – using current and emergent technologies to deliver and support treatment) (Singh & Landman, 2017). It is generally considered that young people have a particular affinity to use technologies such as the internet and smartphones, with many researchers even considering them as "natural users" (Bidargaddi et al., 2017). Given the intensity of mobile phone use by young people, the potential of using mobile applications (*apps*) for improving health must not be underestimated (Lee et al., 2017), not only in regards to addressing diagnosable disorders but also at a behaviour modification level (Altieri et al., 2006). Mobile apps have been shown to be effective to support treatment in conditions such as diabetes (Cafazzo et al., 2012), smoking cessation (Haug et al., 2014; Thornton et al., 2017), alcohol dependence (Hides et al., 2018), weight management (Batch et al., 2014), as well as psychological distress (Berg & Perich, 2022; Kelly, 2019), (Garrido et al., 2019; Williams & Pykett, 2022). However, apps also provide new opportunities to address preventative and strength focused interventions to improve wellbeing levels (Taylor, 2018).

Wellbeing is a broad concept that encompasses different areas, including psychological, emotional and physical dimensions (Keyes, 2002; Keyes et al., 2021). From a positive psychology (PP) perspective, high levels of wellbeing have been related to life satisfaction, positive emotion, higher productivity, and increased life meaning, and in turn less psychological distress (Iasiello et al., 2019; Keyes, 2002; Schotanus-Dijkstra et al.,

2019). Although the field is experiencing growth, within mHealth there are very few studies focusing on wellbeing as defined by PP as its own independent category. In that context, studies that use technology as the privileged medium to deliver those interventions to young people are even fewer, with poor engagement (Goodyear et al., 2019) and high attrition plaguing research (Egilsson et al., 2021).

As much as wellbeing *apps* have the potential to be effective, they remain fruitless if participants fail to engage. In an attempt to cast the net broadly *apps* are usually designed as “one-size-fits-all” to cater for as many people as possible (Karch, M, 2020). The results of doing this however are mixed, and usually insufficient for *apps* in the wellbeing category. Different approaches to address this issue have been proposed, some focus on design such as usability (Torkamaan & Ziegler, 2021) and gamification (Lee et al., 2017; Schmidt-Kraepelin et al., 2020), while others are starting to look deeper into individual differences of users (Orlowski et al., 2015). The authors set out to understand individual user differences to explain why young people engage with wellbeing *apps and* provide insights into what could be done to increase engagement with these resources.

Method

A systematic review of 13 databases was undertaken to identify literature that focused on improving the wellbeing of young people using mobile *apps.* A narrative synthesis was completed to group together and describe those characteristics that contribute to engagement.

Search Strategy

Studies were identified through a comprehensive search of multiple databases designed in consultation with a professional librarian (RD) in collaboration with the principal reviewer (GA) (see Appendix A for search results). The search strategy included searching titles, headings and text, and was tested to ensure it captured the intended type of studies.

Databases were consulted from 2002 until 2021, this date range was chosen as 2002 was the year a smartphone with extensive data connectivity was developed in the US (*The Sidekick 4G Android Phone | T-Mobile*, 2020), although smartphones as currently known took longer to develop it was decided to cover a higher date range to ensure all relevant studies were captured. The databases consulted for this review were: ACM Digital Library, IEEE Xplore, Informit, ProQuest, Cochrane Library, Pub-Med, Current Contents Connect, Web of Science Collection, Scopus, Medline (Ovid), Psychinfo (Ovid) and CINAHL. No limitations on place of publication were used, however the search was limited to only those studies published in English. A search using specialised databases: NDLTD- Cochrane library, ISRCTN, ANZCTR, APA PsycExtra, Open Grey, HSE, CADTH, AHRQ as well as manually searching through the JMIR journal (mHealth for wellness, behaviour change and Prevention) and Google scholar was also performed to identify any grey literature otherwise not captured in peer reviewed databases. As per latest recommendations the first 200 Google Scholar results were retained and screened (Bramer et al., 2017)

Selection of studies

Studies were collected using Endnote (The EndNote Team, 2013) as the reference management software. After filtering for duplicates the selection process followed 3 stages: initially a broad selection filtered unrelated papers based on their title and key words, next a more in-depth search included reviewing abstracts, and finally pre-selected papers were accepted or rejected based on full content. Two authors, GA and AV completed the process. GA consulted with AV about any ambiguous studies at each step of the selection, any disagreement regarding relevance of the abstracts was resolved through discussion.

Inclusion criteria

Type of studies: Given the focus on understanding the characteristics of wellbeing app users, both quantitative and qualitative papers that focused on this area were included. Studies selected encompassed randomised controlled trials, quasi-experimental studies and

longitudinal studies. For this study wellbeing apps were defined in the framework of the complete state model of mental health (CSM) proposed by Keyes and Lopez (Keyes & Lopez, 2002). In that context any mobile app that addresses positive functioning across the categories contemplated in the model was defined as a “wellbeing app”. This includes purposely designed apps within the mentioned theoretical framework as well as any other app targeting behaviours consistent with this approach, these include general health and lifestyle apps commercially designed and freely available online. Papers were not selected based on reporting engagement specifically. The list of papers selected, and their authors is presented in Table 5.

Participants: Participants were young people 16 to 24 years old as defined by the Australian National Survey of Mental Health and Wellbeing (Slade, et al., 2009). We did not exclude studies based on participant characteristics such as their nationality, gender, or any other demographic indicator.

Phenomena of interest: Young people’s engagement with wellbeing apps, including those commercially available as well as custom designed. Comments on completion of research were also gathered as a potential proxy to understand engagement with the apps.

Exclusion criteria

Studies were excluded that were:

- Designed as clinical interventions for already existing conditions: e.g., depression, anxiety, obesity, smoke cessation, alcohol, diabetes, cancer, etc.
- Out of the selected age range. As most studies didn’t fit precisely with the specified age range (16-24 years old), the mean age was taken as a valid reference, including the standard deviation where reported.
- Primarily web based instead of *app* focused: *app* usage was considered as the main intervention strategy given their potential to work as stand alone, mobile tools.
- Studies that used intensive researcher interaction with participants (e.g., SMS and phone calls) over and above the use of *apps* as their main intervention strategy

- Study protocols or design studies with no implementation or results

Keywords

Handheld computer OR App/s OR Applications OR Mobile OR Cell Phone OR Accelerometer OR Actimetry AND Health AND Behaviour/s OR Physical Activity OR Fitness OR Walk/ing OR Eating OR Diet OR Weight OR Wellbeing OR Wellness OR Sleep OR Food consumption OR

Energy AND Expenditure OR Mood OR Emotion

Assessment of methodological quality and Data extraction

Included studies were critically appraised using four widely accepted checklists from the Joanna Briggs Institute (JBI) (*Critical-Appraisal-Tools - Critical Appraisal Tools | Joanna Briggs Institute*, 2017) (Appendix B). The checklists aim to assess the quality of each study's methodology referring to important elements of study designs including randomised, observational (non-randomised) and qualitative studies. These tools include aspects such as the randomisation of participants into groups, methods employed to assess intervention outcomes, the appropriateness of statistical analyses used, the employment of appropriate search strategies and the critical appraisal of studies and methods used to minimise errors in data extraction. Two authors (GA & AV) independently appraised the studies and then compared ratings. When ratings were different, the two authors discussed until agreement was reached. Data extracted included type of study, wellbeing dimension targeted, type of intervention used (e.g., *app,* others), participants demographics, recruitment strategies and context, retention vs attrition, salient engagement elements, outcomes, and limitations and conclusions.

The emphasis of this review was not the methodological quality of the studies selected, but the characteristics of the users and their engagement with the proposed interventions (*apps*). The main intention of this assessment was to identify any salient issues that would seriously impact user engagement.

Analysis and synthesis

In the intent of capturing all data of interest, narrative synthesis was chosen as the preferred approach to evidence synthesis. The three steps of narrative synthesis, as outlined by Popay and colleagues (Popay et al., 2006), were followed: (1) develop a preliminary synthesis, (2) explore relationships in the data, and (3) assess the robustness of the synthesised product. To develop a preliminary synthesis of findings the data were (a) organised into groups by type of intervention (e.g., Randomised Control Trails (RCTs), qualitative, etc) and wellbeing dimensions targeted (e.g., physical activity, healthy eating, etc); and (b) presented in *tabular* form. Both techniques were used in the initial stages of analysis to represent the data visually and assist the authors to identify patterns. To explore the relationships between the data, common characteristics within interventions used (e.g., recruitment, trackers, self-reporting, etc.) and participant demographics were explored using conceptual models. Finally, the methodological quality of included studies, the process of the synthesis itself, and the information obtained in included studies was used to indicate the robustness of the synthesis. Having said that this review did not focus on intervention outcomes, but on participant characteristics as they related to their engagement in the different studies.

Assessing engagement

To assess engagement with the interventions (*apps*) specific comments of the original authors addressing this phenomenon were extracted. We compared engagement specific comments with other indicators such sample characteristics, explicit incentives to participate, recruitment strategies, completion rates and real-life usability as assessed by the authors. These comments are reflected in Table 6 either paraphrased or copied verbatim for fidelity.

Results

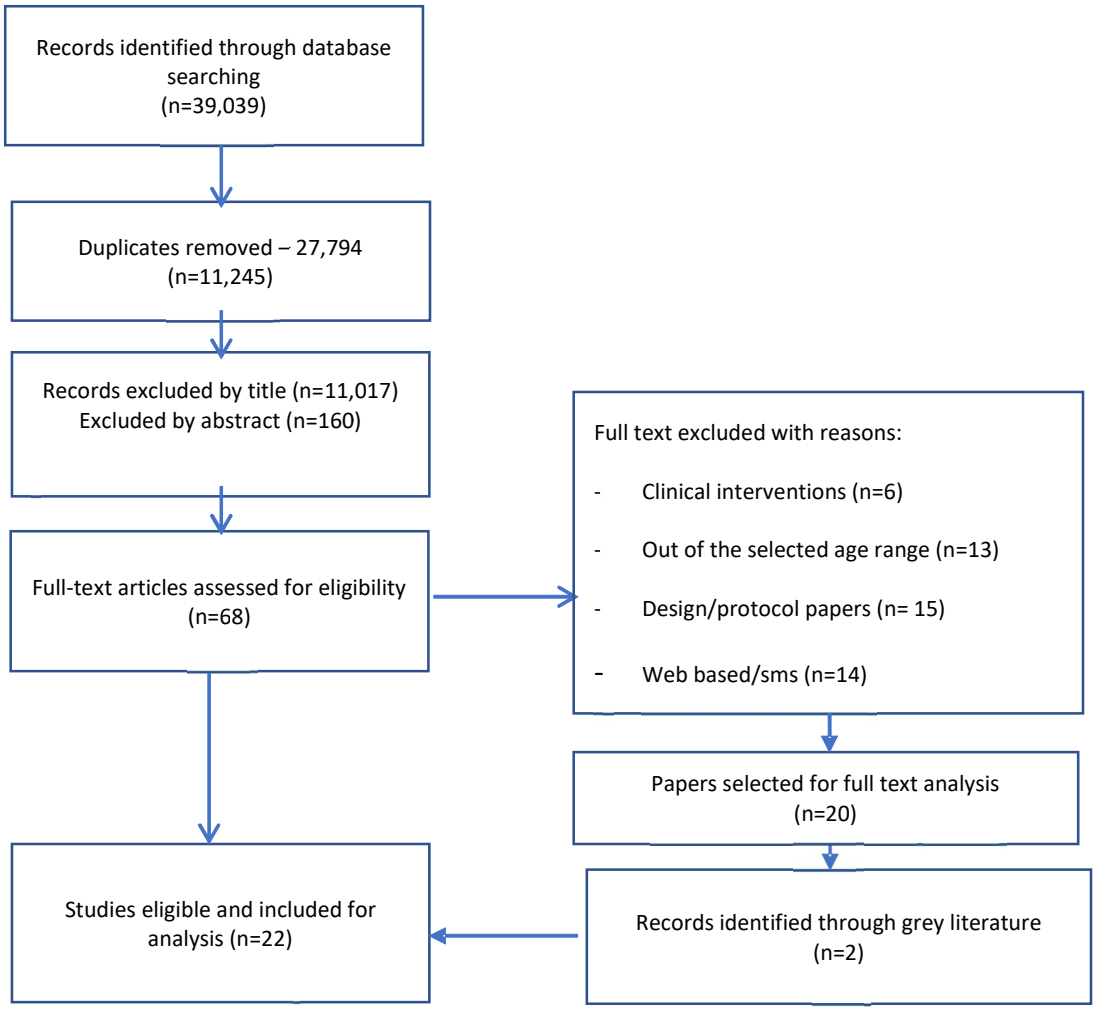
General overview of Search Results and Included Studies

The initial data base searches yielded a total of 39,039 articles. Following the removal of duplicates, the number dropped to 11,245. The initial review stage focused on scanning articles' titles and searching for key words as established in the study selection criteria, this process excluded a further 11,017. The subsequent review of 160 abstracts identified 68 suitable studies and, after a full text assessment, 20 studies remained in the final review (refer to Figure 2). Two extra studies were identified in grey literature searches. Endnote (The EndNote Team, 2013) was used as the reference management software for this review.

Ten studies were identified as RCT's, 6 were cross-sectional, 4 were cohort studies, 1 was qualitative and 1 quasi experimental. No outstanding methodological issues were identified. Out of the 22 studies selected, 4 wellbeing areas were identified: healthy eating (1 study) (Kerr et al., 2016) , physical health (17 studies) (Barkley et al., 2017; DeMasi et al., 2017; Deranek et al., 2021; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Kim et al., 2018; Leinonen et al., 2017; Lewis et al., 2020; Lu & Turner, 2013; Ni et al., 2019; Pasco et al., 2017; Pope et al., 2019; Ráthonyi et al., 2019; Tong et al., 2018; Walsh et al., 2016; Yan et al., 2020; Zhang & Xu, 2020), mindfulness (1 study) (Walsh et al., 2019) and general wellbeing (3 studies) (Carey et al., 2016; Daugherty et al., 2018; Krafft et al., 2019), some

Figure 2

PRISMA Flowchart



studies combined these categories with other areas such as sleep and social activation (Deranek et al., 2021; Kim et al., 2018; Leinonen et al., 2017; Pope et al., 2019; Ráthonyi et al., 2019; Tong et al., 2018). The types of studies are shown in table 5 together with their objectives and conclusions. Consistent with the selection criteria, all the studies analysed used *apps* for their interventions; 6 also included wearable trackers (Leinonen et al., 2017; Pope et al., 2019). Eight out of 22 studies used custom designed *apps* for their interventions (Carey et al., 2016; Daugherty et al., 2018; DeMasi et al., 2017; Kerr et al., 2016; Krafft et al., 2019; Lu & Turner, 2013; Pasco et al., 2017; Tong et al., 2018), while 14 used

commercially available apps (Barkley et al., 2017; Deranek et al., 2021; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Kim et al., 2018; Leinonen et al., 2017; Lewis et al., 2020; Ni et al., 2019; Pope et al., 2019; Ráthonyi et al., 2019; Walsh et al., 2016; Walsh et al., 2019; Yan et al., 2020; Zhang & Xu, 2020); this has relevance in the context of understanding engagement as it allows comparing differences between both approaches.

Table 5
Included Studies

	Article	**Authors**
1	Augmented Reality Games as a New Class of Physical Activity Interventions? The Impact of Pokémon Go Use and Gaming Intensity on Physical Activity	Ni MY, Hui RWH, Li TK, Tam AHM, Choy LYL, Ma KKW, Cheung F, Leung GM,
2	Well-Being Tracking via Smartphone-Measured Activity and Sleep: Cohort Study	DeMasi, O, Feygin, S, Dembo, A, Aguilera A, Recht, B.
3	The impact of exercise motives on adolescents' sustained use of wearable technology	Deranek K, Hewitt B, Gudia A, McLeod A
4	Improving Adolescent Fitness Attitudes with a Mobile Fitness Game to Combat Obesity in Youth	Lu F, Turner K
5	"Pokemon Go!" May Promote Walking, Discourage Sedentary Behavior in College Students	Barkley JE, Lepp AG, Ellen L
6	Continuous use of fitness apps and shaping factors among college students: A mixed-method investigation	Zhang X, Xu X
7	MindSurf: a pilot study to assess the usability and acceptability of a smartphone app designed to promote contentment, wellbeing, and goal achievement	Carey TA, Haviland J, Tai SJ, Vanags T, Mansell W
8	The utility of wearable fitness trackers and implications for increased engagement: An exploratory, mixed methods observational study	Lewis ZH, Pritting L, Picazo AL, Tucker MJM
9	Does it Promote Physical Activity? College Students' Perceptions of Pokémon Go	Yan Z, Finn K, Breton K
10	Wearable Activity Trackers Usage among University Students	Ráthonyi G, Ráthonyi-Odor K, Bendíková E, Bácsné Bába E

	Article	Authors
11	Using a Mobile Social Networking App to Promote Physical Activity: A Qualitative Study of Users' Perspectives	Tong HL, B Health; Coiera E, Laranjo L
12	Smartphone delivery of a hope intervention: Another way to flourish	Daugherty, D. A., Runyan, J. D., Steenbergh, T. A., Fratzke, B. J., Fry, B. N., Westra, E.
13	Apps for IMproving FITness and Increasing Physical Activity Among Young People: The AIMFIT Pragmatic Randomized Controlled Trial	Direito, A, Jiang, Y, Whittaker R, Maddison R
14	Feasibility of Gamified Mobile Service Aimed at Physical Activation in Young Men: Population-Based Randomized Controlled Study (MOPO)	Leinonen, AM, Pyky, R, Ahola, R, Kangas, M, Siirtola, P, Luoto, T, Enwald, H, Ikaheimo TM, Roning, J
15	Promoting physical activity using a wearable activity tracker in college students: A cluster randomized controlled trial	Kim Y, Lumpkin A, Lochbaum M, Stegemeier S, Kitten K
16	The connecting health and technology study: a 6-month randomized controlled trial to improve nutrition behaviours using a mobile food record and text messaging support in young adults	Kerr DA, Harray, AJ, Pollard CM, Dhaliwal SS, Delp EJ, Howat PA, Pickering M R, Ahmad Z
17	The effects of a bike active video game on players' physical activity and motivation	Pasco D, Roure, C, Kermarrec, G, Pope, Z, Gao, Z
18	Fitness mobile apps positively affect attitudes, perceived behavioral control and physical activities	Gabbiadini A, Greitemeyer T
19	Use of Wearable Technology and Social Media to Improve Physical Activity and Dietary Behaviors among College Students: A 12-week Randomized Pilot Study	Pope ZC, Barr-Anderson DJ, Lewis BA, Pereira MA, Gao Z
20	An mHealth Intervention Using a Smartphone App to Increase Walking Behavior in Young Adults: A Pilot Study	Walsh JC, Corbett, T, Hogan M, Duggan, J, McNamara A
21	A Randomized Controlled Trial of Multiple Versions of an Acceptance and Commitment Therapy Matrix App for Well-Being	Krafft J, Pottsa S, Schoendorffb B, Levina ME
22	Effects of a Mindfulness Meditation App on Subjective Well-Being: Active Randomized Controlled Trial and Experience Sampling Study	Walsh KM; Saab BJ; Farb NAS

Table 6

Main Characteristics of Included Studies

Article	Year country	Objective	Wellbeing dimensions	Study type	intervention - custom or commercial	Conflict of interest	Type of tracking	Study length
1	2019 - CHI	To assess the health impact of augmented reality games by examining the association between PokemonGo and physical activity among university students	physical activity	Cohort - Pilot	Commercial	no	automatic	1 week
2	2017 - US	Assess the extent to which activity and sleep tracking with a smartphone can be used for monitoring individuals' mental well-being.	Physical activity and sleep	Cohort	Custom	no	Automatic - self-reported	8 weeks
3	2020- USA	This paper explores if adolescents' inclination towards particular exercise motives influences their commitment to the sustained use of a wearable device (Fitbit)	Physical activity	Cohort	Commercial	no	automatic	3 months
4	2013- CAN	Test an initial mobile fitness prototype's efficacy in generating positive attitudinal changes towards fitness activity using strong socialization components within the game	Physical activity	Cohort - pilot	Custom	no	automatic	6 weeks
5	2017 -US	Assess self-reported walking and sedentary behaviour before and after downloading "Pokemon Go"	Physical activity	Cross sectional	Commercial	no	Self-assessed reporting	3 weeks

Article	Year country	Objective	Wellbeing dimensions	Study type	intervention - custom or commercial	Conflict of interest	Type of tracking	Study length
6	2020- CHI	Exploration of the psychological mechanisms that determine college students' continuance intention to use fitness apps	physical activity	Cross-sectional / mixed methods / semi-structured interviews	commercial	no	Self-reported	N/A
7	2016 - AUS	The aim of the pilot study was to assess the usability and acceptability of receiving MOL-style questions via intermittent daily text messages.	Wellbeing	Cross-sectional	Custom	no	Self-reported	1 week
8	2020 - USA	To explore which features of wearable trackers are used and deemed helpful	Physical activity	Cross-sectional	Commercial	no	automatic	n/a
9	2020 - USA	To compare whether physical activity participation between PokemonGo players a is different than that of non-users	physical activity	Cross-sectional	commercial	no	Self-reported	N/A
10	2019 - Hungary, slovakia	To understand wearable activity trackers among university students	physical activity/sleep	Cross-sectional / focus groups	Commercial	no	automatic	n/a
11	2018 -AUS	Understand users' perspectives regarding mobile social networking intervention to promote physical activity	Physical activity	Qualitative	Custom	Potential benefit from app (fit.healthy.me)	Self-reported	6 months

Article	Year country	Objective	Wellbeing dimensions	Study type	intervention - custom or commercial	Conflict of interest	Type of tracking	Study length
12	2018 - US	Test the feasibility of using EMI's via an app and their effect on EWB and HWB	Wellbeing	Quasi experimental	Custom	no	Response to app messages	28 days
13	2015 - NZ	To determine the effects of two commercially available smartphone apps (Zombies, Run and Get Running) on cardiorespiratory fitness and PA levels in insufficiently active healthy young people. Identify the features of the app design that may contribute to improved fitness and PA levels.	Physical activity	RCT	Commercial	no	automatic	8 weeks + follow up
14	2017 - FIN	Study the feasibility of an automated, gamified, tailored Web-based mobile service aimed at physical and social activation among young men.	Physical and social activation	RCT	Commercial	no	Automatic - wrist-worn physical activity monitor	6 months
15	2018 - US	This study examined the effects of utilizing a wearable activity tracker for promoting physical activity (PA) in college students. in a credit-based physical activity instructional program (PAIP)	Physical activity	RCT	Commercial	1 author worked for Polar Electro	Automatic - misfit flash activity tracker	15 weeks
16	2016 - AUS	Improve nutrition behaviours using a mobile food record and text messaging	Eating behaviour/ weight loss	RCT	Custom	no	Self-reported and sms	6 months

Article	Year country	Objective	Wellbeing dimensions	Study type	intervention - custom or commercial	Conflict of interest	Type of tracking	Study length
17	2017 - FR	Evaluate the effects of an exercise bike video game played by using exergame designed exclusively to promote participants mvpa	Physical activity/ bike cycling	RCT	Custom	no	Automatic	1- 15min session + questionnaires
18	2018- ITA	Effectiveness of mobile fitness apps in changing people's attitudes toward physical activities to pursue health improvement.	Physical activity - walking	RCT	Commercial	no	Automatic/ self-reported	1 semester
19	2018 -US	Evaluate the feasibility of combining a smartwach with social media for delivering health education	Physical activity and diet	RCT - pilot	Commercial	no	Automatic - watch	12 weeks
20	2016 -IRE	Determine the efficacy of the Accupedo-Pro Pedometer mobile phone app intervention for increasing daily step counts in young adults.	Physical activity	RCT - pilot	Commercial	no	Automatic - pedometer	5 weeks
21	2017 - US	Testing the effects of a simple and complex version of a novel app using the ACT matrix in two distinct samples	Wellbeing	RCT - pilot	Custom	no	Automatic - self-reported	4 weeks
22	2019- CAN - SWT	Investigate a newly developed MT app called Wildflowers, which was codeveloped with the laboratory for use in mindfulness research	Mindfulness	RCT	Custom/Commercial	Two authors*	Automatic	3 weeks

*="One author is the Chief Scientist and CEO of Mobio Interactive Inc, but worked only as a technical liaison, he did not contribute to study design methodology. A second author is a scientific advisor and mindfulness guide for Mobio Interactive Inc, this author was involved in all aspects of study design and data analysis, but did not directly contribute to, or have influence over, data collection; nor did he directly perform any of the analyses.

Recruitment

Recruitment methods and their implications are included in Table 7. Data includes recruitment methods, study authors' comments on recruitment validity and study author's comments on the real-life usefulness of the interventions used. These aspects have an impact in the uptake, use and retention of participants and therefore engagement. The majority of studies recruited students both in schools (Deranek et al., 2021; Kim et al., 2018; Lu & Turner, 2013; Zhang & Xu, 2020) and universities (Barkley et al., 2017; Carey et al., 2016; Daugherty et al., 2018; DeMasi et al., 2017; Gabbiadini & Greitemeyer, 2018; Krafft et al., 2019; Lewis et al., 2020; Pasco et al., 2017; Pope et al., 2019; Ráthonyi et al., 2019; Tong et al., 2018; Walsh et al., 2016; Walsh et al., 2019; Yan et al., 2020), only 5 studies recruited members from the community (Direito et al., 2015; Kerr et al., 2016; Krafft et al., 2019; Leinonen et al., 2017; Ni et al., 2019). Several studies recruited convenience samples including researchers' friends (Barkley et al., 2017; Carey et al., 2016; Daugherty et al., 2018; Lewis et al., 2020; Ni et al., 2019; Ráthonyi et al., 2019) and existing users (Lewis et al., 2020; Ni et al., 2019; Ráthonyi et al., 2019). Recruitment techniques included online strategies (websites), volunteers, mailing through the electoral role, inviting conscription candidates, flyers and approaching candidates directly.

Implications of the recruitment strategies described include various researchers acknowledging that their samples were not representative (DeMasi et al., 2017; Kerr et al., 2016; Ni et al., 2019; Pasco et al., 2017; Walsh et al., 2016), as well as highlighting other elements impacting the sample such as participants' mood (DeMasi et al., 2017), tool appropriateness (Deranek et al., 2021), the specificity of the sample (e.g. gamers) (Lewis et al., 2020; Ni et al., 2019), skewed samples such as Psychology students mostly female (Lewis et al., 2020; Walsh et al., 2019) and Apple only users (Walsh et al., 2019).

Participant characteristics

Most studies (18/22) reported higher female participation (Barkley et al., 2017; Carey et al., 2016; Daugherty et al., 2018; DeMasi et al., 2017; Deranek et al., 2021; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Kerr et al., 2016; Kim et al., 2018; Krafft et al., 2019; Lewis et al., 2020; Ni et al., 2019; Pope et al., 2019; Ráthonyi et al., 2019; Tong et al., 2018; Walsh et al., 2016; Walsh et al., 2019; Zhang & u, 2020); this is consistent with existing literature (Carey et al., 2016). Three studies reported mostly male (Leinonen et al., 2017; Pasco et al., 2017; Yan et al., 2020) (one of them focusing solely on males) (Leinonen et al., 2017), and one study didn't report on gender (Lu & Turner, 2013). All the studies with mostly male participants were focused on physical health and used gamifying strategies to engage participants. As for age, all studies fit the 16-24 years of age criteria. Studies that covered age ranges beyond the specified age range were considered if their mean age was within the criteria. Participant characteristics can be found in Table 7. Few studies reported on other demographics besides age and gender, those that did included ethnic background, socio-economic status, and education. In all those cases engagement levels and intervention effects related to those factors were not discussed or reported as non-significant. Five studies were completed in Europe: France (Pasco et al., 2017), Ireland (Walsh et al., 2016), Finland (Leinonen et al., 2017), Hungary (Ráthonyi et al., 2019) and Italy (Gabbiadini & Greitemeyer, 2018), 4 studies were completed in Australia and New Zealand (Carey et al., 2016; Direito et al., 2015; Kerr et al., 2016; Tong et al., 2018) , 2 in China (Ni et al., 2019; Zhang & Xu, 2020), and 11 were completed in the United States and Canada (Barkley et al., 2017; Daugherty et al., 2018; DeMasi et al., 2017; Deranek et al., 2021; Kim et al., 2018; Krafft et al., 2019; Lewis et al., 2020; Lu & Turner, 2013; Pope et al., 2019; Walsh et al., 2019; Yan et al., 2020)

Intervention types and data collection

The majority of interventions (17/22) used physical activity trackers including *apps* based on movement sensors and wristbands (Barkley et al., 2017; DeMasi et al., 2017; Deranek et al., 2021; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Kim et al., 2018; Leinonen et al., 2017; Lewis et al., 2020; Lu & Turner, 2013; Ni et al., 2019; Pasco et al., 2017; Pope et al., 2019; Ráthonyi et al., 2019; Tong et al., 2018; Walsh et al., 2016; Yan et al., 2020; Zhang & Xu, 2020), seven papers also used gamification techniques and or relied solely on games, e.g., Pokemon Go (Barkley et al., 2017; Ni et al., 2019; Yan et al., 2020), Zombies Run (Direito et al., 2015) and custom games (Leinonen et al., 2017; Lu & Turner, 2013; Pasco et al., 2017)); and two *apps* were designed to increase hope and positive emotion by using tailored messages (Daugherty et al., 2018; Kerr et al., 2016). Seven studies relied on self-reports to track data (Barkley et al., 2017; Carey et al., 2016; Daugherty et al., 2018; Kerr et al., 2016; Tong et al., 2018; Yan et al., 2020; Zhang & Xu, 2020) , whereas 15 used automatic tracking in-built in the interventions (DeMasi et al., 2017; Deranek et al., 2021; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Kim et al., 2018; Krafft et al., 2019; Leinonen et al., 2017; Lewis et al., 2020; Lu & Turner, 2013; Ni et al., 2019; Pasco et al., 2017; Pope et al., 2019, 2019; Ráthonyi et al., 2019; Walsh et al., 2016; Walsh et al., 2019).

Table 7

Recruitment and engagement

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
1	Convenience sample of medical students from the University of Hong Kong.	65	20.7	F -65%	Sample is not representative. Findings may be a reflection of specific characteristics of the participants: Gamers. Participants were already Pokemon Go players at the time of recruitment	Exergame	Authors conclude that the use of exergames can improve the levels of physical activity more than usual interventions	High uptake initially but low engagement and low effects after week 1. Repetitive nature of the game lead to loss of interest
2	Participants from the university community through the Experimental Social Science Laboratory (XLab) (Univ of California)	106	20.32 (2.5)	F-55.3%	Small sample size. Participant's mood, depressed participants are less likely to be active. Participants' self-reported well-being is subjective,	none mentioned	Authors conclude that using smartphone's accelerometers can contribute to tracking individual's wellbeing	Participants didn't engage fully due to the highly prescribed nature of the intervention. More work is needed to tailor mood and depression tracking apps to individuals; attrition was high
3	High school students were recruited. Participation was voluntary	59	16-18	38F - 21M	Authors comment on the validity of the tool used to detect motivational factors as not being fully appropriate for this population	Students could keep the "fitbits"	Authors discuss participants motives to use wearables, and assume that they are a legitimate intervention tool	Participants used fitbit as a medium to stay healthy and thus keep current in their social interactions. Stress management, revitalisation, ill-health avoidance, positive health, and weight management were considered as engagement elements "adolescents want to participate in life", exercise is a mechanism to stay healthy

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
4	High School students. No details were given about the recruitment process	12	15-17	non-reported	Authors noticed that socially inclined participants were more likely to benefit from the intervention. No comments about recruitment	All from the same school	Authors comment on the positive changes brought about by the intervention - Socially inclined subjects use the social features of the application as they use the applications exercises.	Fun, enjoyment and social inclination are individual factors pointing to personal preferences (identity). Exergaming implies the element of "fun"; the social dimension is also highlighted; the study makes reference to "socially inclined" participants as most likely to benefit from the intervention
5	University students - random convenience sample, recruited by research members	358	19.8 +/-2.1	F-52.2%	Authors recognise Pokemon Go and GPS enhanced games as viable ways of improving physical activity. No comments about engagement	Existing users	Authors conclude that "Pokemon Go" is associated with higher walking and less sedentary activity	Highlighting enjoyment and interest in a particular type of participants a.k.a gamers, or people with a predisposition for "Pokemon Go" (identity)/ Novelty and fun, joining the enjoyment elements of technology and the outdoors and appealing to "certain individuals". Most "Pokemon Go" engaged users most likely had downloaded the app previous to the study
6	College students - no description about recruitment processes	379 / 10	23 - 23.4	stage 1- F 69.9% stage2: 7F - 3M	The authors didn't comment of recruitment strategies. The study group is composed of college students who are more tech-savvy and proficient at using new technology, which limits the generalization of the findings	Chinese college students who are already using fitness apps	Apps can be useful as long as they feel convenient to use and should be efficient. Strong credibility with negligible effort	Usefulness, ease of use, satisfaction, fitness achievement and social connection. Goal oriented behaviour and personal interest prime over app design/ confirmed usefulness, confirmed ease of use, satisfaction, fitness achievement and social connection). Enjoyment was dismissed as users will keep engaged as long as they have a clear personal goal (health).

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
7	Self-selected, convenience sample recruited through an online volunteering database at the University of Manchester and in person by the second author	23	18+	F-86.9%	Authors acknowledge that the majority of participants were psychology students who are predominantly female.	£5 was offered to participants upon completion of the 2-week data collection period.	The results of this pilot study indicate that MindSurf will be an acceptable and usable app that does not appear to generate adverse events.	Personal reflection and self-awareness point directly to personal/individual motivations/ Users reflected on patterns of thought and behaviour which may play a general role in their wellbeing. This was considered as a reason for engagement with the intervention
8	Recruited via physical flyers with a QR code to access the survey, presentations in student organizations, university email, and social media postings (e.g. Instagram, Snapchat, Facebook). A convenient sample of wearable owners attending or worked at the university, or were friends of research team.	47	18-24	F-80.9%	Researchers believe that the data collected goes into explaining motivational cures and health information. No comments about recruitment	non mentioned	Researchers affirm that the sample is similar to the general population who use wearable fitness devices, mostly young overweight female.	The study comments directly about differences regarding users' individual characteristics (gender, ethnicity, personal goals and others) and engagement with the intervention, however results are inconclusive regarding characteristics and predisposition to explain usage and engagement with wearable fitness. The primary focus is on the user and no necessarily in the intervention itself
9	College students recruited with campus flyers, class visits, word of mouth	393	19.03 (2.04)	F175/393	The authors acknowledge that the study only focused on college population.	non mentioned	Most users agreed that playing the game had a positive impact. The authors conclude that health practitioners may use this game to promote youth and young adults walking and/or	The differences found in this study reference personal characteristics and individual perceptions and explanatory for engagement and outcomes/ Participants in the intervention arm walked less than those in the control group. However, they perceived Pokémon Go as useful, fun and motivating to exercise. This difference in effects and perception may be due to users'

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
							jogging behaviours, with setting specific goals	characteristics / (usually gamers are more sedentary)
10	Participants were selected from among the population of the university in general education courses. For in-depth interviews potential participants were approached and verbally recruited by authors.	400	20.55	F - 56.8% ; F- 54%	-	current users	Wearable devices have positive effects on physical activity among university students	As a general rule the constant wearing of the device is influenced by aesthetic and comfort. Fashionable to wear. / Self-monitoring and goal setting and inherently personal characteristics. Social comparison has shown efficacy in particular contexts / Self-monitoring, goal setting and social comparison were considered, however results are inconclusive regarding engagement
11	University staff and students - purposive sampling techniques (posters, website, social media, email, newsletter)	55	23.6 (4.6)	F-51%	Researchers acknowledge the small sample size and that it may not reflect the experience of other groups	non mentioned	Self-regulatory BCT's seem to be necessary - social comparison, existing social ties and homophily are important. offer goal setting, self-monitoring and feedback as a bundle	Self-regulatory behaviour change techniques as necessary for engagement as well as social. self-regulation techniques and social factor; individual (self-monitoring of behaviour, goal setting, and feedback on behaviour), social (social comparison, similarity and familiarity between users and participations from others in the network. Technological limitations are considered to be a barrier for engagement. Important factors: existing social ties and homophily. It clearly emphasises personalized interventions.

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
12	Convenience sample of residential undergraduate volunteers drawn from behavioural science classes at Indiana Wesleyan University	112	18-25	F 70.5%	-	extra credit + volunteers in the research database	Mobile app based EMIs may provide a feasible means of fostering hope in the moments of daily life.	Hope was framed as a personal element and as such the results are open to interpretation. It is not clear what could have driven engagement in the intervention group; the non-users group didn't engage with the app and it is unclear what would have caused the changes in hope. The study alludes at the religious context of the institution where it was implemented
13	Participants were recruited through advertisements in electronic mailing lists, local newspapers, flyers posted in community locations, and presentations at schools	51	14-17	F -57% - M 43%	High retention rate. Further, using paid apps instead of free ones has likely reduced the chances of contamination and/or cointerventions.	Apps were free of charge to participants after trial completion. Follow up participants received a NZ $10 gift card to a local shopping centre for each visit to complete study measures (i.e., maximum NZ $30 for 3 visits).	Self-regulatory techniques and social factors are important to consider when designing a physical activity intervention, but a one-size-fits-all approach is unlikely to satisfy different users' preferences.	Use of monetary rewards- gamification/ Immersion, leisure and experience are considered important for engagement with exergames. The study emphasises the need for personalised interventions
14	All conscription-aged men (n=1265) living in a small town were invited to participate in the 6- month trial.	496	17.8 (0.6)	M-100%	Authors point out that attrition using wearables is a common phenomenon in research. No comments about recruitment validity	Gamification	To motivate those who are not interested in physical activity but might still benefit from physical activity information and guidance, more persuasive and behaviour change–supporting	This study considers the importance of functionality. "Mobile service users considered the various functionalities related to physical activity important. However, compliance of the service was limited"

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
							intelligence should be implemented.	
15	Two-stage sampling method to recruit participants. In the first stage, a total of 14 classes were randomly selected, out of twenty eligible courses, and randomly assigned to either intervention or control groups, with a 1:1 allocation ratio. In the second stage, a gender-stratified random sampling was used to recruit approximately 60% of students (n ≈ 18) within each course.	187	20 (1.75)	F-67%	No comments about recruitment validity	College context	This study found no effects of utilizing the wearable activity tracker in promoting PA in college students	Engagement cannot be mandated, it responds to individual preferences and motivations/ This study reports low engagement, they attribute this to the impossibility to enforce and/or motivate users externally. It recognises the need to pay attention to individual differences (satisfaction, motivation, etc)

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
16	Young adults aged 18–30 years were recruited from the Federal Electoral Roll. They were selected from 57 suburbs within the Perth metropolitan area to provide representation across socio-economic status. Other recruitment methods supplemented the mail out and included advertising on the University website, flyers posted on campus and referrals from friends or colleagues.	247	24.3 (3.4)	F-68%	Researchers point out that the responders may not have been representative of the population. The response rate from women was higher than men. However, the participants recruited were from a diverse background for socio-economic status and ethnicity.	All participants received a $20 gift voucher of their choice at baseline and six months and were entered into a prize draw to win an iPad, iPod or shopping voucher at the end of the study.	Smartphone-based groups can promote fruit and vegetable consumption and decrease unhealthy snack intake.	This study registered differences in the engagement levels of women (higher) vs men (lower). The engagement differences between genders speaks to identity and motivation factors. Also, the study hypothesis was that the more intensive intervention with greater contact points would be more effective, but this was not the case.
17	Participants in the study were a convenience sample of 163 undergraduate students recruited from the sport science department of a French university located in the northwest region of France.	163	20.31 (1.30)	M- 61.3%	Researchers acknowledge that participants were young adult college students recruited from a department of sport science.	all of the same school	A newly designed mobile application-based exergame played via an exercise bike may enhance situational interest and provide a decent level of PA for players.	Interest is dependent on enjoyment, exploration and attention demand were considered essential for engagement. In order for attention and enjoyment to occur, participants need to be motivated. Situational interest

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
18	Students from the University of Milan were contacted during class and took part as volunteers in the study.	78	19.94 (1.36)	F-88.5	No comments about recruitment validity	not specified	The present study provides encouraging evidence for the positive effects of using a fitness-tracking app in promoting health behaviour.	Fitness apps can influence health behaviour. Intentions, attitudes and norms and mediated by personal motivation, goals and values. This is expressed in perceived behavioural control. intentions are influenced by attitudes and norms.
19	Thirty-eight college students from a large metropolitan Midwest University were recruited via flyer/email communication and in-person recruitment presentations.	38	21.5 (3.4)	F-73.6%	No comments about recruitment validity	Participants were paid $30 for successful study completion (i.e., all data collection sessions completed and study device[s] returned)	While both arms demonstrated initial efficacy in improving CS health outcomes, observations did not indicate the experimental intervention as more efficacious than comparison.	This study captured comments on users' preferences for some design features over others. Comments on engagement refer to persuasive design and usability
20	Students recruited through the university's research participation website.	58	20.5	F-74%	This study acknowledges: (1) self-selection of the sample, (2) limited generalizability of results (given the focus on college students), (3) short follow-up timeline, and (4) use of an active control group.	extra credit + volunteers in the research database	The results of this study demonstrate that a mobile phone app can significantly increase physical activity in a young adult sample by setting specific goals, using self-monitoring, and feedback.	This study comments that a one-size-fits-all approach is not enough to sustain engagement. This study recommends tailoring interventions to the individual level of activity and to include psychosocial factors. motivation or self-efficacy
21	Two recruitment routes were used: advertising the study to university students (Sample 1, n = 63) and directing adults from the	63 and 35	24.57 (7.86) 20.24 (3.88)	F -65.7% / F -73%	This study acknowledges the size of the help-seeking sample being relatively small. Also, the contact of researchers	Academic credit for university Cohort	Improvements in the help-seeking sample were primarily driven by the version of the app with additional features, suggesting that the perceived	This study shows the importance of personal motivation and readiness as the main factor influencing engagement and outcomes. Higher improvements (higher engagement) was found in the help-seeking cohort in contrast to the

Paper	Recruitment	N	Age	Gender	Recruitment validity (author's comments)	Incentives - engagement elements	Realistic intervention in terms of everyday use (authors' comments)	Engagement (authors' comments)
	community interested in self-help (Sample 2, n = 35).				and users made it to be less naturalistic. Both samples were young and ethnically homogeneous.		credibility of an app may be higher when it includes a variety of additional features. Finally, adherence was relatively low, which suggests that it may be helpful to include additional features	incentivised cohort, even though help seekers used the app less. This point to motivation and readiness to make changes at a personal level
22	University students, recruited via the undergraduate recruitment site and via flyers	41 and 45	19.78 (2.43) and 20.24 (2.63)	F -88% - M: 12% - F-80%; M - 20%	Researchers acknowledge that the sample was limited to participants with Apple devices. The study had a female-dominated sample	course credit if recruited via the undergrad recruitment site and $10 p/h for students recruited via flyers max $90	Mindfulness training using a smartphone app, may provide immediate effects on mood and stress while also providing long-term benefits for attentional control.	Personal disposition and reflective awareness are considered as the main drivers for engagement and efficacy of wellbeing interventions/ Dispositional acceptance is related to reduced experiential avoidance, self-awareness in the form of recording mood and stress levels may improve engagement

Wellbeing areas targeted by apps

With the Complete State of Mental Health Model (Keyes & Lopez, 2002) as a reference framework, physical wellbeing was the primary area targeted by interventions using wellbeing *apps* (17 studies). Physical activity and healthy eating constitute discreet, highly measurable categories that have a significant impact on individual wellbeing (Australian Government Department of Health, 2020). The use of pedometers and in-built positioning sensors to track physical activity is more feasible than tracking emotional, psychological, or social wellbeing, as these areas are harder to quantify (Jee, 2017, Kelley et al., 2017). In saying that however, studies such as the one by Leinonen et all (2017) and the one by Demasi et al (2017), targeting physical activity as their main focus did also include social, psychological and emotional variables when discussing both, engagement and outcomes. Plus, Tong et al (2018) used socialisation as a strategy to boost engagement with healthy eating *apps.*

Clear attempts have been made to develop *apps* to impact emotional, psychological and social wellbeing e.g., Walsh et al. (2019), Vella et al. (2018) or Carey et al (2016). Studies targeting these areas often relied on specific psychological approaches that have a consistent evidence base in clinical settings, e.g., CBT (Cognitive Behavioural Therapy) or ACT (Acceptance and Commitment Therapy). These approaches are systematic in nature and lend themselves to being codified in *apps* to be applied remotely. A number of clinical studies support the efficacy of these approaches in mHealth (Stallard et al., 2011), (Christie et al., 2019).

Only 2 studies defined wellbeing in the context of positive psychology (Carey et al., 2016; Daugherty et al., 2018). One study defined wellbeing as an improvement on current deficits (DeMasi et al., 2017). The remaining studies did not define wellbeing as a specific category, focusing instead on discreet behaviours such as physical activity or healthy eating.

Attrition and engagement incentives

Following standard practice (Nunan et al., 2017) studies reporting attrition levels over 20% were considered high. Two studies didn't report attrition results, one that had high participant participation (Pasco et al., 2017), and the other being a prototype with only 12 participants (Lu & Turner, 2013), all cross-sectional studies (n=6) were based on surveys and therefore attrition wasn't considered (Barkley et al., 2017; Carey et al., 2016; Lewis et al., 2020; Ráthonyi et al., 2019; Yan et al., 2020; Zhang & Xu, 2020). Different engagement incentives were used to recruit and maintain participants active involvement in the studies analysed. In the context of this review, these incentives can be classified in 3 types: common practice, context related, and *app* related. Common practice engagement incentives refer to strategies regularly used in research studies, these include social rewards, small economic incentives, and the use of gifts. Four studies offered economic rewards varying from $30 to $90 for participating in interviews (Direito et al., 2015; Kerr et al., 2016; Pope et al., 2019; Walsh et al., 2019). Gifts were also utilised with 1 study giving away fitbits (Deranek et al., 2021). Social rewards were related to being part of the same social group and to cohorts belonging to the same discreet social context (e.g., schools) this was observed in 3 studies. Context related incentives refer to using participation in research as a condition to meet a larger obligation, this was the case of using academic credits and defining research as an assessable component for a particular course (Daugherty et al., 2018; Krafft et al., 2019; Walsh et al., 2016). Three studies used strategies like gamification, situational interest, enjoyment, convenience and enhanced awareness (DeMasi et al., 2017; Direito et al., 2015; Tong et al., 2018). These were highlighted as *app* specific features driving engagement. Lastly, 3 studies recruited participants who were described as existing users (Barkley et al., 2017; Ráthonyi et al., 2019; Zhang & Xu, 2020).

Five studies reported high attrition (Daugherty et al., 2018; DeMasi et al., 2017; Kim et al., 2018; Krafft et al., 2019; Leinonen et al., 2017), 2 of them used university students without a clear indication of their motivation to participate (DeMasi et al., 2017; Kim et al.,

2018), and 1 of them used the intervention as part of a university course (Krafft et al., 2019). One of the studies in this group lasted for 6 months, it recruited only males in a highly context specific setting (military call-out cohort in Finland) and despite using high gamification techniques still reported high attrition (Leinonen et al., 2017). Although two studies used extra university credits and worked with volunteers, engagement was still low (DeMasi et al., 2017; Krafft et al., 2019).

One study reported a mid-range attrition level between 10% and 20% (Kerr et al., 2016). This study reported predominantly female participants in the older end of the spectrum (M= 24 years of age), lasted 6 months, and paid participants $20 for their contribution. This study focused on healthy eating and used self-report requiring participants to actively communicate with researchers and used self-report.

Nine studies demonstrated high retention with attrition levels of under 10% (Carey et al., 2016; Deranek et al., 2021; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Ni et al., 2019; Pope et al., 2019; Tong et al., 2018; Walsh et al., 2016; Walsh et al., 2019). Two themes stand out to explain engagement in these studies, the first one being high reward plus short duration, opposite to long studies with little incentive. In this review examples of high reward/compensation given to participants were keeping the fitbits (Deranek et al., 2021); incentives of $10 to $90 per interview (sometimes for multiple interviews) (Direito et al., 2015; Pope et al., 2019; Walsh et al., 2019); and granting academic credit (Walsh et al., 2016). Most of these studies were short lasting no more than 8 weeks (Carey et al., 2016; Direito et al., 2015; Ni et al., 2019; Walsh et al., 2016; Walsh et al., 2019). The second theme was seamless intervention and low contact, opposite to intense interaction or overwhelming demands from the *apps* themselves. All the studies in this category were designed as low interaction interventions; the demand from participants in these studies was minimal. Automatic tracking was the privileged modality to collect data (Deranek et al., 2021; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Ni et al., 2019; Pope et al., 2019; Walsh et al., 2016; Walsh et al., 2019), only 2 of these studies also used self-report as part

of the intervention (Carey et al., 2016; Tong et al., 2018). In the studies using automatic tracking researchers used in-built *app* features that allowed participants to “forget” about the app, which kept gathering data as long as the mobile was on. This seamless tracking is also part of accelerometer-based pedometers such as the Actigraph GT1M (Direito et al., 2015). Studies in this category also used intense gamification techniques and commercial *apps*: zombies run vs cto5k (Direito et al., 2015); Actigraph accelerometer and the accupedo-pro pedometer app (Walsh et al., 2016).

Engagement

According to the studies analysed, participants engagement with *apps* can be related to identity factors that transcend the *apps* themselves, these were context specific, socially driven and personalised. Examples of context specific and socially driven elements included participants belonging to a very specific setting (e.g., same social circle) (Tong et al., 2018) or accessing the study with pre-existing motivation (Pasco et al., 2017), some studies in this category recruited participants enrolled in specific courses such as sport science or IT (DeMasi et al., 2017). Social comparison seems to be a driver for engagement, with elements as homophily and existing social ties named as highlights (Tong et al., 2018). Elements such as fun and social inclination are pointed as essential engagement elements, (Lu & Turner, 2013) at the same time these factors are linked with individual preferences. Similarly, usefulness, satisfaction and social connection are important for authors (Zhang & Xu, 2020) who in turn dismiss the fun factor in favour of participants having a clear personal goal. Other elements such as health perception were seen as mediators to higher goals, as Deranek et all (2021) states: *"adolescents want to participate in life” (*i.e., keep social connections, avoid stress, revitalisation) and see exercise as a mechanism to stay healthy to achieve this.

Personalised, innovative and contextualised *apps* had better positive engagement comments than simpler themed *apps* without a back story (e.g., pedometers) (Direito et al.,

2015). Gamification was used as a privileged strategy and included elements such as: situational interest, enjoyment, convenience, and enhanced awareness. These were highlighted by researchers as *app* specific features driving engagement. Studies such as those analysing Pokemon Go (Barkley et al., 2017; Ni et al., 2019; Yan et al., 2020), relied on personal identification elements that surpassed the *apps* themselves, highlighting personal characteristics and preferences by identifying most users as “gamers” or as having a natural proclivity for these type of interventions (Barkley et al., 2017), most participants in these studies had already downloaded the *app* before the study. However, these studies also showed high uptake initially with a quick loss of interest after the first week, authors attribute this to the repetitive nature of the game (Ni et al., 2019)

The possibility of setting personal goals was found to be preferable than having the *app* set up in a fixed way (DeMasi et al., 2017). It was also noted that participants in these studies were mostly in the younger end of the age spectrum analysed, with most of them being under 20 years of age.

Identity

Almost all studies in this review emphasised the need to consider individual characteristics and preferences to explain and enhance engagement with health *apps*. This was true with respect to the perception of hope (Daugherty et al., 2018) as well as for participants understanding of wellbeing (Carey et al., 2016). In this context personal reflection and self-awareness were considered as a reason for engagement with the intervention, these are specific individual elements.

Making the user the primary focus, understanding their personal characteristics, instead of the intervention itself was recommended (Barkley et al., 2017; Carey et al., 2016; DeMasi et al., 2017; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Kim et al., 2018; Krafft et al., 2019; Lewis et al., 2020, 2020; Tong et al., 2018; Walsh et al., 2016; Walsh et al., 2019; Yan et al., 2020; Zhang & Xu, 2020). Similarly, motivation understood as an

individual factor was recognised as a primary factor for engagement when comparing men and women in a study looking to improve eating behaviours (Kerr et al., 2016). Consistent with this, situational interest derived from individual motivation (Pasco et al., 2017) was related to enjoyment, exploration, and attentional focus. Personal attitudes, norms, motivation, goals, and values can be expressed in perceived behavioural control (Gabbiadini & Greitemeyer, 2018). An example of this is that in the study by Krafft et al 2019 (2019) where better outcomes were found in the help-seeking cohort (those that didn't get any incentives to participate vs. the incentivised cohort that got academic credit). In a similar way Walsh et al (Walsh et al., 2016) recognised that personal disposition and reflective awareness are considered as the main drivers for engagement. There seems to be agreement that one-size-fits-all approach is not enough to sustain engagement and that tailoring interventions to the individual could improve meaningful engagement with these interventions (Barkley et al., 2017; Carey et al., 2016; DeMasi et al., 2017; Direito et al., 2015; Gabbiadini & Greitemeyer, 2018; Kim et al., 2018; Krafft et al., 2019; Lewis et al., 2020, 2020; Tong et al., 2018; Walsh et al., 2016; Walsh et al., 2019; Yan et al., 2020; Zhang & Xu, 2020).

Design, usability, functionality, and features

Several studies mentioned design and usability factors as mediators for engagement, elements such as aesthetic, comfort and functionality (Leinonen et al., 2017; Ráthonyi et al., 2019), however they still linked these factors with personal preferences and perceptions such as wearables being "fashionable". Usability was also related to specific features and behaviour change techniques (BCT'S), some of these included Self-monitoring and goal setting, self-monitoring of behaviour, and feedback on behaviour. Technological limitations are considered to be a barrier for engagement comparison (Tong et al., 2018).

Discussion

The current systematic review of the literature and narrative synthesis set out to investigate the connection between users' characteristics and level of engagement in interventions using mobile *apps* to increase and support wellbeing. It was found that most studies do not reflect on engagement beyond retention for the duration of the intervention, so therefore there was not a clear definition of what engagement is and how it impacted results. Having said that, most studies commented on the enablers and the limitations of their interventions, their uptake, and participants perceptions. In that context we analysed all the comments related to engagement and included factors such as recruitment strategies, sample characteristics and authors perception of usefulness of their interventions in real life contexts.

It was found that most studies recruited university students, which is in line with regular University recruitment strategies; although this could be seen as a sampling bias, in the context of this study is expected that young people would be mostly students given the age ranges. Recruiting from a very specific context can potentially impact engagement due to affinity, peer pressure or institutional expectations; most studies used convenience samples, often times small and also highly contextualised; only men in the process of conscription, or high concentration of females studying psychology, members of the same class in the same school, existing users of the technologies investigated, IT students testing an *app* (DeMasi et al., 2017); members of the same social group/class (Tong et al., 2018); or pre-existing users (Ráthonyi et al., 2019). While most studies reported demographic characteristics in varying levels of detail, they did not comment in a meaningful way regarding engagement results to any of these demographic indicators.

A clear example of using identity elements to engage participants is "Pokemon Go". The "Pokemon Go" (Butcher, 2016) phenomenon started in 2016 and exploded throughout the world with thousands of people downloading and playing the most successful

"exergame" to date (Waern, 2016). Our review analysed 3 studies focusing on "Pokemon Go" (Barkley et al., 2017; Ni et al., 2019; Yan et al., 2020). Researchers in these 3 studies highlight the personal characteristics of participants: "gamers" and existing users, indicating that users of this *app* are intrinsically motivated. There is agreement that "Pokemon Go" has significantly increased physical activity for players. Undoubtedly this had many positive effects including improvement in physical and mental health, socialisation, and emotional wellbeing (Conditt, 2016) even though the effect has proved to be of short duration, as studies report decrease of activity after 5 to 6 weeks of using the game (Howe et al., 2016). However, by using identity strategies "Pokemon Go" speaks to a generation in the same way "Star Wars" or "Harry Potter" would: it appeals to nostalgia, creates a sub-culture and boosts sense of belonging. As Howe et al, (2016) (Howe et al., 2016) report, the uptake of "Pokemon Go" went beyond *"sex, age, race group, bodyweight status, urbanity, or walkability of the area of residence"* effectively engaging participants at a higher level of identification. This game is also a great example on using personalisation features, using different challenges, difficulty levels and sense of achievement; all of this on top of using enhanced reality to integrate the game with the participants' own environment. Persuasive design elements were also mentioned by some studies, usability and functionality are at the top of the list; however, elements such as aesthetic and being "fashionable" still play an important role in users' adoption and reflect personal preferences based on identity.

In the context of *app* development, establishing the identity elements that would attract participants to engage with the concept that needs to be communicated (i.e., wellbeing) is suggested to be more important than the actual technical design. Most studies in this review focused on the interventions as the first step of the process instead of starting with the individuals and their needs, this points to the need of implementing design strategies based on participatory research methodologies to allow users to be involved in the process from its inception (Orlowski et al., 2015). Having said that it is not clear if successful apps such as "Pokemon Go" do use these design methodologies. In any case, the findings

of this review point to the fact that real engagement doesn't happen unless participants have a personal intrinsic motivation, this is usually either due to the need to satisfy a deficit as it happens in clinical studies or due to having a vested interest such as "having to do it" to satisfy a larger need (e.g., a study course). Several studies in this research hint to the need to consider the individual and their particular characteristics as the starting point to plan and design wellbeing interventions.

Various researchers in the studies analysed in this synthesis noted how elements such as failing to address individual preferences can affect perceived autonomy and personal interest when engaging with wellbeing *apps* (Kim et al., 2018) Similarly, some mentioned how merely using a wellbeing *app* without having a personal motivation and self-awareness of the importance of a healthy lifestyle hinders any expected positive outcomes (Gabbiadini & Greitemeyer, 2018). Boosting personal preferences when designing wellbeing interventions can increase their effect (Lu & Turner, 2013). Games can approach audiences using different identification elements that become more or less accepted in the degree in which users identify with them (Koivisto & Hamari, 2014). These same principles could be applied to the design of mobile *apps*, that although being broader in their approach still hold some features that can be personalised and sequentialised almost in a gamified way.

The current study highlights the need to properly understand who the audience is before implementing features or behaviour change interventions in *app* design. The directionality of research in mHealth should emphasise the individual not only as the intervention recipient, but primarily as its originator. This review suggested that *apps* relying on clear identity driven elements are more likely to produce high levels of engagement, and arguably therefore to be more effective at their intended goals. In turn highlighting the need for and importance of effective participatory research strategies in the design mHealth interventions.

Finally, the paucity on understanding the concept of wellbeing is telling with regards to developing effective interventions, and it's clear that most research is still focused on a deficit driven rather than strength-based approach. At the same time this constitutes an opportunity for new developments aimed at creating positive mental health, boosting wellbeing at population levels, and educating young people on the importance of maintaining and creating a culture that seeks flourishing as an ideal and not only the absence of illness.

Limitations and strengths

The aim of this review was to start a reflective process with regards to delimiting an area of research: engagement with wellbeing interventions in the context of mHealth; and propose themes for design and focus of interventions for future research. As knowledge in this area is constantly changing at an ever-increasing speed, together with the difficulty in conceptualising wellbeing in the context of mHealth, this may have caused some key articles to be missed. However, every effort was made to identify all possible articles, including a review of grey literature. Often studies focused on reporting primary outcomes and overlooked the leading factors in the research process, therefore the lack of consistency in articles reporting high quality data is recognised as a limitation e.g., demographics (including gender diversity), attrition rates and particularly: engagement. In that context the lack of a clear definition for engagement derived from the literature clearly impacts any efforts to investigate this using this type of review. That said, a strength of this review was capturing data within a broad scope, not limiting itself to just one aspect of wellbeing or one type of intervention. Accordingly, this approach contributes by finding common grounds of interaction for research designed with different variables in the context of wellbeing theory. We consider focusing on wellbeing and not in deficit driven clinical interventions as a strength; although wellbeing and PP interventions are used and researched consistently, effectively translating their techniques and content in mHealth interventions is still a challenge and a new direction with clear benefits for the future.

Conclusions

Young people are characterised by peak performance in health and intellectual capacity as well as forming strong social networks, identity, and productivity. Wellbeing *apps* targeting young people have the potential to make a targeted and sustained difference at a critical stage of life and are rapidly becoming the privileged way to achieve this. The current results suggest that effective engagement with wellbeing *apps* happens when their design and content include identity elements that transcend the *apps* themselves and allow users to access personal customisation, in line with their sense of achievement, challenges, motivation, mood, values and rewards. Understanding who young people are, what are their motivations, how they look at themselves, and how they codify their world appears to be the key to effectively shape and apply engagement strategies with long-term impact. However, having and communicating a shared understanding of wellbeing, and involving all actors in the creation of this and associated apps to promote wellbeing remains a challenge.

Chapter 5

An Evaluation of Behaviour Change Techniques in Health and Lifestyle Mobile Applications

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Antezana, G., Venning, A., Blake, V., Smith, D., Winsall, M., Orlowski, S., & Bidargaddi, N. (2020). An evaluation of behaviour change techniques in health and lifestyle mobile applications. *Health Informatics Journal*, *26*(1), 104–113. https://doi.org/10.1177/1460458218813726

Statement of Contributions:

Mr Gaston Antezana (*Candidate*)

I was responsible for the conception and primary authorship of the paper. I conducted the data collection and analyses. I was the corresponding author and primarily responsible for responses to reviewers and revisions to the paper.

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Dr Venning, Ms Blake, Dr Smith, Mrs Winsall, Dr Orlowski, and Dr Bidargaddi (*Co-authors*)

We were the supervisors and co-researchers of the program of research that lead to this publication and there was ongoing collaboration between Mr. Antezana and us in refining the direction of the research. The realisation of the idea, collection of data, and analysis of data were the work of Mr. Antezana. Mr. Antezana was responsible for writing this paper; our role was to comment on drafts, make suggestions on the presentation of material in the paper, and to provide editorial input. We also provided advice on responding to comments by the journal reviewers and editor. We hereby give our permission for this paper to be incorporated in Mr. Antezana's submission for the degree of Doctor of Philosophy from Flinders University.

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Abstract

Despite the current popularity and potential use of mobile applications (apps) in the area of behaviour change, health promotion, and wellbeing for young people, it is unclear if their design is underpinned by theory-based Behaviour Change Techniques (BCT's). Understanding the design of these apps may improve the way they can be used to support young people's wellbeing. The authors set out to investigate what Behaviour Change Techniques (BCT's) are included in the content of health and lifestyle apps and determine which of these are prominent in app design. Thirty of the top listed health and lifestyle apps across three categories (physical activity, diet, and sleep) were freely downloaded from the two most popular app stores (GooglePlay™ and AppStore™). Selected apps were used by trained researchers and the features identified coded against the Behaviour Change Techniques Taxonomy 1 (BCTTv1), a systematic classification of techniques used in behaviour change interventions. It was found that 9 of the 93 BCT's listed in the BCTTv1 were common across the chosen health and lifestyle apps. The app found to include the most BCT's had 20 (21%), while the app found to include the least had 1 BCT (1%). The most frequently used BCT's were related to goal setting and feedback. Entire categories in the BCTTv1 were absent in the design of the selected apps. This research highlights the underuse of theory based BCT's in popular health and lifestyle apps and raises questions for further research, particularly considering how BCT's are currently implemented and what could be the correlation between BCT's and user engagement.

Introduction

Freely available mobile applications (apps) are being used in a range of lifestyle and health settings which is aided by the increasing availability and use of smartphones. Mobile applications (apps) are being used as co-adjuvants for a range of health interventions (Boulos et al., 2014) such as: weight loss and physical activity (Turner-McGrievy et al., 2013), smoking cessation (Whittaker et al., 2010), and psychological distress (e.g., depression, anxiety, and Post-traumatic Stress Disorder) (Donker et al., 2013). The aim of these apps is to help prevent lifestyle related illnesses as well as the improvement of overall health (Middelweerd et al., 2014). Positive health behaviours can be defined as *'any activity undertaken for the purpose of preventing or detecting disease or for improving health and wellbeing'* (Conner, 2002). Negative health behaviours including physical inactivity, poor diet and tobacco smoking are linked to chronic mental and physical disease (Allgöwer et al., 2001; Australian Institute of Health & Welfare, 2012; Teychenne et al., 2008). Improving health behaviours can positively improve mental and physical health at an individual and population level (Fox, 1999; *WHO | Global Status Report on Noncommunicable Diseases, 2014*)

A new opportunity is emerging for apps to be utilised in wellbeing (Antezana et al., 2015; Gaggioli & Riva, 2013). Wellbeing encompasses both an individual's positive feelings and positive functioning in life (Keyes, 2005). Apps associated with wellbeing are designed to support a positive outlook on life and drive on-going positive health behaviours. These health and lifestyle apps are relevant for young people given their affinity with new technologies (Dennison et al., 2013). In Australia, over 20% of young Australians (15-19 years) are thought to meet the criteria for mental illness, and 60% of these report to be *uncomfortable* in seeking face-to-face help or advice for mental illness (Slade, Johnston, Browne, et al., 2009). It is clear that finding new ways of supporting mental health and wellbeing are needed. The use of apps to improve wellbeing is a nascent area of research which aims to cost-effectively promote the engagement of young people with health services

by minimizing stigma and improving accessibility (Dennison et al., 2013; Orlowski et al., 2015). A review of 126 studies (Boydell et al., 2014) found that mental health services delivered using technology resulted in high levels of satisfaction for practitioners, families, and young people, and that young people preferred getting mental health support via technology.

The app stores categories 'health & fitness' and 'lifestyle' contain a number of resources for promoting positive health behaviours. Health apps account for 2.9% and 8.8% of apps found in the GooglePlay™ and AppStore™ libraries respectively (*Fastest Growing Mobile App Categories 2014* |*Statista*, 2015). However, there has been an increase in their use over the last couple of years, registering a growth of 89% and 174% in both app stores in 2014 (*Fastest Growing Mobile App Categories 2014* |*Statista*, 2015). Tracking technologies (capable of recording users' behaviour) are a particular area of growth granting users cost-effective insight into their daily behaviours (Hekler et al., 2013).

Despite the potential of apps to influence changes in health behaviour (Donker et al., 2013), there is limited evidence of their foundation in health theory. The current study investigates Behaviour Change Techniques (BCT's) within popular health and lifestyle apps. BCT's are the basic mechanisms derived from theory that drive behavioural change (Michie & Johnston, 2012). A number of taxonomies have been designed to analyse the BCT content of health interventions, such as alcohol consumption (Michie et al., 2012), physical activity (Michie et al., 2011), and sexual health (Hannah Dale et al., 2013). These taxonomies allow contrasting multiple theoretical frameworks, drawing from multiple behaviour change theories to identify the basic components that change behaviour. Previous studies of BCT's in apps have contributed to our understanding of how behavioural interventions work in this context (Hekler et al., 2013; Michie & Abraham, 2004). One study suggested that effective incorporation of BCT's in an app facilities increased engagement and effectiveness (Neilsen, 2009).

This study focused on tracking apps and their impact on physical activity (Fox, 1999), diet (Jacka et al., 2011), and sleep (Sleep and Mental Health, 2009). These categories were chosen given their importance in mental health. Tracking apps were chosen because they offer personalised and quantifiable feedback versus generic information. The following questions were addressed: What BCT's do the selected health and lifestyle apps include in their design and which are used more often? To the researchers' knowledge this is the first study to analyse BCT's in three categories simultaneously (comparing similarities).

Method

App selection

Apps were identified and selected from GooglePlay™ and AppStore™ and coded according to the Behaviour Change Techniques Taxonomy BCTTv1 (Michie et al., 2013). Accessibility and availability were prioritised in the context of young people as target users. Apps were selected following two main criteria: First, apps had to be present in both of the most popular app stores, second, apps had to be free (i.e., no monetary cost to the user) even if they also offered paid versions, additional criteria included selecting apps that had a user rating of 4 stars or more out of 5 in GooglePlay™, offered tracking capabilities and focused in at least one of the chosen areas of analysis (physical activity, diet or sleep). The top 10 apps arising from the selection process in each category were compared. It is important to clarify that the star rating system in GooglePlay™ works as an indicator of popularity and is calculated from users' feedback, AppStore™ ratings were not used as a criterion. Similar studies have also used this criterion for app selection (Azar et al., 2013; Kirwan et al., 2013). The selection process is illustrated in Figure 2.

Coding

Apps were coded using the Behaviour Change Techniques Taxonomy BCTTv1 (Michie et al., 2013). The BCTTv1 is a comprehensive non-specific classification (refer to

Figure 3

The Process Followed for App Selection

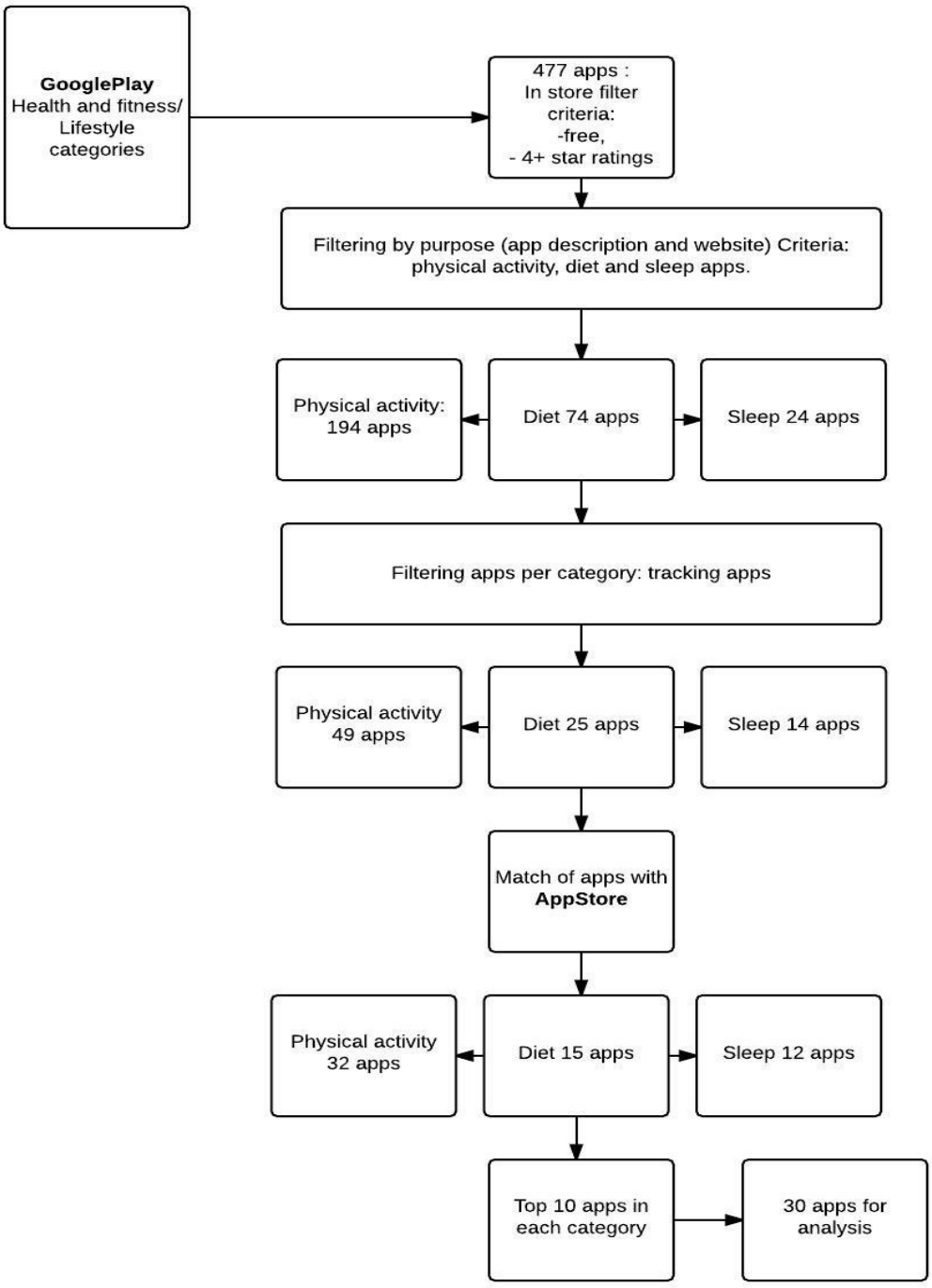

Table 8

Total Number of Categories and Behavioural Change Techniques (BCT's) in the Behaviour Change Techniques Taxonomy (BCTTv1)

Categories	Number of BCT's	%
Goals and planning	9	9.7
Feedback and monitoring	7	7.5
Social support	3	3.2
Shaping knowledge	4	4.3
Natural consequences	6	6.5
Comparison of behaviour	3	3.2
Associations	8	8.6
Repetition and substitution	7	7.5
Comparison of outcomes	3	3.2
Reward and threat	11	11.8
Regulation	4	4.3
Antecedents	6	6.5
Identity	5	5.4
Scheduled consequences	10	10.8
Self-belief	4	4.3
Covert learning	3	3.2
Total	93	100

Table 8 for the 16 categories included in the BCTTv1 and the total number of BCT's in each) that has been used effectively in several research projects including a similar study that analysed electronic activity monitors (Lyons et al., 2014; Morrissey et al., 2016; Presseau et al., 2015). The BCTTV1 was created by experts following a Delphi-type exercise that analysed and classified BCT's from published classification systems and was validated by coding behavioural interventions in which adjusted kappas of ≥ 0.60 were obtained (Michie et al., 2013).

The first three authors (GA, AV, and VB) were self-trained in the BCTTv1 taxonomy by completing the online course designed by Prof Susan Michie and her colleagues from University College London (UCL) (*BCTTv1 Online Training*, 2016). This training does not establish protocols to code apps specifically, but provides information regarding the underlying principles of each BCT in the 16 categories. All coders had backgrounds in one or more of Psychology, Mental Health and Youth Work. Coders were required to download and use the apps for a month. Triple coding was carried out in 50% of the apps selected randomly from the finalised list using the statistical software package Stata version 13 (*StataCorp,2013)*. Coders completed two rounds of analysis. After the first round of coding agreement was reached in 48% of the total number of BCT's identified (2 or more coders). At the end of the second round agreement between 2 or more coders increased to 70%, this was considered acceptable in the context of 3 coders using an extensive taxonomy in comparison to similar studies using more specific taxonomies with just two coders obtaining interrater agreements between 80 to 90% (Lyons & Hatkevich, 2013; Michie et al., 2012). Most differences between coders referred to overlapping concepts and their practical implementation within the apps, e.g., *'Goal setting (behaviour)'* vs. *'Goal setting (outcomes)'*, these two BCTs differentiate depending on the way goals are established and how they are used during the intervention. However, it was clear that there was strong agreement at a categorical level, in this case '*Goals and planning'.* Discussion was guided by analysing the different techniques using specific definitions established by the BCTTv1. After the second

coding round was completed, GA completed the analyses of the remaining 50% of apps. Coding focused on features found in the apps as executed in their mobile phone version; this means that features offered in external websites, or third parties were not coded as they were not considered to be part of the mobile apps.

Results

To investigate which BCT's are included in health and lifestyle apps*,* selected apps were used, and features identified coded against the Behaviour Change Techniques Taxonomy 1 (BCTTv1). Results indicated that all chosen apps did contain at least 1 BCT. The most BCT's found in one app was 20. Only a small portion of the 93 BCT's listed in the BCTTv1 were present overall and entire categories were absent.

Physical activity apps emphasised 'Feedback on outcomes of behaviour', 'Action planning', 'Feedback on behaviour' and 'Self-monitoring of outcomes of behaviour' (80%) as the principal BCTs in their design. Feedback consisted of displaying quantified data including distance travelled, steps taken, and calories consumed. At a second level goal setting BCT's were common: 'Goal setting outcome' 60% and 'Goal setting behaviour' 70 including forums and communities as well as through the implementation of virtual group workouts (challenges). These features were coded as "social support (unspecified) in 80% of the apps in this subcategory. All of the apps in this category could be linked to other apps.

'Feedback on outcome(s) of behaviour' was present in 100% of the analysed calorie tracking apps (diet apps), displayed as daily calorie or kilojoule consumption, also taking into consideration food intake and self-registered exercise together with Body Mass Index (BMI) scores. The 'Goal setting (outcome)' BCT (90%) was present in as these apps require users to set a desired weight. The other two prevalent BCT's in this category: 'Self-monitoring of outcome(s) of behaviour' (90%) and 'Self-monitoring of behaviour' (70%), required users to manually input food intake and activity levels. 'Social support (unspecified)' (80%) was coded to categorise all of the social sharing features embedded in these apps.

Sleep tracking apps relied on movement sensors embedded within smartphones to provide ‘Biofeedback’ (50%) and ‘Feedback on outcomes of behaviour’ (50%) expressed as sleep cycle reports. These apps also used ‘action planning’ (60%) and ‘Prompts/cues’ (70%) in the form of ‘relaxing sounds’ and ‘smart alarms’ designed to help sleep conciliation as well as prompting the wake-up cycle. Two of the apps in this category ‘Calm’ and ‘Deep Sleep Relax Hypnosis’ were distinct because they did not track sleep cycles but were retained given their aim to help users improve sleeping patterns by providing feedback. This category showed a much lower incidence of social support BCT’s.

Overall, 51 BCT’s (54.83%) were unutilised and 9 (9.6%) were used once (by single apps). Non-used categories in the BCTTv1 included ‘Regulation’, ‘Identity’, ‘Covert learning’ and ‘Self-belief’ accounting for 16 BCT’s out of the 93 comprising the BCTTv1 (17.2%).

Results indicated that of the 93 BCT’s listed in the BCTTv1, only 7 were identified as being present in 50% or more of the apps (refer to Table 9 for the number of categories in the BCTTv1 represented by the BCT’s in each app). The most common BCT across apps was ‘Feedback on outcomes of behaviour’ (76%) followed by ‘Self-monitoring of outcome(s) of behaviour’ (67%). Other BCT’s over 50% commonality were ‘Goal-setting outcome’ (50%); ‘Action planning’ (50%); ‘Self-Monitoring of Behaviour’ (53%); The five BCT’s mentioned are classified within the categories ‘Goals and Planning’ and ‘Feedback and Monitoring’. The remaining 2 BCT’s ‘Social support - unspecified’ (60%) were present through different features, from in-app diaries to active participation in online communities. Similarly, BCT ‘Prompts/cues’ (57%) were present as reminders, alarms and customisable messages.

Table 9

Number of BCTTv1 Categories Represented by the Behaviour Change Techniques (BCT's) in each app

App	Total Categories	Total BCT's
Nike+	10	20
micoach train and run	7	13
UP	7	15
Endomondo	6	10
walk with map my walk	6	10
Fitbit	6	10
Runtastic	4	6
Strava	4	6
Runkeeper	4	7
Moves	1	1
Calorie Counter & Diet Tracker – Sparkpeople	8	16
Calorie Counter MyfitnessPal	7	15
My Net Diary	7	12
Calorie counter	6	9
Livestrong	5	9
Yazio	5	8
Lifesum	5	9
My Diet Diary	5	8
Calorie Carb and Fat	5	7
Calorie counter by fatsecret	4	6
Calm	7	13
Pzizz	6	8

Discussion

This study investigated selected health and lifestyle apps and established which BCT's are included in their design. Results indicated that only a small portion of the 93 BCT's listed in the BCTTv1 were present across the selected apps (9.6% commonality). Of the selected apps (i.e., tracking apps), the most frequently used BCT's were related to goal setting and feedback. However, entire categories of the BCTTv1 were not observed, highlighting possible avenues for future app development. Incorporating BCT's of these missing categories in the design of health and lifestyle apps could open new possibilities for app developers in helping users change their behaviour effectively and also in potentially achieving higher engagement with their apps. Previous research (O'Brien & Toms, 2008) highlights that although the use of health tracking apps is increasing, people don't engage with them in the long-term rendering these resources potentially ineffective. Findings like these support the importance of matching theory and engagement to back up effectiveness. This is illustrated in calorie tracking apps, which require the user to register food intake. Calorie tracking apps can achieve this by implementing different features: one option may be to rely on the user to manually input the food, its ingredients, and amounts; another option may be the provision of extensive food lists for the user to choose from; while another may be the inclusion of an automatic bar code scanner to register their food intake seamlessly. In all three scenarios the BCT involved is 'self-monitoring of behaviour'. However, it is reasonable to assume that users will opt for the simplest method and that continued engagement will depend on ease-of-use.

BCT categories such as 'Self-talk', or 'Identity" associated with changed behaviour' may be used to increase user engagement by focusing on intrinsic and social motivation (Khaylis et al., 2010), as these elements have been shown to boost engagement in previous studies (O'Brien & Toms, 2008). A study analysing behaviour change interventions delivered via SMS (short message service) found that studies using un-tailored SMS suffered greater attrition than studies that considered elements like age, gender, behavioural history,

preferences, personal goals, personal barriers and personal details (such as name or nickname) (Fjeldsoe et al., 2009). Another study highlighted that young people emphasized having flexibility in the design and implementation of physical activity interventions based on their personal characteristics including, age, gender and contextual variables (Rees et al., 2006).

Developers may lack understanding of behavioural theory, hindering the development of higher quality apps. Future developers should aim to embrace the repertoire of BCT's used and establish synergies by linking features together. For example, the pedometer app 'moves' can link with the calorie-tracker 'lifesum', expanding the scope of both apps. This could represent an opportunity to provide users with a more comprehensive suite of resources to improve their health behaviours. From a wellbeing perspective, future apps could combine BCT categories such as 'Social support' and 'Identity' with techniques already in use such as 'goals and planning' and 'feedback and monitoring' to help young people create expand their social networks and receive feedback on their behaviours by peers.

Despite all of the above it could also be argued that as long as the techniques are effective, there is no need to include a wide variety of them. The true impact of BCT's on the effectiveness, uptake and continued engagement with health and lifestyle apps is not yet fully understood. The effectiveness of BCT's in health and lifestyle apps could also be related to age, gender, location, and other cultural variables. These considerations warrant further research to enhance the design of apps capable of producing sustained behaviour change.

Limitations

Interpretation of this research is limited by the dynamic nature of apps. New app versions are available frequently and can vary from minimal technical improvements to significant changes in function. Some BCT's may have been omitted from the evaluation as

apps were only used for a short period of time, however coders were asked to use the apps as long as needed to obtain the best possible appraisal of their features. It is also important to highlight that not all app features are available for all versions across all platforms (Android vs. Apple) and some differ depending on the smartphone being used. Further BCT's may have been omitted by poor app design; however, findings are consistent with user experience. The fact that only free versions were coded, and most apps offer paid upgrades with allegedly better features and techniques is also a limitation as we were unable to assess the full capabilities of each app.

Future research

Results highlight the importance of establishing relationships between BCT content and effectiveness in apps to generate sustained behaviour change. Future app development should focus on incorporating evidence-based techniques in a way that is appealing to the user to ensure greater uptake and increased behavioural change. These apps should be assessed either by qualitative (to understand meanings, perception and personal characteristics of users) or quantitative studies (to understand relationships between specific BCT and engagement dimensions).

Conclusion

Current research suggests that health and lifestyle apps designed to modify health behaviours contain low levels of theory-based Behavioural Change Techniques (BCT's). Increased implementation of BCT's could improve interventions and achieve higher levels of user engagement. The importance of this research is highlighted by the increasing consumption of health and lifestyle apps especially by young people. These apps promise to 'improve', 'support' and provide solutions to the user's needs whilst lacking evidence-base. This puts young users at risk by providing ineffective solutions (Hogan & Kerin, 2012). Young people use technology as a valid alternative to face-to-face mental health support

adding to the importance of designing quality products. The increasing reliance on these technologies should highlight the importance of using them to promote wellbeing, as well as connecting people with services and guide them to access the best available help when they need it.

Chapter 6

Predictor of Use of Wellbeing Apps

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Statement of Contributions:

Mr Gaston Antezana (*Candidate*)

I was responsible for the conception and primary authorship of the paper. I conducted the data collection and analyses. I was the corresponding author and primarily responsible for responses to reviewers and revisions to the paper.

Signed: Signature removed for library publication Date 04/03/2023

Dr Venning, Dr Smith, Dr Bidargaddi (*Co-authors*)

We were the supervisors and co-researchers of the program of research that lead to this publication and there was ongoing collaboration between Mr. Antezana and us in refining the direction of the research. The realisation of the idea, collection of data, and analysis of data were the work of Mr. Antezana. Mr. Antezana was responsible for writing this paper; our role was to comment on drafts, make suggestions on the presentation of material in the paper, and to provide editorial input. We also provided advice on responding to comments by the journal reviewers and editor. We hereby give our permission for this paper to be incorporated in Mr. Antezana's submission for the degree of Doctor of Philosophy from Flinders University.

Signed: _ Signature removed for library publication - Date: 28/02/2023
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Signed: ____ Signature removed for library publication ____ Date: 28/02/2023
David Smith

Signed: _ Signature removed for library publication __ Date: 01/03/2023
Niranjan Bidargaddi

Abstract

The potential of mobile applications (apps) as a resource to support wellbeing in young people is hampered by low usage. Suggested reasons for this vary from technical issues to users' psychological and personal characteristics like gender, mood, and perceptions on wellbeing. The authors set out to identify and understand predictive variables related to the use of wellbeing apps by young people in the context of the "Online Wellbeing Centre" (OWC) Randomised Controlled Trial (RCT) (a study assessing changes in wellbeing of young people who use wellbeing apps). A cross-sectional analysis using binary logistic regression was conducted, taking into account previous app usage of participants at baseline versus demographic, ecological momentary assessments, and wellbeing variables, of data collected in the OWC-RCT. To explore predictors further, follow-up post-RCT surveys were coded to better understand user's predisposition towards apps. Results indicated mood ($p < .006$) and gender ($p < .03$) are significantly associated with the use of wellbeing apps. Female participants with elevated mood were more likely to use wellbeing apps before signing up into the study. Two themes were identified from participants at follow-up that related to the design of the app and engagement of the app user. Females were more likely to focus on the purpose of app, whereas males were more likely to focus on specific goals and features (e.g., tracking) offered by the app**.** Females were able to mention the link between wellbeing and app usage. Results indicated that personal characteristics explain engagement with wellbeing apps, with mood and gender significant in the current sample. Further qualitative research may help identify other individual characteristics that explain why and how young people use wellbeing apps and the impact of these on a user's health.

Introduction

In Australia, 1 in 4 young people between the ages of 16 to 24 years struggle with at least one diagnosable mental health problem (Milnes et al., 2011, Australian Institute of Health & Welfare, 2021c). Even though mental health issues represent the highest burden of disease in young people, only a fraction of those who experience distress access traditional mental health (Australian Institute of Health & Welfare, 2021c). Against this background, mobile health (mHealth), defined as the utilisation of technology to deliver mental health interventions (Handel, 2011), is increasingly being regarded as a viable alternative to traditional attempts to reach those in need, particularly young people as they are regarded as natural technology users (Burns et al., 2016). Technology can help solve some of the barriers young people experience when accessing help for mental health issues, these include: distance, accessibility, cost, stigma, limited youth mental health specialists, absence of out-of-hours support and lack of anonymity (Liverpool et al., 2020). A number of online mental health services in Australia currently offer services to young people. An example of an online service designed to promote mental health is ReachOut.com (Kahl et al., 2020) (*ReachOut.Com*, 2016). ReachOut.com is a fully online service that offers comprehensive mental health resources to youth and parents around education, support and self-management; in 2020 according to their website 132,000 people in Australia access ReachOut.com every month. Although use of these resources has increased over time, only a third of young people diagnosed with a mental health issue report using online services for help and information (*Young Minds Matter*, 2020), so improving engagement with these services could have a significant impact in their effectiveness.

In addition to technologically based clinical interventions that target mental health issues, recent developments in mHealth are investigating strength-based approaches to develop an individual's strengths and positive resources (e.g., self-efficacy, goal-orientation)

(Bostock et al., 2019, Carey et al., 2016). These interventions focus on increasing a person's level of wellbeing as opposed to exclusively addressing the reduction of their mental illness symptoms (e.g., depression and/or anxiety) (Chakhssi et al., 2018). Wellbeing encompasses mental health, defined as the presence of positive symptoms in the emotional, psychological, and social areas of functioning (Keyes, 2002, 2005). The significance of building and supporting an individual's wellbeing is demonstrated by the effect it has on the prevention and management of mental illness, as well as the development and maintenance of positive symptoms of functioning (e.g., increase of life satisfaction, happiness, meaning and purpose) (Keyes, 2002; *Well-Being Concepts* | *HRQOL* | *CDC*, 2018). Recent studies show that wellbeing can effectively be targeted by technology, particularly by the use of apps given their prevalence, appeal, accessibility and personalisation (Anderson et al., 2016, Francis, 2018).

Despite the benefits, mHealth interventions usually suffer from high attrition (Eysenbach, 2005; Orlowski et al., 2015). Areas suggested to contribute to this attrition include poor design (Rapp & Cena, 2016), lack of behaviour change techniques (Kim & Baek, 2018; McLean, 2018), and lack of attention given to broad individual characteristics (e.g. gender, mood and age) (Lewis et al., 2020) as well as psychological mediators such as personal motivation, perceived usefulness, expected benefits, enjoyment, and personality types (Johnson et al., 2012; Orlowski et al., 2015). While findings in this area are inconsistent, age and gender seems to be significant elements when trying to explain who uses mobile health interventions and why (Escoffery, 2018; Smail-Crevier et al., 2019). Studies that have explored app features by gender have found that women value the social features more than men (Koivisto & Hamari, 2014), and that men were more likely to use fitness apps while women gravitate towards nutrition, self-care and reproductive health apps (Bol et al., 2018).

Identifying the elements that may influence use and predict higher engagement with wellbeing apps could potentially inform the design and implementation of these resources

and increase their potential. To that end, the current study analysed cross-sectional data obtained from the Online Wellbeing Centre (OWC)- RCT (Bidargaddi et al., 2017) in an attempt to identify and understand predictive variables related to the use of wellbeing apps. The OWC- RCT had two distinct components, the first was a portal called “The Online Wellbeing Centre” used to sign in participants, collect baseline data, administer evaluation measures, and randomise participants. The second component was an app self-recommendation service called “The Toolbox: the best apps for your brain and body” (The Toolbox) (*The Toolbox*, n.d.). The focus of the current study was on identifying relationships between previous app usage as reflected in the initial app use survey of the OWC - RCT, and the independent variables collected: demographics (e.g., age, gender, and location); ecological momentary assessments (e.g., mood, energy and sleep); and wellbeing.

Methods

Participants

Participants in the OWC-RCT were predominantly recruited online using mixed strategies, consistent with the procedure described in Musiat et all (Musiat et al., 2016). At recruitment participants were required to provide demographic information (e.g., age, gender and postcode) and complete the Mental Health Continuum Short Form- MHC-SF (Antezana et al., 2015; Keyes, 2009), recruitment flow can be found in Figure 4. The characteristics of participants app use in relation to the outcome variable (app use before randomisation), using t tests for continuous variables, and chi-square tests of for categorical variables, are presented in Table 10. The trial recruited 488 participants, 308 completed the registration process.

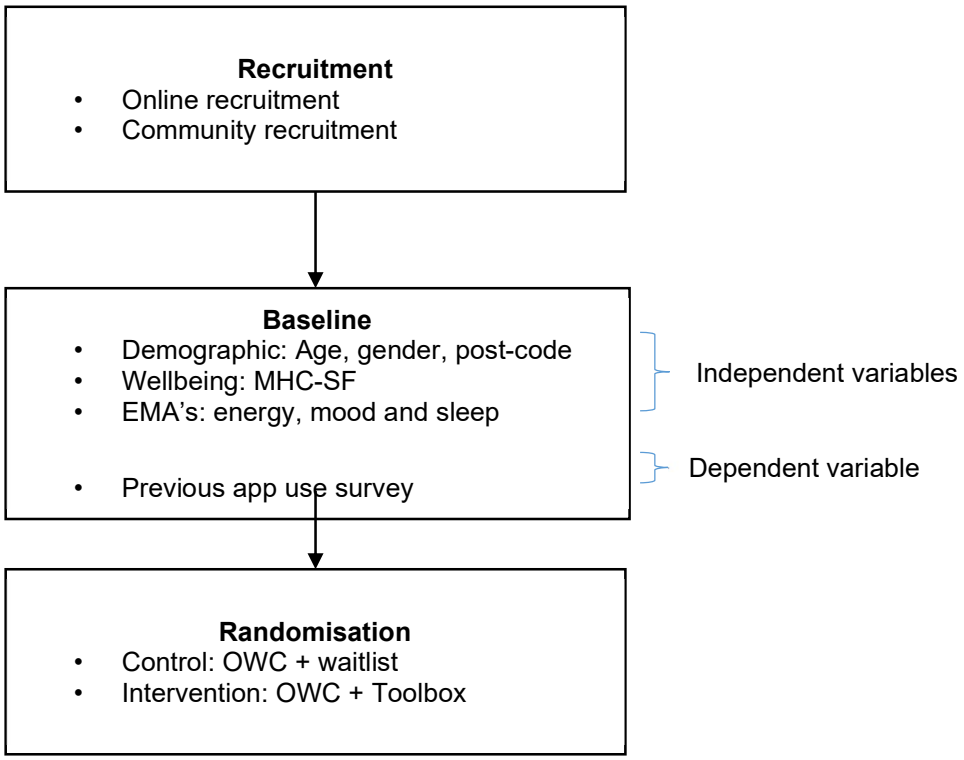
Measures / Procedure

When participants first signed on to the OWC, they were randomised into the treatment arms. Group 1 represented the intervention arm (OWC with The Toolbox), Group

2 represented the waitlist control arm (OWC without The Toolbox). The OWC first used the MHC-SF to assess psychological, social and emotional wellbeing where, depending on the scores, people were classified into three diagnostic categories: languishing, moderate mentally healthy and flourishing, consistent with the classification that has been validated across different cultures and demographics (Joshanloo et al., 2013; Lamers et al., 2012).

Figure 4

OWC-RCT recruitment and baseline data collection



Participants were then asked to self-assess their energy, mood and sleep on three independent Likert scales designed as ecological momentary assessments (EMAs), with 100 being "excellent" or high and 0 being "poor" or low. Lastly, participants were asked to complete a survey designed to identify if they had used any of the 46 apps included in The Toolbox during the previous month prior to signing into the study.

The Toolbox included 46 wellbeing apps that had been reviewed by a panel of both mental health professionals and consumers using the Mobile Application Rating Scale (MARS) (Hides et al., 2014). The Toolbox was designed by ReachOut.com to improve

emotional, physical, social and psychological wellbeing of young people between 16 to 25 years of age by the individualised recommendation of apps according to personal goals (Antezana et al., 2015). In the current study, results from the initial app use survey of the OWC trial were used in order to code app use before randomization, used as the dependant variable “app-use”. Independent variables of the OWC were grouped according to demographics: age (targeted to 16 to 25 years), gender (male, female) and location (urban, rural and remote); ecological momentary assessments (EMAs): mood, energy and sleep; and wellbeing measured by the MHC-SF in 3 categories (languishing, moderate mentally healthy and flourishing). Outcomes of the trial are reported in Bidargaddi et al (Bidargaddi et al., 2017), and no significant differences in the wellbeing of participants from either condition were shown, attrition at 4 weeks post-randomization was 45.1% in the control group versus 55.2% in the active group.

Analysis

Binary logistic regression was used to investigate what predicted participants past use of wellbeing apps. Accordingly, “app-use” was used as the outcome variable: non-use (0) vs. use (1) in relation to the independent variables: age, gender, location, mood, energy, sleep; and wellbeing as described above. A binary variable was produced by coding all the cases that had not used any app (n=191) vs the cases that had used 1 or more apps (n=117). Statistical analyses were conducted using STATA (*Stata: Software for Statistics and Data Science*, 2020). The model was also adjusted to the RCT’s attrition rate as a direct indicator for engagement with apps, this variable was included in the model as an interaction term with study groups, this is consistent with previous research that showed that intervention assignment can influence patterns of attrition, particularly those of a behavioural nature (Hembree et al., 2003; Kistin & Silverstein, 2015). We also reported model estimates for the un-adjusted model. All variables were analysed against the dependent variable in one comprehensive regression model.

Table 10

Baseline Characteristics of Participants in the OWC-RCT

Variable	N (%)	Mean (SD)	No app usage	Previous app usage	p-value
Gender					3.37 (0.07)
Male	67 (22)		48 (71%)	19 (28%)	
Female	241 (78)		143 (59%)	98 (40%)	
Age		21.69 (2.3)			-1.086 (.27)
Area					4.41 (.22)
Major Urban	241 (78)		146	95	
Other Urban	55 (18)		36	19	
Bounded locality	6 (2)		6	0	
Rural balance	4 (1)		2	2	
Blanks	2				
Wellbeing					5.18 (0.08)
Languishing	53 (17)		40	13	
Moderate	167 (54)		98	69	
Flourishing	70 (23)		41	29	
Blanks	18 (6)		12	6	
Sleep		48.9 (20.3)	187	114	-1.49 (.14)
Energy		46.1 (16.8)	188	116	-.744 (.46)
Mood		51.2 (20.7)	188	116	-2.73 (.007)

Values based on t-tests for continuous variables and chi-square tests for categorical variables.

Post-intervention surveys

Unique to the current study, a follow-up online and telephone survey was conducted after the conclusion of the OWC-RCT in order to understand participants' experiences of the online toolbox. The survey questions are shown in Table 11. The follow-up survey sought information on practical aspects such as site-access, usability, and engagement; as well as in motivational factors including personal interests and expectations. A total of 45 participants responded to the survey: 32 females, 13 males. Responses were transcribed and coded using thematic analysis to identify explicit meanings of data at a semantic level, (focusing in the explicit meaning of the data) (Braun & Clarke, 2006).

Table 11 Post

OWC-RCT Follow-up Survey Questions

1. What do you think about the Online Wellbeing Centre?
2. Why did you sign up/where did you hear about us?
3. What do you think worked well about the OWC? What didn't?
4. What device did you use to access the OWC?
5. Where did you use it and were there any barriers to using the site?
6. Any feedback on how it looks, the illustrations, or language used?
7. What do you think about the Toolbox?
8. Did you download any of the apps you selected?
9. Are you still using any of the apps you downloaded?
10. How have the apps changed or influenced your behaviour or lifestyle?
11. If you haven't downloaded anything, can you tell us why?
12. Was there anything specific you were looking for?
13. Did the site meet your expectations? Can you explain?

Results

Research Question 1

When analysing each variable in association with the outcome measure, only mood ($p < .006$) and gender ($p < .03$), were statistically significant (refer to Tables 12 and 13).

Results indicated that females had a higher probability of using apps (odds ratio = 0.68). Mood was analysed as a discrete variable with positive odds ratio corresponding to higher scores in relation to the outcome variable (0.02). In that context results of the final binary logistic regression model show significant effects in two variables (mood and gender), indicating that females and participants with high mood levels are more likely to use wellbeing apps. Post-estimation analyses included a classification table (table 14). This table predicts group classification of the dichotomous variable. The model can effectively predict non-use up to 95.7% accuracy; however, it showed low predictive capacity regarding app use.

Table 12 OWC-RCT

No Adjustment for Group by Attrition

AppUse	**Coefficient**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
Gender						
Female	0.64	0.32	1.98	0.04	0.00	1.28
Mood	0.02	0.00	2.61	0.09	0.05	0.41
Energy	0.01	0.01	-1.33	0.18	-0.34	0.00
Sleep	0.00	0.00	0.24	0.80	-0.13	0.01
Age	0.08	0.05	1.54	0.12	-0.02	0.19
Wellbeing						
Moderate	0.36	0.39	0.92	0.35	-0.41	1.14
Flourishing	0.28	0.47	0.60	0.54	-0.64	1.20
Constant	-3.81	1.32	-2.87	0.00	-6.41	-1.21

Table 13

OWC-RCT – Model Adjusted for Group by Attrition Effect

AppUse	Coefficient	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Gender						
Female	0.68	0.33	2.08	0.03	0.03	1.33
Mood	0.02	0.00	2.75	0.006	0.07	0.43
Energy	-0.01	0.01	-1.34	0.18	-0.34	0.00
Sleep	0.00	0.00	0.25	0.80	-0.13	0.01
Age	0.09	0.05	1.69	0.091	-0.01	0.20
Wellbeing						
Moderate	0.33	0.40	0.83	0.40	-0.45	1.11
Flourishing	0.20	0.47	0.42	0.67	-0.73	1.13
Constant	-3.80	1.35	-2.81	0.00	-6.45	-1.15

Table 14

Post-estimation Analysis - Classification Table

		App usage		Percentage Correct
Observed		0	1	
App Usage	0	180	8	95.7
	1	106	10	8.6
Overall Percentage				62.5

a. The cut value is .500

Marginal Effects and Representative Cases

Marginal effects can be used to predict how a binary outcome can change in relation to changes in predictive factors (Norton et al., 2019). Figure 5 illustrates changes in App-use for male and female in relation to changes in mood. It can be observed that both genders are more likely to use wellbeing apps the higher their mood scores are. Predictive margins also allow to describe representative cases by setting desired values. Tables 15 and 16 below correspond to 18-year-old male and female participants with a mood score of 20/100 when accounting for energy, sleep and wellbeing. Results show an 11.27% probability of app-use for the males vs. 19.4% probability of app use for the females.

Figure 5

Marginal Effects on Previous App Use by Gender and Mood

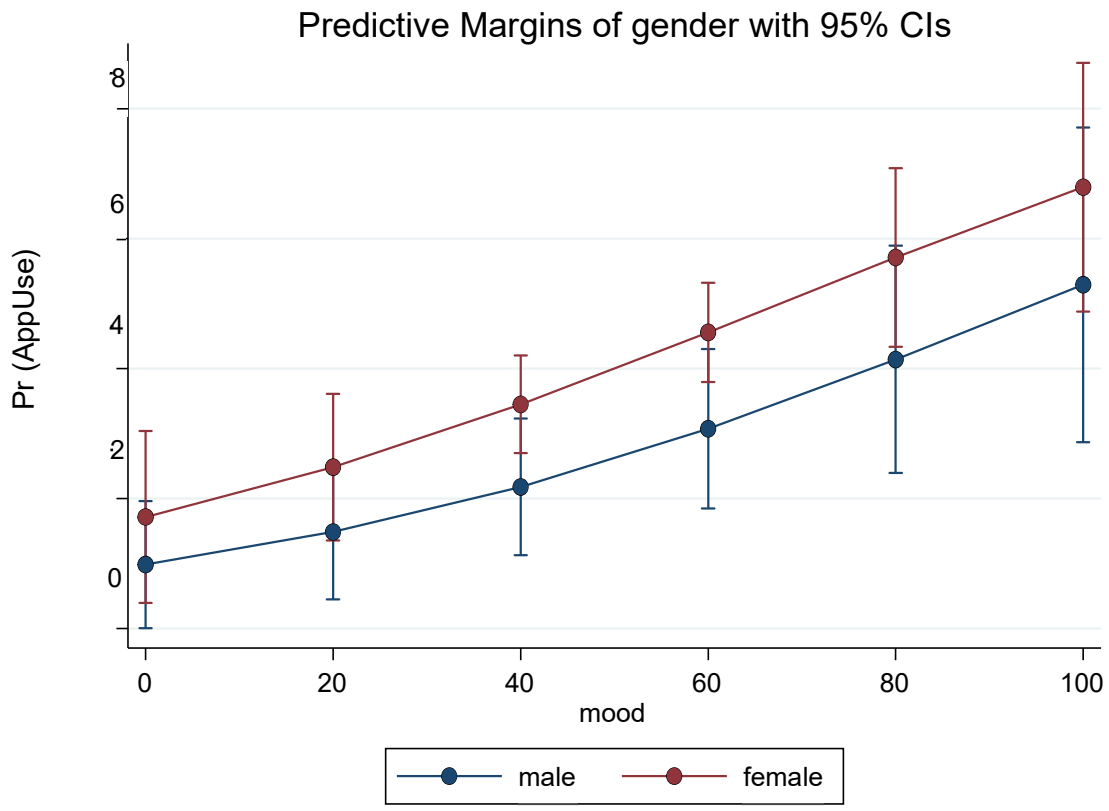


Table 15

Predictive Margins - Representative Cases – Male

Number of observations: 287

Model VCE: OIM

	Margin	Std. Err.	z	P>|z|	[95% Conf.	Interval]
cons |	0.194	0.058	3.3	0.001	0.079	0.31

Margins at: gender = 1; mood= 80; age= 18

Table 16

Predictive Margins – Representative Cases – Female

Number of observations: 287

Model VCE: OIM

	Margin	Std. Err.	z	P>|z|	[95% Conf.	Interval]
cons |	0.112	0.047	2.36	0.018	0.019	0.206

Margins at: gender = 2; mood= 20; age= 18

Research Question 2

To explore research question 2, post RCT follow-up interviews reached a total of 45 participants (female=32). This survey sought feedback on practical aspects such as site-access, usability, and engagement; as well as in motivational factors including personal interests and expectations. We organised participant responses to questions by codes, and also noted any emergent concepts in participant response. The assignment of codes was done at a semantic level (explicit meaning) by identifying key words associated with the concepts being discussed (Braun & Clarke, 2006). Themes and codes identified are presented in Table 17; consistent with the latest reflection of Braun and Clarke (Braun & Clarke, 2019), themes were outlined following researchers' pre-assumptions and were

analysed at a semantic level; special emphasis was given to responses related to gender and mood.

Table 17

Post-RCT Follow-up Survey - Themes Identified During Coding

Themes	Topics	Codes
Design	System interactivity	Ease of use, navigation
	Behaviour change techniques	Tracking mood, sleep, wellbeing
Engagement	Expectations	Motivation and expected outcomes
	Cognitive assessment	Content quality, value
	Emotional dimension	Curiosity, positive emotion

Theme: Design

This theme comprised 2 codes: system interactivity (usability, individual-app interaction) and the inclusion of behaviour change techniques (BCT's) understood as the active features within the apps that are designed to track users' behaviours (Cane et al., 2015).

Several differences were noted in the way females and males interacted with the OWC apps. Males were more likely to focus on specific goals and features (e.g., tracking). Female respondents were more likely than males to mention specific app usage, for example in response to the questions: "Did you download any of the apps you selected" and "Are you still using any of the apps you downloaded?" different participants responded: *"juice, smiling mind, optimism"*; *"to-do-list, time management, smiling mind" and "mindfulness, sleep".* In contrast none of the males responding to these questions were able

to name a specific app, however they were more likely to mention behaviour change techniques (BCT's) built in the OWC and other apps. This is illustrated by responses like: *"I enjoyed tracking sleep and mood patterns, being able to log it"* even though this participant couldn't remember the names of the specific apps he used to do this; similarly, another participant said: *"Like: setting goals. Dislike: following through on goals. Have phone contact to push, self-motivation".* Overall males were more focused on functionality and less interested in apps as discreet entities, as one the participant put it: *"I prefer to keep track of wellbeing, not use apps".*

Theme: Engagement

This theme explored the users' expectations as they pertained their motivations to use the apps, their assessment regarding the apps content, quality and value, and the emotional reaction to the apps.

Most respondents said that their interaction with the OWC and Toolbox was positive; however, there was a clear tendency to disengage with these resources after initial contact. Few respondents referred to specific Toolbox apps or their usage with most comments being on the mood and wellbeing tracking features of the OWC (EMA's).

Females were able to mention the link between wellbeing and app usage. To the question "was there anything specific you were looking for" participants responded with thoughts such as: *"Just something to help improve my wellbeing".* To the question "How have the apps changed or influenced your behaviour or lifestyle?" females were also more likely to specify clear outcomes: *"managing stress and maintaining wellbeing";* and another: *"Better understanding of what's out there to help friends".* Similarly, females were able to clarify the expected and achieved outcomes of app use, indicated by responses to the question: "How have the apps changed or influenced your behaviour or lifestyle?" responses included: *"made me slightly, more attentive and aware of issues".* Being aware of the impact of these apps was also true for those not perceiving any benefit, for example a participant

said: *"No. Used for a month, then found they weren't really working for me",* and another: *"None really appealed, or thought they wouldn't be useful."* In comparison males were more likely to have accessed the toolbox out of "curiosity", as indicated by responses to the question "was there anything specific you were looking for?" This is illustrated by responses like: *"just to try, curious"*; and "*Not really, just looking".* When talking about their motivation to use apps male comments' were non-specific and signalling towards low interest even prior to been offered the recommended apps; this is shown to answer to the question "If you haven't downloaded anything, can you tell us why?", responses included: *"Don't feel like I need it;* and: *"Nothing specific, but I assumed it would help with my overall wellbeing".* Males were also more likely to avoid using the website and apps or stop using them after a short time, some of the comments reflecting this included: *"Accessed it, didn't use it"*; *"Didn't use it originally - intention to use but didn't due to life circumstances"* and *"It was easy to lose interest in trying".*

Most statements related to mood had positive connotations. Some comments referenced the impact of the Toolbox and associated apps in mood, for example: *"It's a good platform to help me, especially when I'm feeling down"*, and *"it makes me feel happy"*. Regarding the value of tracking moods in the OWC, participants said: *"makes me take notice of feelings"*; *"It's good, helpful for tracking moods".* A number of participants expressed their satisfaction with the intervention with comments like: *"Love it!"; "It was inviting"; "it's engaging and pleasant"* and *"it's calming";* these positive appreciations were common on responding questions regarding the layout and navigational features of both the OWC and Toolbox, indicating a possible link between design and engagement.

Discussion

A cross-sectional analysis using data obtained from an online RCT was conducted to identify predictors of app use by young people, followed by an interview with participants to determine what they liked or didn't like about the platform. Results indicated that females with heightened mood levels were more likely to adopt these technologies, and that while

enticing the apps within the OWC and Toolbox fell short of sustaining engagement. These findings add to existing literature by showing that young women are more likely to engage with apps specifically offered as wellbeing apps or specifically designed to improve health aspects; whereas young males tended to lose interest quicker and focused mainly in features such as tracking (Bol et al., 2018; Koivisto & Hamari, 2014).

Analysis from the follow-up interviews showed that females were more likely to think about wellbeing, stress and social elements (i.e., friendships) before they choose a specific app; whereas males were more concerned with the actual functionality of the apps (i.e., tracking). This finding could explain why wellbeing as a concept may initially appeal more to females, while apps designed following gamification techniques may appeal more to males. This consideration could be important at the time of designing and marketing this type of apps (e.g., females orientated more to the relational / social aspects of wellbeing vs. male more behaviourally orientated to the 'doing' aspects of wellbeing). As for mood as a predictor of app usage, it could be associated to motivation, enjoyment and expectations. It has been demonstrated that young people show initial interest when first introduced to these type of interventions, however this effect usually dwindles over time (Lewis et al., 2020, Burns et al., 2010).

Young people increasingly use apps to mediate and facilitate most of their behaviours in all aspects of daily living including social sphere (Burns, 2017). The overabundance of information and the ever-changing speed of technological developments makes meaningful engagement with any health app difficult; and even more so with wellbeing apps (Lewis et al., 2020). Despite this barrier the potential of apps to increase wellbeing shouldn't be overlooked. Apps have the added benefits of abolishing obstacles like accessibility, cost, and perceived stigma; they can be discreet, personal and private (Blanchard et al., 2013). The importance of improving engagement with potentially effective wellbeing apps is highlighted in crisis times such as the current COVID19 pandemic (Hawke et al., 2020).

From this study's findings, understanding gender preferences and developing strategies to improve participants' mood at the time of deciding to install and use wellbeing apps could improve app uptake and their effects in the long term. These strategies could be included in the actual design of the apps with artefacts such as rewards, social recognition, or other types of positive reinforcement (Helf & Hlavacs, 2016). Exploring how gaming features could be included in this design could also be beneficial as studies in this area show promise to increased engagement (Johnson et al., 2013). Some examples in this direction already exist with apps such as "zombies run" designed to improve fitness while at the same time introducing users in an involving gaming environment (Cowdery et al., 2015). Another example that has had an impressive impact is "Pokemon Go", an app/game that has effectively drawn young people outside of their homes into walking (Butcher, 2016; Conditt, 2016). Alternatively, if apps were to be used as part of a planned intervention, mood-enhancing techniques and psycho-education could be used during the process to highlight the meaning and importance of wellbeing at a personal level.

Limitations

There were several limitations arising from the RCT that may have impacted results. The current study was limited by the demographic data collected, this in turn meant that many variables that could have been significant in responding the research question were not present, this scarcity of investigated factors is a considerable limitation By the nature of the intervention to be tested (The Toolbox) the apps assessed were already pre-determined, this eliminates the possibility of having a real appraisal of the totality of wellbeing apps that young people participating in this study could have been using at the time of signing up; having said that, the apps included in the Toolbox were assessed by the MARS scale (Hides et al., 2014) and as such were relevant in their quality and their potential to increase the wellbeing of the participants. A larger number of participants were in their 20's and less in the 16-19 year old bracket, this was due to the added difficulty of obtaining parental consent for underage participants during recruitment (Musiat et al., 2016). Similarly, the great

majority of participants came from urban areas, which may be a reflection of the general demographic distribution in Australia as well as an issue of Internet access in rural areas. This study also suffered from high attrition as reflected in literature for similar studies, with the lack of engagement with digital resources as an expected feature (Eysenbach, 2005). Female participation was higher as consistent with existing literature (Halko & Kientz, 2010; Neville, 2012), however this can also be considered a limitation. In the context of the OWC trial the intervention apps were almost entirely comprised by self-help apps focused on improving discreet aspects of the users lives, from relationships to fitness. Very few apps in the intervention could be used in a “gamified” way, despite the fact of including behaviour change techniques related to rewards and goal setting (Direito et al., 2014; Michie et al., 2011).

Finally, the thematic analysis used in the qualitative phone-based questionnaire must be interpreted with caution, since the questions favoured the identification of specific issues.

Conclusion and future research

Despite the potential of wellbeing apps to improve wellbeing in young people, engagement with these resources continue to be a significant problem. To that end, we sought to identify what predicts engagement with wellbeing apps and found that in the context of this study it was related to personal characteristics like mood and gender. Ignoring the different reasons people are drawn to, remember, and use apps in relation to wellbeing will do nothing to ultimately increase engagement with these apps. In that context, while this study contributes to knowledge of why young people may or may not engage with wellbeing apps, given the importance of this area further research is needed to explore a broader range of variables intrinsic to users such as: personality, age, culture and other identity markers.

Chapter 7

How young people relate to and interact with Health and Lifestyle Apps? A qualitative study

Paper - Submitted: revised version included in Appendix K.

Antezana, G., Venning, A., Smith, D., & Bidargaddi, N. (2022) How young people relate to and interact with Health and Lifestyle Apps? A qualitative study. Submitted to the Journal of Children and Family Studies, awaiting final acceptance.

Statement of Contributions:

Mr Gaston Antezana (*Candidate*)

I was responsible for the conception and primary authorship of the paper. I conducted the data collection and analyses. I was the corresponding author and primarily responsible for responses to reviewers and revisions to the paper.

Signed: Signature removed for library publication Date 04/03/2023

Dr Venning, Dr Smith, Dr Bidargaddi (*Co-authors*)

We were the supervisors and co-researchers of the program of research that lead to this publication and there was ongoing collaboration between Mr. Antezana and us in refining the direction of the research. The realisation of the idea, collection of data, and analysis of data were the work of Mr. Antezana. Mr. Antezana was responsible for writing this paper; our role was to comment on drafts, make suggestions on the presentation of material in the paper, and to provide editorial input. We also provided advice on responding to comments by the journal reviewers and editor. We hereby give our permission for this paper to be incorporated in Mr. Antezana's submission for the degree of Doctor of Philosophy from Flinders University.

Signed: ____ Signature removed for library publication ___ Date: 28/02/2023
Anthony Venning

Signed: ___ Signature removed for library publication ___ Date: 28/02/2023
David Smith

Signed: ___ Signature removed for library publication _____ Date: 28/02/2023
Niranjan Bidargaddi

Abstract

There is a growing interest in promoting mobile app-based interventions to improve wellbeing in young people, as they are natural users of these technologies. This paper aims to understand how young people relate to and interact with health and lifestyle apps in the context of improving their wellbeing. Semi-structured interviews and thematic analysis were used (N=13, 16 to 25 years). Individuality, functionality, and accountability showed special relevance to how young people engage with health and lifestyle apps. Issues like security, peer influence and wellbeing perception are also considered. Young people engage with apps that they can personalise and use in a creative way, therefore adapting them to their own identity.

Introduction

With mental health issues becoming a pressing concern for young people across the globe, the use of technology-based approaches to target and assist young people who are not receiving help for their mental health has gained prominence (Taylor, 2018). Youth, the term used to typically describe the age range of 'young people' is usually defined as the period between 16 to 25 years of age (Antezana et al., 2020; Australian Institute of Health & Welfare, 2020; Dovey-Pearce et al., 2005) and it is characterized as period of intense social, emotional, and biological transformation that leads into adulthood and can impact mental health (Shek et al., 2019). Technology can be used to improve mental health and wellbeing in different ways from making traditional services virtually accessible to tailored app-based interventions (Bergin et al., 2020; Blanchard et al., 2013). Young people are regarded as the natural users of technology, particularly online and with mobile technologies such as smartphones (Burns, 2017). Smartphones have gained global appeal by becoming miniaturized personal computers that perform complex tasks via the use of apps: purposely designed, specialized programs that focus in particular functionalities (Karch, 2020). The statement "there is an app for that" (Wasil et al., 2021) accurately reflects how virtually every aspect of today's life can now be facilitated or supported by the utilisation of mobile apps.

A body of research supports the use of apps to promote health behaviour change, particularly in areas such as smoking cessation, weight control and alcohol dependence (Ghelani et al., 2020; Milne-Ives et al., 2020; Staiger et al., 2020). Equally, there are several apps for mental illness, specific to conditions such as depression (Wu et al., 2021), anxiety (Drissi et al., 2020), psychosis (Steare et al., 2021), suicide prevention (Wilks et al., 2021) and personality disorders (Ilagan et al., 2020). Research on these apps has shown they can be beneficial, not only because of their content, but also because of their accessibility, cost, immediacy and ease of use (Milne-Ives et al., 2020).

From a Mental Health (mHealth) perspective, apps rely on modifying health behaviours (Fitzgerald & McClelland, 2017). Interventions aimed at improving health behaviours seek to include behaviour change techniques (BCT's) (Antezana et al., 2020; Fitzgerald & McClelland, 2017). BCT's are irreducible techniques and interventions aimed at modifying behaviours and originated in evidence-based behaviour change theories, they are observable and replicable (Michie et al., 2013), examples of BCT's include: goal setting, tracking, self-talk, repetitions, and others.

Trying to modify self-care behaviours requires both quantitative and qualitative changes, these types of behaviours involve preserving one's health even in absence of symptoms, and as such they demand a higher involvement of users and a clearer motivation (Dennis, 2020). Understanding people's motivation to behave in a particular way demands understanding different cultures, beliefs, education levels, sociological factors, psychology and public health (Marmot & Bell, 2019); however, several health behaviour models exist attempting to explain the factors influencing their adoption (Chu & Liu, 2021), the most commonly used being the Health Belief model (Carpenter, 2010) which includes factors such as the beliefs people hold about their health, the perceived benefits and barriers to action and self-efficacy; Social cognitive theory (Bandura, 1989, 2009) that explains how people's behaviours and attitudes are influenced by how other people act the how they perceive the outcomes of those behaviours; and most recently the transtheoretical stages of

change model (Prochaska & Prochaska, 2019) this model considers the individual readiness to change in 5 levels: Pre-contemplation, contemplation, preparation, action and maintenance.

In recent years, interventions based on Positive Psychology (PP) framework to target mental health as opposed to mental illness have generated significant interest (Keyes, 2002; Keyes et al., 2021). Mental Health incorporates categories such as emotional, social, psychological and physical wellbeing (Keyes, 2005) and is consistent with the definition provided by WHO (WHO Global Observatory for eHealth, 2011) *: "Mental health is defined as a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community*". In contraposition, mental illness is defined by the presence of symptoms of distress or impairment in day-to-day functioning, which are common in diagnosable mental health disorders such as major depressive episodes, generalized anxiety, panic disorder, and alcohol dependence (Iasiello et al., 2019; Keyes et al., 2010). Corey Keyes' research on mental health (Keyes, 2005) demonstrated that mental health is a different continuum to mental illness, covering a spectrum from languishing (absence of mental health symptoms) to flourishing (full presence of mental health symptoms).

For the purposes of mental health, three types of apps can be identified depending on their focus: clinical, wellbeing and health and lifestyle. The first, *clinical apps*, are designed specifically to target particular conditions or disorders as described above (i.e., depression, anxiety, etc.). The second, *wellbeing apps*, are defined as those using PP theory and focused on using a strength-based approach to increase wellbeing as previously defined. For example, BeWell (Lane et al., 2014) is an app designed to automatically track wellbeing by assessing dimensions such as sleep, social interaction and physical activity, and Mindsurf (Carey et al., 2016) is designed to promote contentment, wellbeing and goal achievement. The final category is *health and lifestyle apps*, which are designed to address

different areas related to wellbeing but as stand alone, off-the-shelf products, not necessarily based on theory. Examples include activity trackers (Lewis et al., 2020), sleep apps (DeMasi et al., 2017) and eating apps (Ghelani et al., 2020). Given the incipient state of wellbeing apps and their use in research, this study merges both: health and lifestyle apps and wellbeing apps. The terms will be used interchangeably. Apps used for specific clinical presentations or conditions will be ignored.

Even though several wellbeing apps exist, and initial assessments of these apps have been positive (Cheng, 2020), it has been argued that young people's engagement with wellbeing apps is generally low (Burns, 2013; Kelders et al., 2020; Lewis et al., 2020) - with reasons focused on poor design, marketing strategies, limited evidence-based content (quality and quantity) and costs (Helf & Hlavacs, 2016). Engagement can be defined in terms of usage time (e.g., how long it takes to use its main features) and by meaning (e.g., motivation, interest and perception) that users invest in each app (Gibson et al., 2015). There is limited research into understanding how young people relate to both these aspects of engagement with regards to apps marketed for their wellbeing.

We adopted a qualitative approach to understand how young people engage with apps that are freely available and not necessarily designed or overtly marketed as a "mental health app". We targeted freely available *health and lifestyle* apps (wellbeing apps) that are presented to the public as sufficient for improving aspects of wellbeing consistent with the Complete State of Mental Health model (Keyes & Lopez, 2002) (i.e., emotional, social, psychological and physical wellbeing). In order to have a deeper understanding of these issues, we sought to explore user's personal motivations and perceptions and to appreciate those values and interests that may influence use of these technologies.

Methods

Qualitative approach

The specific methodology used in this research is consistent with qualitative description (Bradshaw et al., 2017) as the focus was on understanding the phenomenon through the users' experience and the meaning they create when engaging with wellbeing apps (Parahoo, 2014)

Participants

A convenience sample of young people with diverse cultural backgrounds who use smartphones were recruited (N=13; 54% female; aged between 16 to 25 years). Six of these participants had diverse cultural backgrounds, including Asian, Middle eastern and European. Eligible participants were either currently enrolled at Flinders University South Australia or enrolled in the Online Wellbeing Centre - OWC trial (Antezana et al., 2015). For the purpose of the current research, participants were recruited only to determine why and how they engaged with apps, not to determine the effect of the apps, as this was the purpose of the OWC-RCT trial and reported in Bidargaddi et al (2017).

Procedure

Participants were recruited through different channels at Flinders University in South Australia. The process included posting announcements in places such as the University's gym, library and eating facilities, and approaching people via telephone who took part in the OWC-RCT trial (Antezana et al., 2015; Musiat et al., 2016). Interviews took place over a period of three months, lasted for an average of 50 minutes, and were arranged at an interview room in the Flinders University Library. Interviews were audio recorded and the interviewer kept notes of relevant ideas being discussed. Recruitment continued until saturation was reached (Braun & Clarke, 2019). Saturation was assumed the moment that no new themes emerged from 2 consecutive interviews (Coenen et al., 2012). All

participants were given $20 store vouchers as a recognition for their time. Ethics for this study was obtained from the Flinders University Human Research Ethics Committee (Project number 7022).

Analysis

Semi-structured interviews followed by reflective thematic analysis were undertaken, using the steps outlined by Braun and Clarke (Braun & Clarke, 2006) to find meaning and develop in-depth understanding of the subject matter. This process included the initial identification of the author's own assumptions regarding digital health utilization, as Braun and Clarke suggest a researchers' position on the phenomena will eventually impact the analysis, interpretation and reflection of it (i.e., a thematic analysis is never completely objective) (Braun & Clarke, 2019). To that end, the initial assumptions of the authors were (a) young people gravitate naturally to using apps if convenient, but only continue to use them if they are engaging, and (b) individual differences may play a role in the engagement process. Semi-structured interviews included questions like: Do you use wellbeing apps? What apps do you use the most? How often are the apps used, motivations behind app use, and psychological perceptions of the app (e.g., usability, aesthetics, preferences). The interviewer kept notes of relevant ideas being discussed during the interview and completed notes after listening to the recordings to complete notes and build a reflective journal. The interviewer (GA) transcribed all the interviews from the recordings verbatim during a 3-month period, which allowed time to reflect on the data, compare previous notes and identify key ideas and concepts that would guide the ensuing coding stage. Once transcribed, interviews were imported into NVivo (*Qualitative Data Analysis Software | NVivo*, n.d.).

Coding

Initial codes were generated by reviewing the transcriptions and identifying key terms and topics. Interview notes were also included in the analysis, together with any reflective notes. Subsequent themes were identified and reviewed in different iterations until saturation

was achieved. Coding the information followed three stages (*Qualitative Research Guidelines Project*, 2020): (1) Open Coding to form preliminary categories by grouping information with similar themes, (2) Axial coding to bring together categories according to their content and context (i.e., generation of codes) and (3) Selective coding to organize themes and syntheses according to their meaning and the relationships between the concepts discussed. The coding process was conducted by the principal researcher and revised by the secondary researcher until agreement was reached.

Results

In total 11 codes were identified that were grouped into four themes and three syntheses (refer to table 18). Some statements were classified in two or more different codes due to their multiple meanings in a given context. An example of how this was done is provided below: in this instance M4 is talking about a particular app that a friend had recommended to him:

> "*the interface is really nice, and when he showed it to me and told me what it could do I was very interested, so he was saying you know, it tracks your sleep, and that was a very cool idea, it comes with a whole bunch of graphs and stuff, so you can.., it's is very visual and it was very cool at the time, so I was, when I got it I was interested, and then I eventually found it useful, so I got it because I was interested really and then it became useful"* (M4)

This statement provides insight into M4's motivations (social influence) as well as into engagement strategies (persuasive design) and the use of behaviour techniques, specifically functionality (sleep tracking). There are also instances in which a statement has different values depending on a particular context, as in the use of certain features to guarantee usefulness (e.g., enabling tracking sensors) versus the impact this has in usability (e.g., battery drainage).

Table 18

Syntheses, Themes and Codes

Synthesis	**Theme**	**Codes**
Individualise	Personal	*Choice* *Goals* *Control*
	Social	*Recommendations of others* *Desire to be like others*
Functionality	Design	*Persuasive design* *Usability*
Accountability	Risk	*Behaviour change techniques* *Privacy* *Stigma* *Social risk*

Table 19

Type of Apps and Times Mentioned by Users

non-wellbeing specific		
APP	***type***	***users***
facebook	social media	12
snapchat	social media	7
messenger	communication	4
instagram	social media	8
tumblr	social media	1
twitter	social media	3
internet banking	utilitarian	1
University	educational	1
transport - uber	transport	1
photo editing apps	utilitarian	2
data use tracking	utilitarian	1
spotify	entertainment	2
games	gaming	2
youtube	entertainment	2
weechat	social media	1
email	communication	2
playstation	gaming	1
Whatssapp	communication	3
reddit	social media	1
educational apps (language)	educational	1

Wellbeing specific

APP	*type*	*users*
7-minute workouts	physical activity	1
eve- track menstrual periods	physical health	1
Emily Sky	physical activity	1
boost juices	nutrition	1
LG fitness	physical activity	1
training your brain	cognitive health	1
runtastic	physical activity	1
physical training (rowing)	physical activity	1
gym specific app	physical activity	1
fitbit	physical activity	4
sleepcycle	sleep	2
myfitnesspal	physical activity	2
ashy bines	physical activity	1
Lorna Jane	physical activity	1
runkeeper	physical activity	2
moves	physical activity	1
webmd	physical health	1
samsung health	physical activity	1

Synthesis 1: Individualise

> "*you can change through the app, I can change what I can see, so if I flick through there … I can change what to watch and when I tap that, it'll come up with something else, yeah, it's quite a lot of customization" F7*

This synthesis refers to modifying elements in the apps in a way that is intrinsically unique to a particular participant. Synthesis 1 contains two subthemes that refer to elements that defined individual's patterns of behaviour and interactions with the apps: (1) Personal and (2) Social (refer to Table 18).

Theme 1: Personal

The theme Personal referred to elements that are intrinsically unique to participants in their interactions with the apps in as much as they reflect values, idiosyncrasies, and worldviews.

Choice

Choice was defined as adjusting the configuration of the app in order to reflect personal preferences beyond ease of use (analysed in a different code). An example of this is how young people attempted to protect anonymity by controlling the information flow coming from the apps. For instance, one participant mentioned *"I disable all push notifications straight away" (M4),* which was consistent with another who added *"So I don't want random people to know where I am I guess" (M1).* Participants reported that despite their specific purpose, apps are used in unique and personalised ways: *"for me Facebook is primarily just social, not really even social these days, it's also information, like news stories" (F1).* There were also comments regarding changing features in the apps that would reflect participants' own personalities and idiosyncrasies (e.g., colours, displays, sounds, etc.). Although many of these personalisation changes were considered and appear under the

codes “usability” and “persuasive design”, the psychological components related to identity at the time of personalising these apps are important to consider.

Goals

Participants indicated that their motivation focused on intrapersonal goals. One participant mentioned: *“my app choices are based on my goals, on my fitness and all that kind of stuff are very big things to me so my apps are based on that” (M1).* These goals are varied and include aspects such as improving self-image to goals around general health. This theme differed from others in respect to its directionality, considering the goals were the driver to select and install a particular app, instead of the goals arising after installing an app. This distinction is relevant when considering that wellbeing apps privilege goal setting as a main feature to attract and engage users (Antezana et al., 2020). On this thought, another participant said: *“…I’d set a goal, MyFitnessPal offers, offers you to set a goal and how to achieve them and stuff like that, and I have personal goals at the gym and that kind of stuff – yeah—"(M1).*

Control

Control refers to how participants “pick and select” features of wellbeing apps to use them when and if they want to. For example, one user, while discussing how they used a fitness app originally designed as a stepped program, explained how they would only use it to come up with ideas on how to vary her already existing routines, participant F4 stated: “*After I know how it works I knew it was 20 a set or 30 a set I already know how the program went, it wasn’t new to me, so I just deleted it and developed my own program”* (F4). Another user of a diet app, which are generally interaction intensive as they need constant input to feedback relevant information, indicated the app was used solely to copy recipes and compare nutritional values with what she was already doing. In most cases, the sensation of relenting control to the app is perceived as a threat, or in the best-case scenario a nuisance as expressed by the same participant: *“Yeah for the first time I thought oh it’s quite good ,*

it's quite encouraging, but after that I found it disturbing and I don't really need to keep encouraging me and I know the voice is a human voice recorded but I thought it was quite stupid because a phone (app) is directing you to do something then" (F4).

Theme 2: Social

The theme Social identified perceptions on how peers and other people (e.g., role-models) mediate individuals' interaction with wellbeing apps, this theme assumed that behaviour can be influenced by others, including enhancing motivation and engagement.

Recommendations of others

Most participants indicated that they had come to know and install their wellbeing apps because of recommendations of close friends or relatives. For example: *"I was just looking into my friends' phone, and she had downloaded it" (M1),* and *"yeah that's how I got this app, all of my friends use it" (F1)*. This was also true in terms of using apps to achieve a particular goal in order to gain social status and acceptance (e.g. losing weight, participant F7 said: "*…if the people, if your friends, you would see them doing it and you see figures of a certain body type or stuff like that you would like to find how they're doing it or find a way to be similar and fit in, I mean not everybody can but everybody can try yeah" (F7).*

Desire to be like others

Participants reported that they easily related to people they consider as ideal in a particular area and then sought to emulate the person or the quality, as participant F1 mentioned: *" Yeah I mean I guess it's about the person that faces the app, Lorna Jane for example you can just think well, you know who that is you can just trust her it's based more on the person you can trust in rather than it being necessarily evidence based on science, hmm a lot of the fitness stuff is like that actually, even in nutrition I doubt that many of these people are dieticians yeah I guess it's more on what popular than what's necessarily*

accurate"(F1). Similarly, participants indicated that using apps in particular contexts such as during training, at the gym or in social contexts seems to produce higher engagement, as reflected by participant F7: *"Yeah, I find it a lot easier to keep the goals if you have someone else to kind of not report to, but to -- compare notes with, -- yeah." (F7)*

Synthesis 2: Functionality

> *"The reason why I keep using this app is because it automatically detects my steps and then gives me feedbacks from that, so it's the functionality of the app to make things easy for the consumer, that's the reason why I want to use that I app" M6*

This synthesis refers to users' perceptions on the utility and usability of the app. This includes design, structure, and content. Synthesis 2 contains one subtheme that refers to functionality delved on technical characteristics of wellbeing apps and their role on engagement: Design (refer to Table 18).

Theme 1: Design

The theme Design encompassed persuasive design, structure, and content of wellbeing apps. This theme focused on technical elements that contribute to the overall experience of the user.

Persuasive design

The look, feel and overall "good design" of the app was seen as particularly relevant for engagement as expressed by users: *"I guess user interface, the interface of the app, and in some apps make you wanna use them because they look nice to use, yeah the interface looks nice", (F2) and "How it looks, the interface and user friendly operating system is definitely important" (M2).* Participants indicated they liked the apps which allowed for features to be changed, including activating or deactivating sensors, trackers, notifications and also choosing colours, displays and other design features in line with their personal preferences. These appreciations refer to having access to a variety of features and not

necessarily how those features are used by each individual as analysed on the code "choice".

Usability

Usability refers to the easiness with which users reported they could navigate and use the different features of a given app. Usability was named as a pivotal element for using or discarding an app- up to the point of choosing usability over usefulness when selecting an app, even at the cost of losing quality content. Participants M3 and M4 said: *"Yeah, and that would be really frustrating, because I want really good data, but if it's easier to use quicker and it doesn't waste most of my time, then I'd probably prefer less data but easy to use" (M4)* and *"Ahmm fast that reacts quickly, that doesn't stay lagging and stuff like that, hmm easy to find things and gives you what you want , hmm lots of different feature as well so you can do lots of different things on it, that's always good"(M3)*

Behaviour change techniques

Behaviour change techniques (BCT's) are discrete methods derived from theory and used to modify behaviour in planned interventions (Michie et al., 2013). In that context, participants identified several BCT's as effective for engagement. For example, goal setting and tracking: *"one you can set you height, current weight and ideal weight, so they can kind of give you a goal to work towards, so you can track your steps and stuff like that, and they also categorise whether the steps you took where walking, running or cycling, yeah"(F2)* and *"I guess if they give tips on how to get your goals and stuff like that, that would be important because it's a health app and that would be important yeah" (F2).* The presence of BCT's is linked to the perceptions of users regarding app effectiveness, as reflected by M1: *"Yeah, really, really useful I find it probably the favourite app for my phone, it doesn't give you warnings or nothing like that but it almost predicts like symptoms like bloating or cramps or feeling hungry, stuff like that because it has a feature that you can log, so you can put like how you're feeling, what you've eaten what exercise you've done and it gives you like future*

information like oh you are now probably hungry or craving salty foods around now or stuff like that" (M1). The lack of quality BCT's can also become a reason for disengagement as mentioned by participant F7: *"Well one of the main reasons I stopped using it is because it wasn't accurate enough" (F7)*.

Synthesis 3: Accountability

> ***"****I guess people would be embarrassed or they don't want to be seen as if they're pleading for attention from someone, cause that can lose a lot of respect, like saying hey look at me I have problems or something like that, no one would respect that in our generation, and people have respect for other people's privacy. No one wants to invade personal space I think" M2*

The accountability synthesis is defined by elements regarding risk management and privacy both at a personal level as well as social. Security online is one of the main concerns for app users and it can greatly impact engagement (Finkelhor et al., 2021). Synthesis 3 contains one subtheme about accountability regarding personal information use and perceived shortcomings when using wellbeing apps: Risk (refer to Table 18).

Theme 1 Risk:

The theme Risk refers to the reservation participants reported about sharing wellbeing information on social media or within close circles of friends and family, albeit less so in some cases.

Privacy

Despite acknowledging they would like to read information from other people, participants indicated that their information was no one's business but their own: *"I don't want people knowing of my personal... whatever" (F6), mirroring what* another participant said: *"No, I don't like the idea of sort of glorifying your workout or you know it shouldn't personally my sort of sleep, my workout, my diet, my exercise, my Fitbit, my MyFitnessPal*

those are personal things those are personal achievements and goals, no-one else needs to know it" (M4).

Most participants reflected primarily on the benefits they expected to achieve by using the apps, however a certain scepticism was present. Participants reported a heightened awareness regarding the potential pitfalls of the apps, more specifically in terms of security, anonymity and privacy. M1 said *"I'd say you got to be cautious of GPS (location) and stuff, 'cause they say that you can be found and stuff like that*" (M1). If an app is seen as suspicious in any of these aspects, it is enough to disengage: *"Today you have so much information online that if you ever want to take it all off you can't" (M1).* Users reported they were willing to try the apps for a while before making a decision to engage with it in the long term, with the average use period for these apps being between one to two months. M4 said: *"Depends on at what point I am in terms of my work out regime and I'm kind of dieting, but I would say the longest I've gone would be at least a month"; "Hmm, probably the app that I'm using now is the longest which is about 5 or 6 weeks, I get bored of them pretty quickly and delete them a lot. …I don't know why I just don't find them user friendly, I just end up deleting them.." (M4).*

Participants were asked about their understanding and their perceptions on their own wellbeing. In general, wellbeing is perceived as a given and not as an area that should necessarily be addressed in any structured way. Overall, the general thought is that wellbeing means feeling well, as in "happy" (hedonic). However, there was also an overall agreement about the benefits of working on areas such as physical and emotional health. Almost all participants agreed that discussing their wellbeing in their social circles and by extension the use of wellbeing apps was not relevant or desirable. One user indicated: *"I don't talk about apps too much, app discussion would come down to discussion about a broader topic, like someone saying, ah you know I had a very bad night sleep and you know I would go on what happened and maybe at the end I would have a fleeting moment when I say maybe you should check this app, or if someone is talking about the gym and they are*

wanting to gain weight and they don't think their eating enough calories or that kind of stuff then I would say oh, check this app, it may help, so those would be the kind of situations but I wouldn't push the app onto people straight away, cause I don't work for the app company and you know they might not use apps as much and it might just be like a sort of lost moment checking it out" (M4).

Stigma

Participants indicated that by sharing their wellbeing information they could be perceived as being sick or somehow in a less than desirable state. For example, F1 said: *"I don't want people to know that either, because they might think that if I'm using a sleeping app then I have a sleep problem, and that may be some of the things that people that have some problem like a sleeping problem or exercise would use it" (F1)*.

Social risk

Finally, participants reported that sharing wellbeing information amounts to bragging about oneself and could therefore be a social risk for rejection. For example:

> *"Yeah, I would if it was anonymous, I just don't like the idea of going to my facebook page and some people are bragging about going to the gym" (F1).*

> *"Mmh I'm in my opinion to be honest I'm not really interested to compare what are my achievements in this particular app, because it's not really an achievement to boast to share with other people, because this is my personal kind of achievement and it really gets me like motivation internally rather than getting recognition from other people, so I don't really care about sharing with other people" (F1).*

Discussion

In order to have a deeper understanding of why young people use wellbeing apps, participants from a university setting and the OWC-RCT trial (Bidargaddi et al., 2017) were

recruited and semi-structured interviews were used to explore how their personal motivations, values and interests influence the way apps are used. Results highlighted that different people use apps in different ways. As obvious or common sense as this may seem, these implications have a significant impact when considering how to engage potential users in the area of wellbeing as non-engagement may render any intervention with these technologies ineffective.

Consistent with our initial assumptions, young people are now living in a world where their behaviour is mediated by the apps they have on their phones. However, they mostly use wellbeing apps for brief periods, not engaging in a way that would make full use of the apps' capabilities. From a wellbeing perspective, one can notice both the risks and potential benefits of app designers being able to influence behaviour by providing information individuals can access at the tip of their fingers. As expressed by Sherry Turkle (Turkle, 2011a), due to technology, young people feel that their lives are being controlled externally. The challenge therefore exists in finding ways to ensure apps are used transformationally (i.e., producing meaningful change) and not just transactionally (in a utilitarian / disposable way) (Gardner & Davis, 2013). One of the challenges suggested by the current research is trying to reconcile how young people tend to be more individualistic and isolated while living in their apps, but at the same time needing accountability by comparing themselves with their peers. Respondents commented on how they would select apps that would allow them to create an outward facing socially desirable "personality" (e.g., the use of photo editing and filtering apps), shaped by comparisons with others health specific information while at the same time restricting access to their own information. The resultant tension between anonymity and socialization is consistent with research that has looked at social media (e.g., Facebook, Instagram) in which young people present a polished identity designed to appeal to others, but dimmish personal defects and shortcomings (Afshar et al., 2015). Future research in this area could focus on trying to establish in what ways apps could contribute to a healthy identity that is closer to the "real self" and be presented in ways to encourage

productive interaction with others and the world instead of forcing people to set up socially desirable but false fronts.

The limited insight that exists about the multidimensionality and achievable states of wellbeing is an important issue to address (i.e., flourishing vs. languishing). In the current sample of young people, it was found that talking about personal wellbeing was a source of shame, particularly to, but not only if this was related to their mental health. In contrast to an ideal in which young people would be comfortable talking with their peers about wellbeing to in turn improve wellbeing, participants indicated that talking about it was not desirable unless within very specific contexts (e.g., the gym). Counterintuitively then, apps that focus on proactively educating and building wellbeing seem to be viewed with suspicion, and while young people may be happy to use apps to present and compare socially desirable fronts, they do not seem ready to use them for proactive purposes. Using apps as tools to educate about wellbeing as a journey instead of as a discrete outcome could be more effective at opening the discussion on this area, as this approach would reconceptualize apps from being designed to meet specific targets, to becoming a means to facilitate a dynamic ever evolving process of growth.

Acknowledging the small sample size given data saturation (Braun & Clarke, 2021), and limited analysis by cultural background, gender, or specific ages, it seems that young people value app designs that are easy to navigate and that are highly responsive. Young people seemed to be attracted to and use apps that speak to them at an individual level, that they could personalize and be creative in adapting to ideal identities, and that include effective, streamlined, and understandable BCT's. Moreover, immediacy is paramount when using apps, as the massive choice on offer reduces a user's tolerance to wait for feedback, along with good visuals. These things are essential in app design, as images and symbols constitute a language in themselves that needs to be carefully considered when marketing apps designed to improve health and wellbeing (Ruijten, 2021; Torkamaan & Ziegler, 2021), and when the importance of underpinning BCT's is arguably lost in an industry that tends to

design with very low level of evidence-based techniques imbedded in their apps (Antezana et al., 2020).

Conclusion

To say that apps and young people are inseparable is an understatement. Technology is occupying spaces that used to be intrinsically private and there seems to be no task that cannot be perceived to be improved or facilitated by using apps. Young people are engaged with these technologies, so not harnessing the power of apps to increase wellbeing at every level is a wasted opportunity. The current results highlight a need to create engagement with wellbeing, rather than with “wellbeing apps”. How to do this in a transformational rather than transactional way remains a challenge.

Chapter 8

Results Integration and Conclusion

Preamble

The research presented in this thesis sought to explore elements that contribute to a young person's engagement with wellbeing apps; based on the presumption that increasing engagement with wellbeing apps may in turn lead to higher levels of wellbeing. A mixed methods approach using a convergent study design was adopted (Kuss et al., 2018). Subsequently, four independent but connected papers were presented, three of these have already been published in peer-reviewed journals and one is awaiting a final decision following the submission of a revised manuscript based on three reviewers' suggestions and comments (an updated version and response to the reviewers is presented in appendix K). Figure 6 shows each of the steps in the research flow. The initial step involved a systematic review of the literature and narrative synthesis to investigate the common characteristic of wellbeing app user's (study 1). Next, it was important to understand the composition of wellbeing apps from an evidence-based perspective in the form of Behaviour Change Techniques - BCT's (study 2) as these techniques are embedded in the design of the apps and arguably constitute the active components for behavioural change .A statistical modelling strategy was then used to predict specific user characteristics of young people who naturally engaged with wellbeing apps with a qualitative component involving follow up interviews (study 3). Finally, in-depth interviews with app users were undertaken to understand their perceptions and motivations to use wellbeing apps (study 4). The mixing or integration of findings from these four study phases lead to the identification of three main themes: Identity, Design, and Evidence Based content. In Identity, young users of wellbeing apps seek to meet their personal needs and goals, and engagement will occur only if the app responds to a user's intrinsic motivation; Design, the usability and personalisation of

apps are essential for engagement; and Evidence-Based content, BCT's need to be embedded in apps more consistently (Table 20 & Figure 6). The Complete State of Mental Health model (CSM) (Keyes & Lopez, 2002) was used to link wellbeing to the findings of this thesis.

Table 20

Integration of Findings According to Concepts Across the Three Main Finding Categories: Identity, Design and Evidence Base

Key Concepts	Findings	Study -Integration
Identity	Personalisation and preferences	1-2-3-4
Identity	Goals and sense of purpose	3-4
Identity	Self-image	3-4
Identity	Intrinsic motivation	1-3-4
Identity	Personal expression	3-4
Identity	Social influence /role models	1-3-4
Design	Aesthetics	1-2-3-4
Design	Usability – ease of use	1-2-3-4
Design	BCT integration/Effectiveness	2-3-4
Design	Flexibility in design	1-3-4
Evidence base content	BCT′s can work synergistically	2-4
Evidence base content	BCT′s can be transformed into app features	2-3-4
Evidence base content	BCT′s should link to ease of use	1-2-3-4

Identity

Personalisation and Preferences

Based on the insights provided across the four studies undertaken, it appears that young people “negotiate” their interactions with technology. These interactions can range from being merely transactional or contextual (studies 1-3-4) to being integrative in the sense of merging aspects of a user’s personality with the functionalities of the apps (study 4). An example of this was mentioned by two participants of study 4 when describing their use of a particular exercise app. One user indicated it was useful to copy training routines, while the other used it to follow the person promoting it, as in the case of following a celebrity. The negotiation between the individual and the app could also be seen as a dialogue, in which each user assesses the ways in which a particular app can expand their presence, function and effectiveness in the world (study 4). Based on the findings of this research, it is suggested that whenever a young person successfully uses an app to express and expand their identity, the app ceases to be a tool for a specific task (transactional use) and becomes a means for personal expansion (i.e., real engagement takes place). For example, linking specific apps to social forums or using apps to join activities such as gym membership might be ways in which personal values, preferences, idiosyncrasies, and goals can be projected in both the real and virtual worlds. In the framework of the CSM, personalisation links with psychological wellbeing (self-acceptance, environmental mastery, autonomy), social wellbeing (social integration), and emotional wellbeing. Personalising apps allows users to gain higher control of their environment, and if properly directed, improve their wellbeing. Examples of how personalisation can support the use of apps for wellbeing are: regulating social interactions (by choosing to connect at particular times with particular people), allowing filtering of information, directing their behaviour according to their intrinsic motivations, etc.

Goals and Sense of Purpose

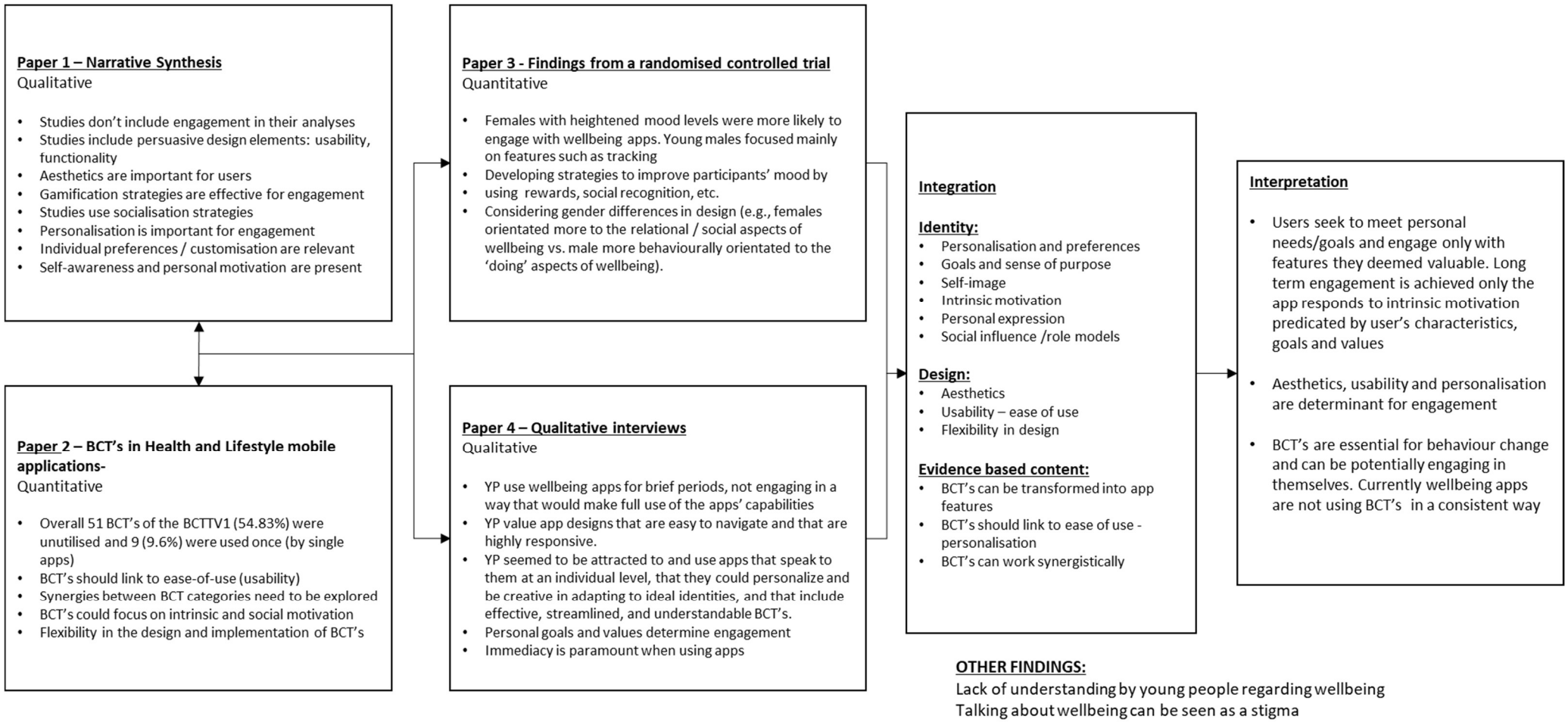
The results of this program of research show that young people are more likely to engage with wellbeing apps if the apps enable them to reach their objectives. This link between pursuing personal goals and engagement emerged in study 2, as the most used BCT's were tracking and goal setting, and study 3 with comments on these aspects also raised by OWC participants. Linked to this idea, it is suggested that if young people have clarity in the end goal / higher purpose, they are more likely to engage with the tools that can lead them there. Study 4 highlighted how a sense of purpose drives the motivation to engage in changing behaviours (i.e., engaging with an exercising app to prepare for a competition), and that this goes beyond specific techniques, design features and persuasion. Within the CSM, goals and sense of purpose can be linked to social wellbeing (contribution, social coherence), and psychological wellbeing (autonomy, environmental mastery, purpose in life). Apps that enable users to set goals and support them to achieve them are more likely to increase engagement through providing a sense of agency and control.

Self-image

Self-image with respect to physical appearance was mentioned by young people, and often related to health behaviours linked to wellbeing such as exercising, sleeping and proper nutrition (studies 3 and 4). When exploring the use of apps, participants commented that they see some apps as accessories to enable them to project their image at a higher level in the virtual world. An example of this is how users tend to use photo editing apps to change their images to standards they think are acceptable to be shared on social media (study 4), which speaks to the significant weight that social media has in the propagation and sharing of values, meanings, and identities among young people (Chen & Wang, 2021; Dinh & Lee, 2021). Integrating these findings, it can be said that self-image for young people is an essential element for wellbeing; withing the CSM model self-image is related primarily with self-acceptance (psychological wellbeing), social acceptance (social wellbeing) and physical

Figure 6

Integration of the Wellbeing Apps Study Data Using a Mixed Methods Convergent Design



wellbeing. If by using apps young people can modify and express their self-image in a healthy way, this can have a significant impact in their self-esteem and self-perception improving their sense of wellbeing.

Intrinsic Motivation

For an app to elicit engagement it is suggested they need to connect to a users' value hierarchies by targeting domains that represent meaning (e.g., self-image, and social connection). Put another way, to increase a young person's motivation to engage with an app, the app in turn has to offer high reward value (e.g., perceived image or social benefits) with functions / interventions that are short in duration (e.g., quick, and seamless) (studies 1 and 2). In line with this, participants commented during the in-depth interviews (studies 3 and 4) of how their use of an app responds to intrinsic motivation, like using an app to place themselves socially (e.g., social media, image editing) as compared to using the same type of apps for news feeds only with no personal investment, or adapting their app use to respond to immediate needs as compared to those using the app in its totality (e.g., using healthy eating apps as a recipe repository versus following stepped nutritional programs imbedded in the app). Intrinsic motivation can be linked to all four realms of wellbeing included in the CSM model; however, it would be closely related to autonomy and environmental mastery (psychological wellbeing). Connecting with young people's intrinsic motivations can provide them with a sense of ownership over their own actions, this seems to be an essential element to facilitate engagement. If the young persons' focus is on wellbeing, engaging with apps that can connect to that motivation should happen naturally.

Personal Expression

Consistent with Howard Gardner's research (Gardner & Davis, 2013), apps that allow individual creativity can potentially reinforce a user's personal identity by engaging with their emotions and allowing personal expression (e.g., avatars, pictures, videos, memes, backgrounds, etc.). Study two found that apps emphasise graphic design investing in

persuasive layouts and calls to action. Similar elements were mentioned by several papers analysed in study 1, particularly those designed around games (Carey et al., 2016; Direito et al., 2015; Ni et al., 2019). Participants in the interviews of study 3 alluded personal expression when describing what they liked about the OWC apps, with comments on how they liked the presentation of the apps or in the case of male participants, how they engaged with gamification features. Platforms such as Snapchat, TikTok, Instagram and YouTube were used by participants in study 4 to bolster and promote their identity and interests, with the potential of imagination becoming transformational lying in the possibility of apps facilitating emotional expression, for example using snapchat to link with friends and common interest networks. Personal expression links significantly with wellbeing aspects such as emotional wellbeing, social wellbeing (social integration, contribution) and psychological wellbeing (self-acceptance, autonomy). If young people are able to express themselves in a safe and accepting environment, it can have significant positive effects in their wellbeing.

Social Influence – Role Models

Several users reported that they became aware of apps through their friends and kept using them to enhance their social position within their group linked to social validation and acceptance (studies 3 and 4). An example of using apps to fit in a social group was mentioned by participants in study 4, specifically using healthy eating apps to achieve a desired weight / body shape that was consistent with peer expectations. It is suggested personal validation floats between the physical and virtual worlds, with personal interests and values linked to, distributed between, and reliant upon multiple platforms simultaneously (e.g., Instagram, TikTok, etc.), with young people strongly attracted to role models within the apps they can identify with (study 4). It was found young people engage more easily with apps that are championed by individuals with whom they have level of affinity (e.g., physical fitness influencers, sports people, celebrities, or fashion celebrities). Comments from participants indicated that they admired people that have achieved inspirational personal

goals and provided details of their journey. Taken together, these findings show how young people emulate role models in as much as they identify themselves with them. Social influence is linked to social wellbeing in the CSM framework, if the potential of working with role models is used appropriately it may be a good way of promoting wellbeing awareness and opening meaningful discussions removed from the stigma of mental health difficulties. Celebrities promoting wellbeing apps can have a significant impact in young people's wellbeing perception and awareness.

Design

Aesthetics

The importance of app design was prevalent across the four studies undertaken. The narrative synthesis (study 1) identified several studies that mentioned design and usability factors as mediators for engagement, such as aesthetic, comfort and functionality (Leinonen et al., 2017; Ráthonyi et al., 2019). Participants in studies 3 and 4 emphasised the importance of apps being attractive and aesthetically appealing, and that first impressions were important to either boost their interest or prevent them from using it at all. While to a lesser degree, study 2 also considered design when attempting to identify and code the BCT composition of apps. It is not clear however, if there are universal aesthetic styles that would appeal to most users, this is once again a personal preference element in which more research is needed. Aesthetic value can be interpreted from an individual perspective and as such be linked to identity (Fingerhut et al., 2021) which reinforces the findings of this thesis regarding identity as the main driver for engagement. The case for aesthetics to be considered as a social shared perception and values can also be argued (Aljukhadar et al., 2020), and be linked to social integration within the framework of the CSM.

Usability – Ease of Use

The findings of the first two studies were reinforced by the comments offered by users in the interviews of the Online Wellbeing Centre-RCT (OWC-RCT) baseline study (study 3), with usability being named by most responses when describing their decision to interact with the apps presented to them. Users interviewed in study 4 were fully aware of the importance of interacting with apps that were appealing, easy to use and intuitive, this shows that usability is an essential element of design and user experience (Nitsch et al., 2019). Participants interviewed in studies 3 and 4 expressed how they would stop using wellbeing apps if they struggled to understand how to use them or if the process was too cumbersome. It is not clear however how usability links to wellbeing constructs apart from highlighting its importance as an essential technical design element that has the power to enable or prevent engagement at the outset.

Flexibility in Design

Flexibility in design to allow users to modify and accommodate the apps to their preferences, this is linked to personalisation as elaborated before and includes considering personal characteristics such as age, gender, location and other cultural variables that can be translated into specific features and functionalities, several examples were named by interviewees such as using filters to modify pictures, using social connection functionalities in particular ways, using alarms, setting goals, etc. Flexible features were named in papers analysed in study 1, particularly when the apps used in those studies allowed participants to modify features or follow different pathways while using the apps (e.g., while completing a game). Modifiable features were also noted when completing study 2 as part of app design. It was in studies 3 and 4 where participants emphasised the value of manipulating their apps to fit their likes and needs. When linked to personalisation, flexible design allows identity expression, and from a technical design perspective is possibly the most important factor to enable engagement with wellbeing apps.

Evidence-Based Content

BCT's can be Transformed into App Features

Evidence based content was defined by the presence of BCT's embedded in the design of wellbeing apps, these techniques are derived from several behaviour modification theories and are defined as basic mechanisms to facilitate behaviour change (Michie & Johnston, 2012). In this thesis BCT's were discussed across all four studies from different perspectives. In the narrative synthesis (study 1), different apps features were considered as reflecting BCT's, and their potential to enhance or diminish engagement was noted (i.e., "self-reporting" related with lower engagement, while "automatic tracking" did the opposite). The analysis on the composition of apps (study 2) focused on understanding the presence of BCTs in wellbeing apps and used a comprehensive inventory to do this (Michie et al., 2013). The Behavioural Change Techniques Taxonomy 1 (BCTTv1) references 93 BCT's across 16 categories and indicated that freely available and commonly used wellbeing apps failed to include more than half of these. Results suggested that wellbeing apps are currently designed with low levels of evidence-based techniques, which in turn raised questions regarding their effectiveness and ability to sustain engagement in the long term. It is suggested that the industry should consider a broader spectrum of BCT's and attempt adapting them into their app design with the goal of ensuring effective behaviour change.

BCT's Should Work Synergistically and Link to Ease of Use

An opportunity to investigate the characteristics of users who engage with wellbeing apps was presented in study 3. Results highlighted differences between genders regarding a young person's preference towards specific app features and associated BCT's. For example, males were more oriented to goal setting, tracking and gamification, while females were orientated more towards social interaction and recognition. The results of study 3 highlighted the potential of BCT's embedded in the design of wellbeing apps to improve engagement based on individual differences, and this was corroborated by the interview

responses in the second half of that study. The thematic analysis conducted in study 4 consisted of in-depth qualitative interviews and reinforced results of the OWC-RCT that BCT's are intrinsically engaging only if they respond to the needs of the user. It is suggested that if BCT's are synergistically positioned to enhance the usability of apps and increase intrinsic rewards, this will ultimately set up users to achieve their goals. This was a common feature of four studies, in that apps could act as mediators to achieve personal goals and therefore higher levels of wellbeing (study 1).

Other findings

This thesis found an overall lack of understanding of wellbeing by young people. Participants in studies 3 and 4 explained how they would not reflect on wellbeing as an encompassing whole, but only on an aspect of it if it was affected. The study by Winsall et all (2018) had similar findings, possibly showing that young people tend to take for granted aspects of their life that they perceive being under control most of the time. Even though young people did not think about wellbeing in an integral manner, it was clear in the interviews of study 4, that they had the capacity to understand the importance of considering their wellbeing as a comprehensive whole when it was pointed out to them; participants were able to understand the importance of looking after themselves holistically and potentially investing in maintaining and building their strengths in the four areas contemplated in the CSM.

Interviews in studies 3 and 4 also showed that participants perceive talking about wellbeing as akin to talking about mental illness. Based on these results it would seem that discussing wellbeing is perceived as discussing deficits and how to solve them instead of having a conversation on strengths and how to keep them. The stigma surrounding the conversation about personal wellbeing could be a reflection of lack of knowledge about the concept and of the importance of wellbeing that comes from society in general and the traditional focus on deficits.

Interpretation summary and recommendations

With the aims of this thesis in mind, this section will present further interpretations of what the results mean in the context of young people and wellbeing. In line with research stating that increasing wellbeing can in turn maximise mental health and prevent mental illness in young people (Provencher & Keyes, 2011), this program of research was based on the presumption that increasing engagement with wellbeing apps would in turn lead to higher levels of wellbeing (Chapter 3). Using the Complete State of Mental Health model (CSM) (Keyes & Lopez, 2002) as a theoretical framework, wellbeing is organised in four categories (psychological, social, emotional and physical wellbeing) that can be targeted and enhanced by the use of technology (Bakker & Rickard, 2018; Bolier & Abello, 2014; Chen & Wang, 2021; Cheng, 2019; Leinonen et al., 2017). However, despite the potential of wellbeing apps to support young people to increase their wellbeing, the engagement with these technologies is low. This is where the current thesis sought to fill the gap and argues that to improve wellbeing, apps need to be used significantly in time but most importantly in purpose. It could be said that existing apps seem to be too generic with their design driven by theory, as in the case of aps designed for mental illness or physical health (Abroms et al., 2011; Berg & Perich, 2022; Crombie et al., 2014), or industry, as in the case of commercial enterprises (Cowdery et al., 2015; Ráthonyi et al., 2019). Either way, it is suggested that little consideration is given to the characteristics of the final user in the design of apps, or worse making assumptions without involving users in the design process. Using apps to disseminate information is not enough, personalisation is the key and long-term engagement is achieved only when the app responds to intrinsic motivations predicated by user's characteristics, goals and values.

Recommendations

The current program of research highlighted the importance of including evidence based, effective design and most importantly identity elements in the engagement of young

people with wellbeing apps and mobile health technologies. The following recommendations will relate to the specific aims of the thesis.

Aim 1: Analyse the composition of wellbeing apps from a behavioural change perspective

Wellbeing apps do not currently seem to be using BCT's in a consistent way which, in turn, impacts its effectiveness and the users' experience. Wellbeing apps adapt and shape BCT's into features, these can act independently, such as: setting reminders, or creating lists of goals; however, it is suggested that integrating these features could maximise their engagement potential. Integration refers to users' experience that is not circumscribed to individual apps themselves but expands into the virtual world connecting and sharing information with other apps, sites and devices. The effective implementation of BCT's and associated app features are also linked with usability which is one of the main determinants of engagement with apps. Usability allows access to relevant information seamlessly and may greatly improve the value and engagement with apps as means of enhancing users' behaviours that ultimately increase wellbeing. App design requires implementation of BCT's in a synergistic way where different techniques can be used in appealing ways while being directed to the same objectives.

Aim 2: Understand engagement from an individual psychological perspective

Using apps to enhance young people's identity could translate into concrete changes in their personal life that could improve wellbeing in the areas outlined in the CSM such as physical health (e.g., levels of fitness, or losing weight) while at the same feeding-back into the way they express themselves in the virtual world, impacting their social and psychological health (e.g. social media presence, the use of avatars, contribution to the community, etc.).

Aim 3: Analise personal motivations to use mobile apps focused on wellbeing, emphasising the personal characteristics that enable users to make significant use of wellbeing apps.

As much as specific apps target specific behaviours, providing an encompassing framework such as wellbeing could potentially boost the apps' appeal and place them in an integrative perspective to be used alongside other apps and interventions designed to promote health. The industry could benefit from engaging with the concept of wellbeing integrally and promoting it in that way. This program of research found that users seek to meet personal needs and goals, engaging only with apps that presented features they deemed valuable; long term engagement is achieved only when the app responds to intrinsic motivations predicated by user's characteristics, goals and values.

Aim 4: Propose ways of maximising engagement to enhance the effect of quality wellbeing apps.

This thesis presupposes that increased engagement with wellbeing apps offers the capacity to enhance the wellbeing of young people, this link still needs to be investigated in future research, however meaningful engagement with these apps is the first step towards establishing their effectiveness.

Participants in this research re-affirmed the need of using apps that look good, are easy to use and elicit a significant level of enjoyment. Usability and personalisation were also found to be determinant for engagement.

As for significant engagement to take place, identity elements need to be included in the design of wellbeing apps. A clear example on how to include identity elements in design is using gaming strategies. Although the focus of this program of research is not on games, we can reflect on how the elements included in their design can help developers to produce apps with higher levels of engagement. Gamification is usually cited as a technique implemented in health interventions and in apps precisely with this purpose, and there is evidence of the positive effects it can have. A clear example is "Pokemon Go," an app designed to motivate people into walking and being physically active that became a worldwide phenomenon when it was launched in 2016 (Atanda, 2016). Games target mood

(enjoyment) and identity, including the possibility of playing different roles at different moments in history, etc. Perhaps the most important element of an online game is the sense of purpose and meaning accompanied by achievement; games explicitly state missions, levels and skills to be gained and rewards to be reaped. Online games reflect the findings of this research, as much as they need to include usability, content related to meaning, and personal appeal. The importance of role models is another factor that points towards identity for engagement. Role models should be used not only for promoting apps in and of themselves, but most importantly to promote wellbeing as an achievable goal, which in turn can be supported by the use of dedicated technologies, aka apps.

Strengths of this Thesis

This thesis has several strengths. Firstly, being supported by a larger research project it was able to access data specifically targeted to the area of enquiry. The participants and the context of the OWC-RCT provided the background needed to access data of primary sources (e.g., RCT participants). Secondly, this thesis focuses in a new area of enquiry that merges a relatively new concept in psychology such as wellbeing together with mobile applications with the relevance of the use of technology to promote wellbeing that is poorly understood and as such this program of research is placed in newly expanding grounds.

Whereas most research in mHealth focuses on deficits, this thesis focuses on strengths, looking at apps that are available to the general public and not designed for a deficit-focused specific intervention. This is a strength in as much as it looks deeply into what people use every day and questions the outcomes offered by those apps starting at the very first link in the chain: engagement. The focus on engagement precedes questions about efficacy as it is the primordial condition that needs to be met to evaluate any ensuing intervention.

Finally, the focus on the individual user and not solely on technical data brings a dimension of humanity to this research that seeks to reflect on the experience of those who are the final target of these apps. The value extracted from understanding young people's motivations to engage with apps and most importantly the way they perceive wellbeing, opens the opportunity to translate those findings into more concrete steps as it regards educating people on the value of wellbeing and improving app design by including identity elements.

Limitations

Initially, it can be said that the lack of a systematic program of research can be detrimental to the findings. Each study can be seen as a stand-alone piece with apparently little relation with each other. However, the way research evolved is better explained as an explanatory convergent design with quantitative data being contrasted with qualitative data and opening new lines of enquiry based in the results attained.

Secondly, some components of this study would have benefited from obtaining a larger sample with richer data. This is particularly true of the demographic data obtained from the OWC-RCT; however, this was also mentioned as one of the limitations of that study. This lack of data is another demonstration of the lack of user engagement that this thesis addresses. As noted, this limitation was mitigated by follow up interviews with those users who did sign up into the RCT.

The broad focus of this research can also be counted as a limitation. Being exploratory in nature in a field with little previous research, this thesis explores large categories such as identity and wellbeing which cannot be strictly measured in an objective way. The final emphasis of this research is qualitative in nature, and the recommendations are in line of developing a deeper understanding on the interaction of these elements placing the final users (young people) at the centre.

Finally, we recognise the time that this program of research took to complete as a limitation, particularly given the increasing speed at which technology develops and the ever-changing nature of this field. The delays on the completion of this research are addressed in the exegesis chapter (chapter 2). Having acknowledged this, it is our belief that the findings arising from this research are still relevant precisely because they speak of individuals, their identity, and the uniqueness of their role in the interaction with technology; the relevance of this individuality is unlikely to change.

Future Directions

Eliciting health behaviours conducive to increasing wellbeing levels is the intended goal of wellbeing apps. The evidence content in the composition of wellbeing apps sets the bases for behaviour modification and as such they need to be carefully selected, included, and implemented in app design. Evidence based content in the form BCT's can also be intrinsically motivating (i.e., social support, positive feedback) and therefore have an impact on engagement. Appeal, usability, and personalisation as elements of effective design rely on good implementation of BCT's and in understanding who the users are and what is the final outcome sought. This is where identity elements can play an essential role in engagement, as it links the behavioural and technological elements included in the apps and provides them with the meaning, intentionality and uniqueness that arise from the individual user. This research points to considering the individual first as the origin and end of design, behaviour change and engagement, in that context it proposes design from the top down (users first) instead than bottom up (techniques first). A research suggestion it to include engagement as a measure in research designs so it can be assessed as a significant variable potentially accounting for dropouts and non-completions; this implies designing engagement measures and looking into the determinant factors that influence it. Lastly, harnessing the power of social media as a supra-app, to integrate the conversation of wellbeing into the culture in general, removes stigma and incentivizes wellbeing as a lifestyle.

Concluding Statement

Nowadays, technology impacts virtually every area of human activity. However, it seems that to benefit from the hyper-connectivity represented by mobile apps we first need to disconnect as paradoxical as this sounds this research has shown how engagement can only be meaningful if it related to young people's identity and represents their values and goals. Perhaps the emphasis for technology to work should not be the technology, but rather promoting understanding of the importance of wellbeing so it becomes part of the users identity. It is our hope that this thesis will serve as a reflection platform for future researchers to reframe technology as the means to enhance and empower young people, by engaging them with apps that offer meaning in terms of wellbeing.

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Appendices

Appendix A – Search Strategy for Narrative Synthesis – Chapter 4 -Study 1

Understanding what we know so far about engagement with wellbeing apps. A scoping review and narrative synthesis

Database	No. results
ACM Digital Library	110
IEEE Xplore Digital Library	31
Informit	1869
ProQuest	2549
Cochrane Library	2389
PubMed (non-indexed only)	1319
Current Contents Connect	3103
Web of Science Core Collection	5538
Scopus	5993
Medline (Ovid)	10946
PsycINFO (Ovid)	2383
CINAHL (EBSCOhost)	2809
Total retrieved citations	39039
Total after duplicates removed	**11245**

CINAHL search (EBSCOhost)

#	Query	Limiters/Expanders
S1	(MH "Smartphone") OR (MH "Cellular Phone")	Search modes - Boolean/Phrase
S2	TI (mhealth* or “m-health*” or “mobile health” or “m-wellbeing” or mwellbeing or “mwell-being”) OR AB (mhealth* or “m-health*” or “mobile health” or “m-wellbeing” or mwellbeing or “mwell-being”)	Search modes - Boolean/Phrase
S3	TI (((Mobile or tablet* or smartphone* or “smart-phone*”) N2 (app or apps or application* or device* or technolog*))) OR AB (((Mobile or tablet* or smartphone* or “smart-phone*”) N2 (app or apps or application* or device* or technolog*)))	Search modes - Boolean/Phrase
S4	TI (((cell* or mobile*) N2 (phone* or telephone*))) OR AB (((cell* or mobile*) N2 (phone* or telephone*)))	Search modes - Boolean/Phrase
S5	TI (smartphone* or “smart-phone*” or Android* or iPad* or iPod* or iTunes or GooglePlay or appstore* or “app store*” or iOS) OR AB (smartphone* or “smart-phone*” or Android* or iPad* or iPod* or iTunes or GooglePlay or appstore* or “app store*” or iOS)	Search modes - Boolean/Phrase
S6	TI ((tablet* N2 (computer* or device*))) OR AB ((tablet* N2 (computer* or device*)))	Search modes - Boolean/Phrase
S7	TI (((handheld or “hand-held”) N2 (computer* or device*))) OR AB (((handheld or “hand-held”) N2 (computer* or device*)))	Search modes - Boolean/Phrase
S8	TI (app or apps or wearable*) OR AB (app or apps or wearable*)	Search modes - Boolean/Phrase
S9	TI ("Calorie Carb" or “My Net Diary” or “My Diet Diary” or Lifesum or MyfitnessPal or fitbit or “Calorie Counter” or “Diet Tracker” or Sparkpeople or fatsecret or “micoach train” or "map my walk" or runtastic or Nike or endomondo or runkeeper or dailymile or “lose it” or fitnow or Strava or “smart sleep manager” or “Good Night's sleep alarm” or Sleepbot or “Relax Hypnosis”) OR AB ("Calorie Carb" or “My Net Diary” or “My Diet Diary” or Lifesum or MyfitnessPal or fitbit or “Calorie Counter” or “Diet Tracker” or Sparkpeople or fatsecret or “micoach train” or "map my walk" or runtastic or Nike or endomondo or runkeeper or dailymile or “lose it” or fitnow or Strava or “smart sleep manager” or “Good Night's sleep alarm” or Sleepbot or “Relax Hypnosis”)	Search modes - Boolean/Phrase

S10	(MH "Attitude to Health") OR (MH "Health Beliefs") OR (MH "Health Behavior")	Search modes - Boolean/Phrase
S11	(MH "Health Knowledge")	Search modes - Boolean/Phrase
S12	TI ((health* N1 (behavior* or behaviour* or attitude* or belief* or personal or promotion or prevention))) OR AB ((health* N1 (behavior* or behaviour* or attitude* or belief* or personal or promotion or prevention)))	Search modes - Boolean/Phrase
S13	TI (((behavior* or behaviour*) N1 (chang* or modif*))) OR AB (((behavior* or behaviour*) N1 (chang* or modif*)))	Search modes - Boolean/Phrase
S14	(MH "Quality of Life")	Search modes - Boolean/Phrase
S15	(MH "Personal Satisfaction")	Search modes - Boolean/Phrase
S16	(MH "Life Style") OR (MH "Life Style Changes")	Search modes - Boolean/Phrase
S17	TI (wellbeing or “well-being” or wellness or satisfaction or lifestyle* or “life-style*” or "quality of life" or “mental health” or healthy or “positive psycholog*”) OR AB (wellbeing or “well-being” or wellness or satisfaction or lifestyle* or “life-style*” or "quality of life" or “mental health” or healthy or “positive psycholog*”)	Search modes - Boolean/Phrase
S18	(MH "Motivation")	Search modes - Boolean/Phrase
S19	TI motivat* OR AB motivat*	Search modes - Boolean/Phrase
S20	(MH "Exercise+")	Search modes - Boolean/Phrase
S21	(MH "Physical Fitness") OR (MH "Physical Activity")	Search modes - Boolean/Phrase
S22	TI (“physically active” or “daily activit*” or “physical activit*” or exercis* or “activity level*” or fitness or “physically fit” or running or sedentary or inactiv* or tracking) OR AB (“physically active” or “daily activit*” or “physical activit*” or exercis* or “activity level*” or fitness or “physically fit” or running or sedentary or inactiv* or tracking)	Search modes - Boolean/Phrase
S23	(MH "Energy Metabolism")	Search modes - Boolean/Phrase

S24	(MH "Diet") OR (MH "Energy Intake") OR (MH "Food Intake")	Search modes - Boolean/Phrase
S25	TI (energetic or energy or calori* or kilojoule*) OR AB (energetic or energy or calori* or kilojoule*)	Search modes - Boolean/Phrase
S26	(MH "Body Weight") OR (MH "Weight Gain") OR (MH "Weight Loss")	Search modes - Boolean/Phrase
S27	(MH "Body Weight Changes")	Search modes - Boolean/Phrase
S28	(MH "Eating") OR (MH "Eating Behavior") OR (MH "Food Habits") OR (MH "Food Preferences")	Search modes - Boolean/Phrase
S29	TI ((weight N2 (loss or gain or manage* or control* or maintain* or body))) OR AB ((weight N2 (loss or gain or manage* or control* or maintain* or body)))	Search modes - Boolean/Phrase
S30	TI (diet* or food or eat* or nutrition*) OR AB (diet* or food or eat* or nutrition*)	Search modes - Boolean/Phrase
S31	(MH "Sleep")	Search modes - Boolean/Phrase
S32	TI sleep* OR AB sleep*	Search modes - Boolean/Phrase
S33	(MH "Relaxation")	Search modes - Boolean/Phrase
S34	(MH "Stress Management")	Search modes - Boolean/Phrase
S35	TI (relax* or mood* or stress management or unwind*) OR AB (relax* or mood* or stress management or unwind*)	Search modes - Boolean/Phrase
S36	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9	Search modes - Boolean/Phrase
S37	S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35	Search modes - Boolean/Phrase
S38	S36 AND S37	Search modes - Boolean/Phrase
S39	TX (teen* or "young adult*" or "young people*" or "young person*" or youngster* or juvenile* or adolescen* or youth) OR TX ((("high school*" or college* or universit* or international or secondary or school*) N1 student*))	Search modes - Boolean/Phrase
S40	S38 AND S39	Search modes -

		Boolean/Phrase
S41	S38 AND S39	Limiters - Published Date: 20020101-2021531 Search modes - Boolean/Phrase

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present

#	Searches
1	(mhealth* or m-health* or mobile health or m-wellbeing or mwellbeing or mwell-being).tw.
2	cell phones/ or smartphone/
3	((Mobile or tablet? or smartphone? or smart-phone?) adj2 (app? or application? or device? or technolog*)).tw.
4	((cell* or mobile*) adj2 (phone? or telephone?)).tw.
5	(smartphone or smart-phone$ or Android? or iPad? or iPod? or iTunes or GooglePlay or appstore* or app store* or iOS).tw.
6	(tablet* adj2 (computer* or device*)).tw.
7	((handheld or hand-held) adj2 (computer? or device?)).tw.
8	(app or apps or wearable*).tw.
9	("Calorie Carb" or My Net Diary or My Diet Diary or Lifesum or MyfitnessPal or fitbit or Calorie Counter or Diet Tracker or Sparkpeople or fatsecret or micoach train or "map my walk" or runtastic or Nike or endomondo or runkeeper or dailymile or lose it or fitnow or Strava or smart sleep manager or Good Night's sleep alarm or Sleepbot or Relax Hypnosis).tw.
10	or/1-9
11	Health Behavior/ or attitude to health/ or health knowledge, attitudes, practice/
12	(health* adj1 (behavio?r* or attitude* or belief* or personal or promotion or prevention)).tw.
13	(behavio?r* adj1 (chang* or modif*)).tw.

14	"Quality of Life"/ or Personal Satisfaction/ or Life Style/
15	(wellbeing or well-being or wellness or satisfaction or lifestyle* or life-style* or "quality of life" or mental health or healthy or positive psycholog*).tw.
16	Motivation/ or motivat*.tw.
17	exp Exercise/
18	Motor Activity/
19	Physical Fitness/
20	(physically active or daily activit* or physical activit* or exercis* or activity level* or fitness or physically fit or running or sedentary or inactiv* or tracking).tw.
21	Energy Metabolism/
22	Diet/ or Energy Intake/
23	(energetic or energy or calori* or kilojoule*).tw.
24	body weight/ or body weight changes/ or weight gain/ or weight loss/
25	feeding behavior/ or food habits/ or food preferences/ or eating/
26	(weight adj2 (loss or gain or manage* or control* or maintain* or body)).tw.
27	(diet* or food or eat* or nutrition*).tw.
28	Sleep/ or sleep*.tw.
29	Relaxation/ or (relax* or mood* or stress management or unwind*).tw.
30	or/11-29
31	(teen* or young adult* or young people* or young person* or youngster* or juvenile* or adolescen* or youth).mp.
32	((high school* or college* or universit* or international or secondary or school*) adj1 student*).mp.
33	or/31-32
34	10 and 30 and 33
35	limit 34 to yr="2002 -Current"

Psychinfo Searches

#	
1	(mhealth* or m-health* or mobile health or m-wellbeing or mwellbeing or mwell-being).tw.
2	cellular phones/ or mobile devices/
3	((Mobile or tablet? or smartphone? or smart-phone?) adj2 (app? or application? or device? or technolog*)).tw.
4	((cell* or mobile*) adj2 (phone? or telephone?)).tw.
5	(smartphone$ or smart-phone$ or Android? or iPad? or iPod? or iTunes or GooglePlay or appstore* or app store* or iOS).tw.
6	(tablet* adj2 (computer* or device*)).tw.
7	((handheld or hand-held) adj2 (computer? or device?)).tw.
8	(app or apps or wearable*).tw.
9	("Calorie Carb" or My Net Diary or My Diet Diary or Lifesum or MyfitnessPal or fitbit or Calorie Counter or Diet Tracker or Sparkpeople or fatsecret or micoach train or "map my walk" or runtastic or Nike or endomondo or runkeeper or dailymile or lose it or fitnow or Strava or smart sleep manager or Good Night's sleep alarm or Sleepbot or Relax Hypnosis).tw.
10	or/1-9
11	health behavior/ or behaviour change/ or behaviour modification/ or health attitudes/
12	(health* adj1 (behavio?r* or attitude* or belief* or personal or promotion or prevention)).tw.
13	(behavio?r* adj1 (chang* or modif*)).tw.
14	well being/ or life satisfaction/ or lifestyle/ or lifestyle changes/ or mental health/ or positive psychology/ or "quality of life"/
15	(wellbeing or well-being or wellness or satisfaction or lifestyle* or life-style* or "quality of life" or mental health or healthy or positive psycholog*).tw.
16	Motivation/ or motivat*.tw.
17	active living/ or daily activities/ or physical activity/ or exercise/ or aerobic exercise/ or activity level/ or physical fitness/
18	(physically active or daily activit* or physical activit* or exercis* or activity level* or fitness or physically fit or running or sedentary or inactiv* or tracking).tw.

19	energy expenditure/ or calories/
20	(energetic or energy or calori* or kilojoule*).tw.
21	weight control/ or body weight/ or diets/ or food intake/ or weight loss/ or eating behavior/ or dietary restraint/ or food intake/
22	(weight adj2 (loss or gain or manage* or control* or maintain* or body)).tw.
23	(diet* or food or eat* or nutrition*).tw.
24	Sleep/ or sleep*.tw.
25	Stress Management/ or Relaxation/
26	(mood* or stress management or relax* or unwind*).tw.
27	or/11-26
28	(teen* or young adult* or young people* or young person* or youngster* or juvenile* or adolescen* or youth).mp.
29	((high school* or college* or universit* or international or secondary or school*) adj1 student*).mp.
30	or/28-29
31	10 and 27 and 30
32	limit 31 to yr="2002 -Current"

Search string master

(mhealth* OR “m-health*” OR “mobile health” OR “m-wellbeing” OR mwellbeing OR “mwell-being” OR ((Mobile OR tablet? OR smartphone? OR “smart-phone?”) adj2 (app? OR application? OR device? OR technolog*)) OR ((cell* OR mobile*) adj2 (phone? OR telephone?)) OR smartphone$ OR “smart-phone$” OR Android? OR iPad? OR iPod? OR iTunes OR GooglePlay OR appstore* OR “app store*” OR iOS OR (tablet* adj2 (computer* OR device*)) OR ((handheld OR “hand-held”) adj2 (computer? OR device?)) OR app OR apps OR wearable* OR "Calorie Carb" OR “My Net Diary” OR “My Diet Diary” OR Lifesum OR MyfitnessPal OR fitbit OR “Calorie Counter” OR “Diet Tracker” OR Sparkpeople OR fatsecret OR “micoach train” OR "map my walk" OR runtastic OR Nike OR endomondo OR runkeeper OR dailymile OR “lose it” OR fitnow OR Strava OR “smart sleep manager” OR “Good Night's sleep alarm” OR Sleepbot OR “Relax Hypnosis”) AND ((health* adj1 (behavio?r* OR attitude* OR belief* OR personal OR promotion OR prevention)) OR (behavio?r* adj1 (chang* OR modif*)) OR wellbeing OR “well-being” OR wellness OR satisfaction OR lifestyle* OR “life-style*” OR "quality of life" OR “mental health” OR healthy OR “positive psycholog*” OR motivat* OR “physically active” OR “daily activit*” OR “physical activit*” OR exercis* OR “activity level*” OR fitness OR “physically fit” OR running OR sedentary OR inactiv* OR tracking OR energetic OR energy OR calori* OR kilojoule* OR (weight adj2 (loss OR gain OR manage* OR control* OR maintain* OR body)) OR diet* OR food OR eat* OR nutrition* OR sleep* OR mood* OR “stress management” OR relax* OR unwind*) AND (teen* OR “young adult*” OR “young people*” OR “young person*” OR youngster* OR juvenile* OR adolescen* OR youth OR ((“high school*” OR college* OR universit* OR international OR secondary OR school*) adj1 student*))

Scopus

(mhealth* OR “m-health*” OR “mobile health” OR “m-wellbeing” OR mwellbeing OR “mwell-being” OR ((Mobile OR tablet* OR smartphone* OR “smart-phone*”) W/2 (app OR apps OR application* OR device* OR technolog*)) OR ((cell* OR mobile*) W/2 (phone* OR telephone*)) OR smartphone* OR “smart-phone*” OR Android* OR iPad* OR iPod* OR iTunes OR GooglePlay OR appstore* OR “app store*” OR iOS OR (tablet* W/2 (computer* OR device*)) OR ((handheld OR “hand-held”) W/2 (computer* OR device*)) OR app OR apps OR wearable* OR "Calorie Carb" OR “My Net Diary” OR “My Diet Diary” OR Lifesum OR MyfitnessPal OR fitbit OR “Calorie Counter” OR “Diet Tracker” OR Sparkpeople OR fatsecret OR “micoach train” OR "map my walk" OR runtastic OR Nike OR endomondo OR runkeeper OR dailymile OR “lose it” OR fitnow OR Strava OR “smart sleep manager” OR “Good Night's sleep alarm” OR Sleepbot OR “Relax Hypnosis”)

AND

((health* W/1 (behavior*r* OR attitude* OR belief* OR personal OR promotion OR prevention)) OR (behavior*r* W/1 (chang* OR modif*)) OR wellbeing OR “well-being” OR wellness OR satisfaction OR lifestyle* OR “life-style*” OR "quality of life" OR “mental health” OR healthy OR “positive psycholog*” OR motivat* OR “physically active” OR “daily activit*” OR “physical activit*” OR exercis* OR “activity level*” OR fitness OR “physically fit” OR running OR sedentary OR inactiv* OR tracking OR energetic OR energy OR calori* OR kilojoule* OR (weight W/2 (loss OR gain OR manage* OR control* OR maintain* OR body)) OR diet* OR food OR eat* OR nutrition* OR sleep* OR mood* OR “stress management” OR relax* OR unwind*)

AND

(teen* OR “young adult*” OR “young people*” OR “young person*” OR youngster* OR juvenile* OR adolescen* OR youth OR ((“high school*” OR college* OR universit* OR international OR secondary OR school*) W/1 student*))

Entered as:

(((TITLE-ABS-KEY (mhealth* OR "m-health*" OR "mobile health" OR "m-wellbeing" OR mwellbeing OR "mwell-being") OR TITLE-ABS-KEY (((mobile OR tablet* OR smartphone* OR "smart-phone*") W/2 (app OR apps OR application* OR device* OR technolog*))) OR TITLE-ABS-KEY (((cell* OR mobile*) W/2 (phone* OR telephone*))) OR TITLE-ABS-KEY (smartphone* OR "smart-phone*" OR android* OR ipad* OR ipod* OR itunes OR googleplay OR appstore* OR "app store*" OR ios) OR TITLE-ABS-KEY ((tablet* W/2 (computer* OR device*))) OR TITLE-ABS-KEY (((handheld OR "hand-held") W/2 (computer* OR device*))) OR TITLE-ABS-KEY (app OR apps OR wearable* OR "Calorie Carb" OR "My Net Diary" OR "My Diet Diary" OR lifesum OR myfitnesspal OR fitbit OR "Calorie Counter" OR "Diet Tracker") OR TITLE-ABS-KEY (sparkpeople OR fatsecret OR "micoach train" OR "map my walk" OR runtastic OR nike OR endomondo OR runkeeper OR dailymile OR "lose it" OR fitnow OR strava OR "smart sleep manager" OR "Good Night's sleep alarm" OR sleepbot OR "Relax Hypnosis")) AND SUBJAREA (mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci)) AND ((TITLE-ABS-KEY ((health* W/1 (behavio*r* OR attitude* OR belief* OR personal OR promotion OR prevention)) OR ((behavior* OR behaviour*) W/1 (chang* OR modif*))) OR TITLE-ABS-KEY (wellbeing OR "well-being" OR wellness OR satisfaction OR lifestyle* OR "life-style*" OR "quality of life" OR "mental health" OR healthy OR "positive psycholog*" OR motivat*) OR TITLE-ABS-KEY ("physically active" OR "daily activit*" OR "physical activit*" OR exercis* OR "activity level*" OR fitness OR "physically fit" OR running OR sedentary OR inactiv* OR tracking OR energetic OR energy OR calori* OR kilojoule*) OR TITLE-ABS-KEY ((weight W/2 (loss OR gain OR manage* OR control* OR maintain* OR body)) OR diet* OR food OR eat* OR nutrition* OR sleep* OR mood* OR "stress

management" OR relax* OR unwind*)) AND SUBJAREA (mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci)) AND (TITLE-ABS-KEY (teen* OR "young adult*" OR "young people*" OR "young person*" OR youngster* OR juvenile* OR adolescen* OR youth OR (("high school*" OR college* OR universit* OR international OR secondary OR school*) W/1 student*)) AND SUBJAREA (mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci))) AND SUBJAREA (mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci)) AND (LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2007) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2002)) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "ip"))

Web of Science Core Collection

(mhealth* OR “m-health*” OR “mobile health” OR “m-wellbeing” OR mwellbeing OR “mwell-being” OR ((Mobile OR tablet$ OR smartphone$ OR “smart-phone$”) NEAR/2 (app$ OR application$ OR device$ OR technolog*)) OR ((cell* OR mobile*) NEAR/2 (phone$ OR telephone$)) OR smartphone$ OR “smart-phone$” OR Android$ OR iPad$ OR iPod$ OR iTunes OR GooglePlay OR appstore* OR “app store*” OR iOS OR (tablet* NEAR/2 (computer* OR device*)) OR ((handheld OR “hand-held”) NEAR/2 (computer$ OR device$)) OR app OR apps OR wearable* OR "Calorie Carb" OR “My Net Diary” OR “My Diet Diary” OR Lifesum OR MyfitnessPal OR fitbit OR “Calorie Counter” OR “Diet Tracker” OR Sparkpeople OR fatsecret OR “micoach train” OR "map my walk" OR runtastic OR Nike OR endomondo OR runkeeper OR dailymile OR “lose it” OR fitnow OR Strava OR “smart sleep manager” OR “Good Night's sleep alarm” OR Sleepbot OR “Relax Hypnosis”) AND ((health* NEAR/1 (behavio$r* OR attitude* OR belief* OR personal OR promotion OR prevention)) OR (behavio$r* NEAR/1 (chang* OR modif*)) OR wellbeing OR “well-being” OR wellness OR satisfaction OR lifestyle* OR “life-style*” OR "quality of life" OR “mental health” OR healthy OR “positive psycholog*” OR motivat* OR “physically active” OR “daily activit*” OR “physical activit*” OR exercis* OR “activity level*” OR fitness OR “physically fit” OR running OR sedentary OR inactiv* OR tracking OR energetic OR energy OR calori* OR kilojoule* OR (weight NEAR/2 (loss OR gain OR manage* OR control* OR maintain* OR body)) OR diet* OR food OR eat* OR nutrition* OR sleep* OR mood* OR “stress management” OR relax* OR unwind*) AND (teen* OR “young adult*” OR “young people*” OR “young person*” OR youngster* OR juvenile* OR adolescen* OR youth OR ((“high school*” OR college* OR universit* OR international OR secondary OR school*) NEAR/1 student*))

Current Contents Connect (Thomson Reuters)

(mhealth* OR “m-health*” OR “mobile health” OR “m-wellbeing” OR mwellbeing OR “mwell-being” OR ((Mobile OR tablet$ OR smartphone$ OR “smart-phone$”) NEAR/2 (app$ OR application$ OR device$ OR technolog*)) OR ((cell* OR mobile*) NEAR/2 (phone$ OR telephone$)) OR smartphone$ OR “smart-phone$” OR Android$ OR iPad$ OR iPod$ OR iTunes OR GooglePlay OR appstore* OR “app store*” OR iOS OR (tablet* NEAR/2 (computer* OR device*)) OR ((handheld OR “hand-held”) NEAR/2 (computer$ OR device$)) OR app OR apps OR wearable* OR "Calorie Carb" OR “My Net Diary” OR “My Diet Diary” OR Lifesum OR MyfitnessPal OR fitbit OR “Calorie Counter” OR “Diet Tracker” OR Sparkpeople OR fatsecret OR “micoach train” OR "map my walk" OR runtastic OR Nike OR endomondo OR runkeeper OR dailymile OR “lose it” OR fitnow OR Strava OR “smart sleep manager” OR “Good Night's sleep alarm” OR Sleepbot OR “Relax Hypnosis”) AND ((health* NEAR/1 (behavio$r* OR attitude* OR belief* OR personal OR promotion OR prevention)) OR (behavio$r* NEAR/1 (chang* OR modif*)) OR wellbeing OR “well-being” OR wellness OR satisfaction OR lifestyle* OR “life-style*” OR "quality of life" OR “mental health” OR healthy OR “positive psycholog*” OR motivat* OR “physically active” OR “daily activit*” OR “physical activit*” OR exercis* OR “activity level*” OR fitness OR “physically fit” OR running OR sedentary OR inactiv* OR tracking OR energetic OR energy OR calori* OR kilojoule* OR (weight NEAR/2 (loss OR gain OR manage* OR control* OR

maintain* OR body)) OR diet* OR food OR eat* OR nutrition* OR sleep* OR mood* OR “stress management” OR relax* OR unwind*) AND (teen* OR “young adult*” OR “young people*” OR “young person*” OR youngster* OR juvenile* OR adolescen* OR youth OR ((“high school*” OR college* OR universit* OR international OR secondary OR school*) NEAR/1 student*))

PubMed

(((mhealth*[tiab] OR “m-health*”[tiab] OR “mobile health”[tiab] OR “m-wellbeing”[tiab] OR mwellbeing[tiab] OR “mwell-being”[tiab] OR ((Mobile[tiab] OR tablet*[tiab] OR smartphone*[tiab] OR “smart-phone*”[tiab]) AND (app[tiab] OR apps[tiab] OR application*[tiab] OR device*[tiab] OR technolog*[tiab])) OR ((cell[tiab] OR cellular[tiab] OR mobile*[tiab]) AND (phone*[tiab] OR telephone*[tiab])) OR smartphone*[tiab] OR “smart-phone*”[tiab] OR Android*[tiab] OR iPad*[tiab] OR iPod*[tiab] OR iTunes[tiab] OR GooglePlay[tiab] OR appstore*[tiab] OR “app store*”[tiab] OR iOS[tiab] OR (tablet*[tiab] AND (computer*[tiab] OR device*[tiab])) OR ((handheld[tiab] OR “hand-held” [tiab]) AND (computer*[tiab] OR device*[tiab])) OR app[tiab] OR apps[tiab] OR wearable*[tiab] OR "Calorie Carb"[tiab] OR “My Net Diary”[tiab] OR “My Diet Diary”[tiab] OR Lifesum[tiab] OR MyfitnessPal[tiab] OR fitbit[tiab] OR “Calorie Counter”[tiab] OR “Diet Tracker”[tiab] OR Sparkpeople[tiab] OR fatsecret[tiab] OR “micoach train”[tiab] OR "map my walk"[tiab] OR runtastic[tiab] OR Nike[tiab] OR endomondo[tiab] OR runkeeper[tiab] OR dailymile[tiab] OR “lose it”[tiab] OR fitnow[tiab] OR Strava[tiab] OR “smart sleep manager”[tiab] OR “Good Night's sleep alarm”[tiab] OR Sleepbot[tiab] OR “Relax Hypnosis” [tiab]) AND ((health*[tiab] AND (behavior*[tiab] OR behaviour*[tiab] OR attitude*[tiab] OR belief*[tiab] OR personal[tiab] OR promotion[tiab] OR prevention[tiab])) OR ((behavior*[tiab] OR behaviour*[tiab]) AND (chang*[tiab] OR modif*[tiab])) OR wellbeing[tiab] OR “well-being”[tiab] OR wellness[tiab] OR satisfaction[tiab] OR lifestyle*[tiab] OR “life-style*”[tiab] OR "quality of life"[tiab] OR “mental health”[tiab] OR healthy[tiab] OR “positive psycholog*”[tiab] OR motivat*[tiab] OR “physically active”[tiab] OR “daily activit*”[tiab] OR “physical activit*”[tiab] OR exercis*[tiab] OR “activity level*”[tiab] OR fitness[tiab] OR “physically fit”[tiab] OR running[tiab] OR sedentary[tiab] OR inactiv*[tiab] OR tracking[tiab] OR energetic[tiab] OR energy[tiab] OR calori*[tiab] OR kilojoule*[tiab] OR (weight[tiab] AND (loss[tiab] OR gain[tiab] OR manage*[tiab] OR control*[tiab] OR maintain*[tiab] OR body[tiab])) OR diet[tiab] OR diets[tiab] OR dietary[tiab] OR food[tiab] OR eat*[tiab] OR nutrition*[tiab] OR sleep*[tiab] OR mood*[tiab] OR “stress management”[tiab] OR relax*[tiab] OR unwind*[tiab]) AND (teen*[tiab] OR “young adult*”[tiab] OR “young people*”[tiab] OR “young person*”[tiab] OR youngster*[tiab] OR juvenile*[tiab] OR adolescen*[tiab] OR youth[tiab] OR ((“high school*”[tiab] OR college*[tiab] OR universit*[tiab] OR international[tiab] OR secondary[tiab] OR school*[tiab]) AND student*[tiab]))) NOT Medline[sb]

Cochrane library

(mhealth* OR “m-health*” OR “mobile health” OR “m-wellbeing” OR mwellbeing OR “mwell-being” OR ((Mobile OR tablet* OR smartphone* OR “smart-phone*”) NEAR/2 (app OR apps OR application* OR device* OR technolog*)) OR ((cell* OR mobile*) NEAR/2 (phone* OR telephone*)) OR smartphone* OR “smart-phone*” OR Android* OR iPad* OR iPod* OR iTunes OR GooglePlay OR appstore* OR “app store*” OR iOS OR (tablet* NEAR/2 (computer* OR device*)) OR ((handheld OR “hand-held”) NEAR/2 (computer* OR device*)) OR app OR apps OR wearable* OR "Calorie Carb" OR “My Net Diary” OR “My Diet Diary” OR Lifesum OR MyfitnessPal OR fitbit OR “Calorie Counter” OR “Diet Tracker” OR Sparkpeople OR fatsecret OR “micoach train” OR "map my walk" OR runtastic OR Nike OR endomondo OR runkeeper OR dailymile OR “lose it” OR fitnow OR Strava OR “smart sleep manager” OR “Good Night's sleep alarm” OR Sleepbot OR “Relax Hypnosis”) AND ((health* NEAR/1 (behavio*r* OR attitude* OR belief* OR personal OR promotion OR prevention)) OR (behavio*r* NEAR/1 (chang* OR modif*)) OR wellbeing OR “well-being” OR wellness OR satisfaction OR lifestyle* OR “life-style*” OR "quality of life" OR “mental health” OR healthy OR “positive psycholog*” OR motivat* OR “physically active” OR “daily activit*” OR “physical activit*” OR exercis* OR “activity level*” OR fitness OR “physically fit” OR running OR sedentary OR inactiv* OR tracking OR energetic OR energy OR calori* OR kilojoule* OR (weight NEAR/2 (loss OR gain OR manage* OR control* OR maintain* OR body)) OR diet* OR food OR eat* OR nutrition* OR sleep* OR mood* OR “stress management” OR relax* OR unwind*) AND (teen* OR “young adult*” OR “young people*” OR “young person*” OR youngster* OR juvenile* OR adolescen* OR youth OR ((“high school*” OR college* OR universit* OR international OR secondary OR school*) NEAR/1 student*))

ProQuest

Search string run on title, abstract and subject headings fields to reduce number of false hits.

ti((mhealth* OR "m-health*" OR "mobile health" OR "m-wellbeing" OR mwellbeing OR "mwell-being" OR ((Mobile OR tablet* OR smartphone* OR "smart-phone*") NEAR/2 (app OR apps OR application* OR device* OR technolog*)) OR ((cell* OR mobile*) NEAR/2 (phone* OR telephone*)) OR smartphone* OR "smart-phone*" OR Android* OR iPad* OR iPod* OR iTunes OR GooglePlay OR appstore* OR "app store*" OR iOS OR (tablet* NEAR/2 (computer* OR device*)) OR ((handheld OR "hand-held") NEAR/2 (computer* OR device*)) OR app OR apps OR wearable* OR "Calorie Carb" OR "My Net Diary" OR "My Diet Diary" OR Lifesum OR MyfitnessPal OR fitbit OR "Calorie Counter" OR "Diet Tracker" OR Sparkpeople OR fatsecret OR "micoach train" OR "map my walk" OR runtastic OR Nike OR endomondo OR runkeeper OR dailymile OR "lose it" OR fitnow OR Strava OR "smart sleep manager" OR "Good Night's sleep alarm" OR Sleepbot OR "Relax Hypnosis") AND ((health* NEAR/1 (behavio*r* OR attitude* OR belief* OR personal OR promotion OR prevention)) OR 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Within ProQuest Central

- ProQuest Education Journals
- ProQuest Family Health
- ProQuest Health & Medical Complete
- ProQuest Health Management
- ProQuest Nursing & Allied Health Source
- ProQuest Psychology Journals
- ProQuest Social Science Journals
- ProQuest Research Library
- ProQuest Sociology
- ProQuest Telecommunications

Within ProQuest Social Sciences Premium Collection

- Applied Social Sciences Index and Abstracts (ASSIA)
- International Bibliogrpahy of the Social Sciences (IBSS)
- PAIS International
- Sociological Abstracts

Informit (all 95 databases)

((diet* OR food OR eat* OR nutrition* OR sleep* OR mood* OR "stress management" OR relax* OR unwind*) OR ((loss OR gain OR manage* OR control* OR maintain* OR body) %2 weight) OR (((behavior* OR behaviour* OR attitude* OR belief* OR personal OR promotion OR prevention) %1 health*) OR ((chang* OR modif*) %1 behaviour*) OR ((chang* OR modif*) %1 behavior*) OR (wellbeing OR "well-being" OR wellness OR satisfaction OR lifestyle* OR "life-style" OR "quality of life" OR "mental health" OR healthy OR "positive psycholog*" OR motivat* OR "physically active" OR "daily activit"* OR "physical activit"* OR exercis* OR "activity level"* OR fitness OR "physically fit" OR running OR sedentary OR inactiv* OR tracking OR energetic OR energy OR calori* OR kilojoule*))) AND ((((computer* OR device*) %2 tablet*) OR ((handheld OR "hand-held") %2 computer*) OR ((handheld OR "hand-held") %2 device*) OR (app OR apps OR wearable*)) OR (smartphone* OR "smart-phone"* OR Android* OR iPad* OR iPod* OR iTunes OR GooglePlay OR appstore* OR "app store"* OR iOS) OR (((cell* OR mobile*) %2 phone*) OR ((cell* OR mobile*) %2 telephone*)) OR ((mobile OR tablet OR smartphone* OR "smart-phone"*) %2 app*) OR (mhealth* OR "m-health"* OR "mobile health" OR "m-wellbeing" OR mwellbeing OR "mwell-being")) AND ((teen* OR "young adult"* OR "young people"* OR "young person"* OR youngster* OR juvenile* OR adolescen* OR youth) OR (("high school"* OR college* OR universit* OR international OR secondary OR school*) %1 student*))

IEEE Xplore Digital Library

(wearable* OR app* OR smartphone* OR "smart-phone" OR "smart-phones") AND (adolescen* OR teen* OR young*)

ACM Digital Library

Variations on textwords. Only supports basic search.

Appendix B – Critical Appraisal Tools - Joanna Briggs Institute – Chapter 4 – Study 1

JBI Critical Appraisal Checklist for analytical cross sectional studies

Reviewer_____

Date_____

Author_____Year_____Record Number_____

	Yes	No	Unclear	Not applicable
1. Were the criteria for inclusion in the sample clearly defined?	□	□	□	□
2. Were the study subjects and the setting described in detail?	□	□	□	□
3. Was the exposure measured in a valid and reliable way?	□	□	□	□
4. Were objective, standard criteria used for measurement of the condition?	□	□	□	□
5. Were confounding factors identified?	□	□	□	□
6. Were strategies to deal with confounding factors stated?	□	□	□	□
7. Were the outcomes measured in a valid and reliable way?	□	□	□	□
8. Was appropriate statistical analysis used?	□	□	□	□

Overall appraisal: Include □ Exclude □ Seek further info □

Comments (Including reason for exclusion)

_____

_____

_____

_____

JBI Critical Appraisal Checklist for cohort studies

Reviewer_____

Date_____.

Author_____Year_____ Record Number_____

	Yes	No	Unclear	Not applicable
1. Were the two groups similar and recruited from the same population?	□	□	□	□
2. Were the exposures measured similarly to assign people to both exposed and unexposed groups?	□	□	□	□
3. Was the exposure measured in a valid and reliable way?	□	□	□	□
4. Were confounding factors identified?	□	□	□	□
5. Were strategies to deal with confounding factors stated?	□	□	□	□
6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	□	□	□	□
7. Were the outcomes measured in a valid and reliable way?	□	□	□	□
8. Was the follow up time reported and sufficient to be long enough for outcomes to occur?	□	□	□	□
9. Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	□	□	□	□
10. Were strategies to address incomplete follow up utilized?	□	□	□	□
11. Was appropriate statistical analysis used?	□	□	□	□

Overall appraisal: Include □ Exclude □ Seek further info □

Comments (Including reason for exclusion)

_____

_____

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JBI Critical Appraisal Checklist for Qualitative Research

Reviewer_____
Date_____

Author_____Year_____ Record Number_____

	Yes	No	Unclear	Not applicable
1. Is there congruity between the stated philosophical perspective and the research methodology?	□	□	□	□
2. Is there congruity between the research methodology and the research question or objectives?	□	□	□	□
3. Is there congruity between the research methodology and the methods used to collect data?	□	□	□	□
4. Is there congruity between the research methodology and the representation and analysis of data?	□	□	□	□
5. Is there congruity between the research methodology and the interpretation of results?	□	□	□	□
6. Is there a statement locating the researcher culturally or theoretically?	□	□	□	□
7. Is the influence of the researcher on the research, and vice- versa, addressed?	□	□	□	□
8. Are participants, and their voices, adequately represented?	□	□	□	□
9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	□	□	□	□
10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	□	□	□	□

Overall appraisal: Include □ Exclude □ Seek further info □

Comments (Including reason for exclusion)

_____

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_____

JBI Critical Appraisal Checklist for randomized Controlled trials

Reviewer_____

Date_____

Author_____Year_____ Record Number_____

	Yes	No	Unclear	NA
1. Was true randomization used for assignment of participants to treatment groups?	□	□	□	□
2. Was allocation to treatment groups concealed?	□	□	□	□
3. Were treatment groups similar at the baseline?	□	□	□	□
4. Were participants blind to treatment assignment?	□	□	□	□
5. Were those delivering treatment blind to treatment assignment?	□	□	□	□
6. Were outcomes assessors blind to treatment assignment?	□	□	□	□
7. Were treatment groups treated identically other than the intervention of interest?	□	□	□	□
8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately	□	□	□	□
9. Were participants analyzed in the groups to which they were randomized?	□	□	□	□
10. Were outcomes measured in the same way for treatment groups?	□	□	□	□
11. Were outcomes measured in a reliable way?	□	□	□	□
12. Was appropriate statistical analysis used?	□	□	□	□
13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	□	□	□	□

Overall appraisal: Include □ Exclude □ Seek further info □

Comments (Including reason for exclusion)

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Appendix C – Behaviour Change Techniques Taxonomy V1 – Chapter 5 -Study 2

Page	Grouping and BCTs
1	**1. Goals and planning**
	1.1. Goal setting (behavior) 1.2. Problem solving 1.3. Goal setting (outcome) 1.4. Action planning 1.5. Review behavior goal(s) 1.6. Discrepancy between current behavior and goal 1.7. Review outcome goal(s) 1.8. Behavioral contract 1.9. Commitment
3	**2. Feedback and monitoring**
	2.1. Monitoring of behavior by others without feedback 2.2. Feedback on behaviour 2.3. Self-monitoring of behaviour 2.4. Self-monitoring of outcome(s) of behaviour 2.5. Monitoring of outcome(s) of behavior without feedback 2.6. Biofeedback 2.7. Feedback on outcome(s) of
5	**3. Social support**
	3.1. Social support (unspecified) 3.2. Social support (practical) 3.3. Social support (emotional)
6	**4. Shaping knowledge**
	4.1. Instruction on how to perform the behavior 4.2. Information about Antecedents 4.3. Re-attribution
7	**5. Natural consequences**
	5.1. Information about health consequences 5.2. Salience of consequences 5.3. Information about social and environmental consequences 5.4. Monitoring of
8	**6. Comparison of behaviour**
	6.1. Demonstration of the behavior 6.2. Social comparison 6.3. Information about others' approval
9	**7. Associations**
	7.1. Prompts/cues 7.2. Cue signalling reward 7.3. Reduce prompts/cues 7.4. Remove access to the reward 7.5. Remove aversive stimulus 7.6. Satiation 7.7. Exposure 7.8. Associative learning
10	**8. Repetition and substitution**
	8.1. Behavioral practice/rehearsal 8.2. Behavior substitution 8.3. Habit formation 8.4. Habit reversal 8.5. Overcorrection 8.6. Generalisation of target behavior 8.7. Graded tasks
11	**9. Comparison of outcomes**
	9.1. Credible source 9.2. Pros and cons 9.3. Comparative imagining of future outcomes
12	**10. Reward and threat**
	10.1. Material incentive (behavior) 10.2. Material reward (behavior) 10.3. Non-specific reward 10.4. Social reward 10.5. Social incentive 10.6. Non-specific incentive 10.7. Self-incentive 10.8. Incentive (outcome) 10.9. Self-reward 10.10. Reward (outcome) 10.11. Future punishment
15	**11. Regulation**
16	**12. Antecedents**
	12.1. Restructuring the physical environment 12.2. Restructuring the social environment 12.3. Avoidance/reducing exposure to cues for the behavior 12.4. Distraction 12.5. Adding objects
17	**13. Identity**
	13.1. Identification of self as role model 13.2. Framing/reframing 13.3. Incompatible beliefs 13.4. Valued self-identify 13.5. Identity associated with changed behavior
18	**14. Scheduled consequences**
	14.1. Behavior cost 14.2. Punishment 14.3. Remove reward 14.4. Reward approximation 14.5. Rewarding completion 14.6. Situation-specific reward 14.7. Reward incompatible behavior 14.8. Reward alternative behavior 14.9. Reduce reward frequency 14.10. Remove punishment
19	**15. Self-belief**
	15.1. Verbal persuasion about capability 15.2. Mental rehearsal of successful performance 15.3. Focus on past success 15.4. Self-talk
19	**16. Covert learning**
	16.1. Imaginary punishment 16.2. Imaginary reward 16.3. Vicarious consequences

1.

	emotional consequences 5.5. Anticipated regret 5.6. Information about		11.1. Pharmacological support 11.2. Reduce negative emotions 11.3. Conserving mental resources 11.4. Paradoxical instructions		

Appendix D – Ethics Approval and Modification for Follow-up Interviews – Chapter 6 - Study 3

FW: 6478 Final approval granted (11 June 2014)

Principal Researcher:	A/Prof Niranjan Bidargaddi
Email:	niranjan.bidargaddi@flinders.edu.au

Approval Date:	6 June 2014	Ethics Approval Expiry Date:	**6 June 2016**

The above proposed project has been **approved** on the basis of the information contained in the application, its attachments and the information subsequently provided.

RESPONSIBILITIES OF RESEARCHERS AND SUPERVISORS

1. **Participant Documentation**
   Please note that it is the responsibility of researchers and supervisors, in the case of student projects, to ensure that:
   - all participant documents are checked for spelling, grammatical, numbering and formatting errors. The Committee does not accept any responsibility for the above mentioned errors.
   - the Flinders University logo is included on all participant documentation (e.g., letters of Introduction, information Sheets, consent forms, debriefing information and questionnaires – with the exception of purchased research tools) and the current Flinders University letterhead is included in the header of all letters of introduction.The Flinders University international logo/letterhead should be used and documentation should contain international dialling codes for all telephone and fax numbers listed for all research to be conducted overseas.
   - the SBREC contact details, listed below, are included in the footer of all letters of introduction and information sheets.

     This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project Number 'INSERT PROJECT No. here following approval'). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au.

2. **Annual Progress / Final Reports**
   In order to comply with the monitoring requirements of the*National Statement on Ethical Conduct in Human Research (March 2007)*an annual progress report must be submitted each year on the **6 June** (approval anniversary date) for the duration of the ethics approval

bout:blank

1.

MODIFICATION REQUEST

For previously approved projects

A Modification Request should be submitted for all items listed below:	IMPORTANT
1. proposed changes to the research protocol; 2. proposed changes to participant recruitment methods; 3. amendments to participant documentation and/or research tools' 4. change of project title; 5. extension of the ethics approval expiry date / extension of time; and 6. personnel changes (e.g., additions, removals, supervisor changes) Submit modification requests to human.researchethics@flinders.edu.au. Committee response will be emailed to you in 1-2 weeks.	a) Proposed modifications should *not* proceed until formal notification of modification approval has been received. b) Annual reports - annual progress reports should be up to date *before* a modification request is submitted. c) Indigenous peoples – modifications that impact and/or involve Indigenous peoples will also be reviewed by Yunggorendi which will impact Committee response time. d) Contact Details – email SBREC if details change as Ethics *is not* linked to Student Two or Human Resources.

1. Project Information

Project No.	**6478**	Ethics Approval **Expiry Date**	6 June
Project Title	Evaluation of the Online Wellbeing Centre (OWC)		
Principal Researcher	A/Prof Niranjan Bidargaddi	Email address:	Niranjan.bidargaddi@flinders.edu.au
Annual Reports up to date?		Next annual report due?	6 June 2015

2. Extension of time

2A Extension of Time Requested (if applicable)

Current Ethics Approval Expiry Date		New Expiry Date requested	

2B Justification

3. Change of Project Title

3A Change of Project Title (if applicable)

Old project title:

New project title:

3B Participant Document Revisions

Please note: if the project title is changed, copies of all documents to be distributed to potential participants will need to be revised to include the new title (e.g., email text, Letter of introduction, Information Sheet, Consent Form). Please submit copies of the revised documents for review.

Revised Participant Documents Attached?

4. Change of Personnel

4A Change of Personnel Summary (if applicable)

Add/ remove	Full name & title	Postal address	Email address

4B Conflicts of Interest

Comment on whether a conflict of interest may exist for any new personnel (e.g., role / relation to participant source). If yes, explain how this will be managed.

4C Participant Document Revisions

Please note that if personnel are added and/or removed from a project that documents to be distributed to potential participants will need to be revised to ensure that a current list of researchers is included (e.g., email text, Letter of Introduction, Information Sheet, Consent Form).

Revised Participant Documents Attached?

5. Modified Research Protocol

5A Revision of Research Protocol Table

Please indicate in table below what type of changes are proposed.

Select Options that Apply	
Research Objectives Revision, or addition to, research objectives (item D1c)	
Research Method – Revision of approved research method – Addition to approved research method	
Research Participants – Addition of new participant group – Exclusion of participant group already approved by Committee	
Consent – Revised method for seeking informed consent from participants – New method for seeking consent	
Recruitment Process Change to approved process for participant recruitment	
Research Tools For example, survey, interview questions, focus group discussion topics. – Revision of approved research tools – New research tools	**X**
Other (if yes, please specify)	**X**

Changes in follow up methods.

5B Outline of Research Protocol Changes

Provide a clear outline of changes and/or additions to the research protocol are being requested and explain why it is necessary to address the research objectives (e.g, change to research objectives; changes to recruitment process; change to research tools; addition of research tools etc).

Changes in provision of relevant services details

In the original ethics submission we said that participants with high scores in items that may indicate the presence of depression would be sent an email or SMS with details of relevant service providers. (C--C1A; F--F3; Information Sheet)

We would like to change this method and give access to relevant service providers' information to all participants independently of their depression scores. The Online Wellbeing Centre features service providers' details prominently in its noticeboard and the Toolbox displays permanent links with this information on each screen. Participants are constantly encouraged to seek help if necessary (including in the information sheet and consent form).

We believe that this change is necessary, as presenting information to all participants doesn't single out individuals or put extra demands on them. This method also ensures that people with potential difficulties that were not identified by the measures can access help at any time. Finally it is more technically feasible as it doesn't burden the system.

The following sentence has been removed from the Information Sheet to reflect this change:

"If we detect via our questionnaires that you might need some professional help we will send you an email or SMS with service providers details for you to contact."

This section now reads:

"The Online Wellbeing Centre and the Toolbox websites will have a detailed list of service providers for easy access. We will not provide any individual psychological treatment during this study. The different applications included in the Toolbox have been reviewed by experts in the

field of mental health and selected according to their relevance and high quality. These applications offer support for psychological (e.g. personal strengths), emotional (e.g. increasing happiness) and social wellbeing (e.g. positive relations with others)"

Addition of direct follow up strategies to increase post-- intervention data completion

In order to increase data recovery at post assessment, we would like to contact participants who haven't completed the measures even after being reminded via SMS as originally described in the protocol. This contact will be done over the phone and the conversation will focus on guiding participants into completing the questionnaire. A previous SMS will be sent saying:

"We've noticed you didn't come back to the OWC to complete your questionnaire. Would it be ok if we give you a call so you can complete it over the phone? Please send "no" if you prefer to log back in and complete it online. Thank you very much"

These calls will focus exclusively in completing the main outcome measure (Mental Health Continuum-- Short Form) and will not last more than 10 minutes.

Addition of post--study semi structured interviews to gather qualitative data

As the study progresses we may need to contact participants via telephone to gather qualitative data about their user experience and general feedback on the intervention site. We expect to have these conversations with a random sample of participants who have completed the study, via a semi--structured interview (questionnaire attached). As a compensation for agreeing to provide their extra input, participants will be offered a Westfield gift card to the value of $20. The interviews would last from 15 to 30 minutes. Being able to retrieve this data will help refine the study findings and will provide valuable information regarding the design and implementation of similar studies in the future. The procedure we would follow in implementing this interview will start with an SMS inviting them to participate voluntarily. This message would read:

"Hi, we would like to give you a brief call to ask you some questions about your experience with the Online Wellbeing Centre. As a thank you, we have a Westfield gift card we'd like to give you. If you are not interested in having this conversation please send "NO" to this number. Thank you very much!

5C Participant Document Revisions

To ensure that informed consent can be obtained changes to the research protocol may need to be reflected in the documents to be distributed to potential participants.(e.g., email text, Letter of Introduction, Information Sheet, Consent Form). Revised documents and/or new participant documents may need to be provided for review.

Revised Participant Documents Attached?	yes

6. Permissions / Other Ethics Committee Approvals

Please indicate whether any other ethics committee approvals and/or permissions need to be sought that are related to the requested modification. If yes, please either (a) provide a copy of approvals and/or permissions **OR** (b) confirm that copies will be submitted to the committee on receipt.

7. Aboriginal and/or Torres Strait Islander peoples

7A Impact and/or involvement of Indigenous peoples

Please indicate whether the *proposed modification* will involve and/or impact Australian Indigenous peoples.

YES ☐

NO ☐

7B Explanation

IF the proposed modification involves and/or impacts Aboriginal and/or Torres Strait Islander peoples please explain how.

8. Burdens and/or Risks

Could there be any potential inconveniences or risks to participants as a consequence of the modifications requested? If **YES,** outline what they are and specify whether there will be any changes to anonymity and confidentiality assurances given to participants, time commitments and research location. Please explain how you will reduce inconveniences and/or risks to participants.

We will not force any participant to be part of these calls. Giving them the option to opt-out ensures only voluntary participation.

9. Document amendments and/or additions

New or amended?	Document	Brief outline of changes made	Attached yes/no
New	Semi-structured interview questions		Y
Amended	Information Sheet	Removed sentence: *"If we detect via our questionnaires that you might need some professional help we will send you an email or SMS with service providers details for you to contact."*	Y

Appendix E – Participants Information letter and consent – Chapter 6 – Study 3

A/Prof Niranjan Bidargaddi
School of Medicine
Faculty of Health Sciences

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Niranjan.bidargaddi@flinders.edu.au
CRICOS Provider No. 00114A

INFORMATION SHEET

Title: Evaluation of the Online Wellbeing Centre

Investigators:

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Mr Yang Yang
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Ms Megan Roberts
School of Medicine – Flinders University
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Description of the study:

In the context of the increasing use of technology by young people, this project will evaluate a website called the "Online Wellbeing Centre" (OWC) which will provide you with different resources to improve and track your wellbeing. The main resource we will be testing is the "Toolbox: the best apps for your brain and body" which consists of a website for young people to access a personalised, ongoing recommendation service for apps to support their wellbeing and mental health. Access to the toolbox will be gained through the OWC.

Please note that this project is co-funded by Flinders University, Young and Well Cooperative Research Centre and Country Health SA.

Purpose of the study:

The purpose of this research is to evaluate the effectiveness of the use of technology (apps, website) in supporting wellbeing and mental health in young Australians. We will achieve this by measuring wellbeing levels before and after the use of the Online Wellbeing Centre (with and without access to the Toolbox) at different times (4 weeks, 3 and 6 months).

We will also compare changes in wellbeing levels to information such as geographical location, gender and cultural background to identify all the areas where changes need to be made in the future to help young people thrive.

What will participants be asked to do?

These are the steps the project will follow:

- Access to the study website (OWC) and registration: you will access our website and will be provided with information regarding this research including what to expect in the ensuing steps. You will also be required to create an account by registering via our website by creating a new account. All accounts will be password protected and confidential.

- Initial assessment: Once you are registered you will be asked to complete the first assessment that consists of questionnaires measuring emotional, psychological and social wellbeing and consist of simple multiple choice questions. The questionnaires don't require participants to write any ideas or disclose any personal information and you'll be able to complete them in 10 minutes.

- Randomisation: Initially participants will be automatically divided in two groups. Group 1 (intervention) will be allowed to access the Toolbox directly and group 2 (control) will be asked to wait for 4 weeks while still having access to the OWC.

- Second assessment: 4 weeks after the first assessment you will be contacted via email/SMS to access our website and complete the questionnaires for a second time independently to the group you were part of at the beginning. At this moment participants that were part of the control group will be given full access to the Toolbox. You will require around 10 minutes to complete the questionnaires.

- Third assessment: 3 months after first using the Toolbox you will be asked to complete the questionnaires once more (10 minutes).

- Fourth assessment: 6 months after first using the Toolbox you will be asked to complete the questionnaire for the last time (10 minutes).

- During the study and in order to help you track your wellbeing we will communicate with you via SMS and ask you to respond 3 simple questions about your sleep, energy and feelings. This will happen only once every week and will take you 5 seconds to respond. You will be able to track your progress using the Online Wellbeing Centre.

All information will be de-identified. No personal details will be disclosed at any time. Only the researchers will have access to personal data (see confidentiality).

All communication with you will follow computer generated pre-established templates and will not contain any personal information, e.g.: *"Hey, we've missed you at the Online Wellbeing Centre, Log in to track your wellbeing, browse the apps and discover the website's new features and improvements"*

Duration

Your participation in this study will be 6 months in total. During that time, it will be necessary for you to complete the assessment questionnaires in 4 opportunities and use the OWC and the Toolbox at your will.

What benefit will participants gain from being involved in this study?

If you participate in this research, you may experience the following potential benefits:

- Access to expert approved technological applications to improve your wellbeing

- Assistance to establish personal goals, increase happiness and solve problems

effectively With your participation other young people will benefit in the future by:

- Being offered proven technological support to prevent mental health problems and improve quality of life.

- Our society will be leading the way in finding innovative ways to increase the wellbeing of young people.

No payment will be made to participants.

Will I be identifiable by being involved in this study?

The information that we collect from this research project will be kept confidential. Information about you will be de-identified and put away and no-one but the researchers will be able to see it. Any information about you will have a number on it instead of your name. Regarding anonymity only the researchers will have access to your personal details including name, age and contact details.

The study website uses goACT web application for trial management and the Toolbox by Reachout.com for recommending apps. goACT collects study measures and keeps a log of your Computer's Internet Protocol ("IP") address, browser type or the webpage you were visiting before you came to the study website, pages of our study website you visit, access times and dates, and other statistics. For research purposes, we extract information from goACT and the Toolbox websites and de-identify it before we use the data for analysis. Participating in this study means you accept to the privacy policy and terms of service of goACT (http://goact.co/privacy.php) and The Toolbox (thttp://thetoolboxtest.au.reachout.com/privacy).

Right to Refuse or Withdraw

You do not have to agree to take part in this research if you do not wish to do so and refusing to participate will not affect your access to the Toolbox once it is released to the public by early 2015.

Are there any risks or discomforts if I am involved?

Given the nature of this project and the focus on wellbeing and positive psychology there are not significant risks foreseen. However, depending on your mental and physical health we recommend approaching relevant health services if any discomfort is experienced following the use of the Toolbox. The Online Wellbeing Centre and the Toolbox websites will have a detailed list of service providers for easy access. We will not provide any individual psychological treatment during this study. The different applications included in the Toolbox have been reviewed by experts in the field of mental health and selected according to their relevance and high quality. These applications offer support for psychological (e.g. personal strengths), emotional (e.g. increasing happiness) and social wellbeing (e.g. positive relations with others).

How do I agree to participate?

Voluntary Participation

Your decision to participate in this study is entirely voluntary. It is your choice whether to participate or not. This means that you will be able to withdraw and stop being asked to complete questionnaires at any moment. Also, you will have the freedom to stop or keep using the Toolbox at any time even if you desire to withdraw from research.

If you are not interested in participating in this study but would like to use this site please note that the Toolbox will be freely available to the public once the evaluation is completed.

How will I receive feedback? Tracking scores

Every time you login into the projects website (Online Wellbeing Centre) and complete your questionnaires you'll be able to track how your wellbeing scores are changing in different areas

(social, psychological and emotional). You will also be able to keep track of your sleep, energy and feelings scores through time.

Additionally every time you login into the Toolbox you will be able to work around your goals and keep a diary to monitor your progress towards them.

Sharing of the results

The knowledge that we get from this study will be reported to the Young and Well CRC and shared with the community via publications in different mediums (scientific journals, publications, etc.). We will not contact you directly to report results. Your personal information will not be published at any time. All data gathered in this study will be aggregated in different categories for statistical analysis.

Thank you for taking the time to read this information sheet and we hope that you will accept our invitation to be involved.

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project number: 6478). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au

Appendix F– Interview Guide – Chapter 6 – Study 3

Evaluation of the Online Wellbeing Centre

Semi-structured interview

"Hi, my name is ( ). I am a researcher on the Online Wellbeing Centre project and was wondering if it' would be ok to have a short conversation with you regarding your experience with the website?"

1. What do you think about the Online Wellbeing Centre?
2. Why did you sign up?
3. What do you think worked well and what didn't?
4. What do you think about the Toolbox?
5. Did you download any of the apps you selected (list the ones corresponding to that user)?
6. Are you still using any of the apps you downloaded?
7. How have they changed or influenced your behaviour or lifestyle?
8. If you haven't downloaded anything, can you tell us why?
9. Was there anything specific you were looking for?
10. Did it meet your expectations? Can you explain...

Thank you very much

Appendix G – Ethics Approval and Modification for Follow-up Interviews – Chapter 7 - Study 4

FW: 7022 SBREC final approval notice (14 September 2015)

This message was sent with High importance.

GA Gaston Antezana
To: Gaston Antezana Ortiz <G.Antezana@murdoch.edu.au>
Mon 26/08/2019 2:14 PM

From: Human Research Ethics <human.researchethics@flinders.edu.au>
Date: Monday, 14 September 2015 9:44 am
To: Niranjan Bidargaddi <niranjan.bidargaddi@flinders.edu.au>, Simone Orlowski <simone.orlowski@flinders.edu.au>, Flinders <gaston.antezana@flinders.edu.au>, "m.roberts@flinders.edu.au" <m.roberts@flinders.edu.au>, "geoffrey.schrader@adelaide.edu.au" <geoffrey.schrader@adelaide.edu.au>, Peter Musiat <peter.musiat@kcl.ac.uk>, Ermes Miikka <Miikka.Ermes@vtt.fi>, Miikka Ermes <miikka.ermes@flinders.edu.au>
Subject: 7022 SBREC final approval notice (14 September 2015)

Dear Niranjan,

The Chair of the Social and Behavioural Research Ethics Committee (SBREC) at Flinders University considered your response to conditional approval out of session and your project has now been granted final ethics approval. This means that you now have approval to commence your research. Your ethics final approval notice can be found below.

FINAL APPROVAL NOTICE

Project No.:	**7022**
Project Title:	Real-time tracking of health trajectories through the use of wearable technologies and mobile apps

MODIFICATION REQUEST

For projects previously approved by SBREC

A Modification Request should be submitted for all items listed below:	IMPORTANT
1. proposed changes to the research protocol; 2. proposed changes to participant recruitment methods; 3. amendments to participant documentation and/or research tools' 4. change of project title; 5. extension of the ethics approval expiry date / extension of time; and 6. personnel changes (e.g., additions, removals, supervisor changes) Submit modification requests to human.researchethics@flinders.edu.au Typically, the Committee's response will be emailed to you in 1-2 weeks.	a) Proposed modifications should *not* proceed until formal notification of modification approval has been received. b) Annual reports - annual progress reports should be up to date *before* a modification request is submitted. c) Indigenous peoples – modifications that involve or impact on Indigenous peoples in Australia will also be reviewed by the Flinders University Office of Indigenous Strategy and Engagement (OISE), which will impact Committee response time. d) Contact Details – email SBREC if details change as Ethics *is not* linked to Student Two or Human Resources.

1. Project Information

Ethics Approval

Project No. **Expiry Date** 01-06-2017

7022

Project Title **Real-time tracking of health trajectories through the use of wearable technologies and mobile apps**

Principal Researcher AProf Biddargadi Email address: Niranjan.biddargadi@flinders.edu.au

Annual Reports up to date? Y Next annual report due? 01-06-2016

2. Extension of time

2A Extension of Time Requested (if applicable)

Current Ethics Approval Expiry Date

New Expiry Date requested

2B Justification

3. Change of Project Title

3A Change of Project Title (if applicable)

Old project title:

New project title:

3B Participant Document Revisions

Please note: if the project title is changed, copies of all documents to be distributed to potential participants will need to be revised to include the new title (e.g., email text, Letter of introduction, Information Sheet, Consent Form). Please submit copies of the revised documents for review.

Revised Participant Documents Attached?

4. Change of Personnel

4A Change of Personnel Summary (if applicable)

Add/ remove	Full name & title	Postal address	Email address

4B Conflicts of Interest

Comment on whether a conflict of interest may exist for any new personnel (e.g., role / relation to participant source). If yes, explain how this will be managed.

4C Participant Document Revisions

Please note that if personnel are added and/or removed from a project that documents to be distributed to potential participants will need to be revised to ensure that a current list of researchers is included (e.g., email text, Letter of Introduction, Information Sheet, Consent Form).

Revised Participant Documents Attached?

5. Modified Research Protocol

5A Revision of Research Protocol Table

Please indicate in table below what type of changes are proposed.

Select Options that Apply	
Research Objectives Revision, or addition to, research objectives (item D1c)	

Research Method – Revision of approved research method – Addition to approved research method	
Research Participants – Addition of new participant group – Exclusion of participant group already approved by Committee	
Consent – Revised method for seeking informed consent from participants – New method for seeking consent	
Recruitment Process Change to approved process for participant recruitment	
Research Tools For example, survey, interview questions, focus group discussion topics. – Revision of approved research tools – New research tools	**X**
Documents / Information For example, verbal script, email text, Letter of Introduction, Information Sheet, Consent Form	**X**
– Revision of existing documents / information – New documents / information	
Other (if yes, please specify)	

5B Outline of Research Protocol Changes

Provide a clear outline of changes and/or additions to the research protocol are being requested and explain why it is necessary to address the research objectives (e.g, change to research objectives; changes to recruitment process; change to research tools; addition of research tools etc).

We are seeking permission to perform a second round of focus groups/interviews with participants of our developmental pilot study (C.C1.II.1) in order to deepen our findings regarding the use of wellbeing applications (apps) and psychological mechanisms involved in the use and engagement with these resources by young people.

Original participants of the developmental pilot study will be re-contacted and invited to participate in these interviews. Participants will be asked to contribute one hour of their time and will be compensated with a $20 voucher from Myers-Coles. As approved in modification #1 (28/09/2015), participants of the developmental study were recruited from Headspace Murray Bridge and from Flinders University. The first round of participation was completed in October 2015.

Given the nature of this component of the study (qualitative enquiry) we may need to recruit additional participants in order to reach data saturation. As approved in the initial Ethical Approval Submission we would consider recruiting participants from FlindersONE (modified letter attached), this population is relevant in as much as this study seeks to understand motivations of young people already using health and wellbeing apps. Potential differences between groups will be accounted for and evaluated in the final analysis.

This phase will not collect clinical or sensitive data on these participants, as it constitutes a user experience consultation and not an intervention. Participants will be offered the opportunity to review and edit interview transcripts.

A verbal/email script has been designed to contact these participants (attached).

5C Participant Document Revisions

To ensure that informed consent can be obtained changes to the research protocol may need to be reflected in the documents to be distributed to potential participants.(e.g., email text, Letter of Introduction, Information Sheet, Consent Form). Revised documents and/or new participant documents may need to be provided for review.

Revised Participant Documents Attached?	Y

6. Permissions / Other Ethics Committee Approvals

Please indicate whether any other ethics committee approvals and/or permissions need to be sought that are related to the requested modification. If yes, please either (a) provide a copy of approvals and/or permissions **OR** (b) confirm that copies will be submitted to the committee on receipt.

7. Aboriginal and/or Torres Strait Islander peoples

7A Impact and/or involvement of Indigenous peoples

Please indicate whether the *proposed modification* will involve or impact on Australian Indigenous peoples.

YES	
NO	

7B Explanation

IF the proposed modification involves or impacts on Australian Indigenous peoples, please explain how.

8. Burdens and/or Risks

Could there be any potential inconveniences or risks to participants as a consequence of the modifications requested? If **YES,** outline what they are and specify whether there will be any changes to anonymity and confidentiality assurances given to participants, time commitments and research location. Please explain how you will reduce inconveniences and/or risks to participants.

9. Document amendments and/or additions

New or amended?	Document	Brief outline of changes made	Attached yes/no
New	Information sheet and Consent to be interviewed		Y
New	Invitation email		Y
New	Interview/focus groups themes/questions		Y
Amended	Letter to recruit from FlindersOne	Focus of research, 2nd paragraph	Y

Appendix H– Participants' Information Sheet and Consent – Chapter 7 – Study 4

A/Prof Niranjan Bidargaddi
School of Medicine
Faculty of Health Sciences

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Niranjan.bidargaddi@flinders.edu.au
CRICOS Provider No. 00114A

INFORMATION SHEET

(For app interview and focus groups)

Title: 'Real-time tracking of health trajectories through the use of wearable technologies and mobile apps'

Researchers:

Associate Professor Niranjan Bidargaddi School of Medicine – Flinders University
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Description of the study:

This study is part of the project entitled 'Young and Well Towns" which is co-funded by the Young and Well Cooperative Research Centre, Country Health SA and Flinders University.

This project will investigate how commercially available personal health apps and wearable devices can be used to support young people's mental health and wellbeing.

Purpose of the study:

This project aims to find out if mobile health apps can be used to:

- Track your health by monitoring your behaviour.
- Identify what elements will make you more likely to use these technologies
- Detect if using online mental health and wellbeing resources can improve your health in the long term.
- Analyse the quality of popular health apps.

What will I be asked to do?You will be required to:

- Attend an interview and a focus group with young people like you to discuss the value of health and wellbeing apps. These interviews will be recorded and used for analysis only by the researcher.

Keep in mind that your participation is voluntary.

What benefit will I gain from being involved in this study?

The sharing of your data will improve the use and design of health apps to support young people like you in different areas, from mental health to getting fit.

As a thank you for your participation we will give you a $20 voucher from Myers-Coles.

Will I be identifiable by being involved in this study?

We will ask your name and other personal details, as we need to collect general information, and to contact you to coordinate our meetings. However, all your information will be seen only by the research team and will not be shared with anyone else. Once we analyse the data it will be de-identified; this means that your personal details will never be disclosed or reported. All the information will be stored on a password-protected computer accessed only by the project researchers.

If the recordings need to be shared with other researchers your identity will not be revealed.

Are there any risks or discomforts if I am involved?

We anticipate very few risks from your involvement in this study. If you have any concerns regarding anticipated or actual risks or discomforts, please keep in mind that you can access help at any time by accessing the resources and links provided by our partner: ReachOut.com. We can't provide any clinical service or advice.

How do I agree to participate?

Participation is voluntary. If you chose to participate just make sure you read the consent form attached and contact the research team.

How will I receive feedback?

Outcomes from the project will be summarised and reported in scientific journals. You can receive feedback about your participation at the study if you require it.

You can also read the transcripts of the interview if you wish to ascertain the veracity of the content.

Thank you for taking the time to read this information sheet and we hope that you will accept our invitation to be involved.

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee Project number 7022. *For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au*

Flinders UNIVERSITY

CONSENT FORM FOR PARTICIPATION IN RESEARCH

(for interview, focus groups)

'**Real-time tracking of health trajectories through the use of wearable technologies and mobile apps**'

I……hereby consent to participate as requested in the research project named above.

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I agree to audio recording of my information and participation.
4. I am aware that I can ask for a copy of the Information Sheet and Consent Form for future reference.
5. I understand that:
   - I may not directly benefit from taking part in this research.
   - I am free to withdraw from the project at any time and am free to decline to answer particular questions.
   - While the information gained in this study will be published as explained, I will not be identified, and individual information will remain confidential.
   - Whether I participate or not, or withdraw after participating, will have no effect on any treatment or service that is being provided to me.
   - Whether I participate or not, or withdraw after participating, will have no effect on my progress in my course of study, or results gained.
   - I may ask that the recording/observation be stopped at any time, and that I may withdraw at any time from the session or the research without disadvantage.
6. I agree to the tape/transcript being made available to other researchers who are not members of this research team, but who are judged by the research team to be doing related research, on condition that my identity is not revealed.
7. I have had the opportunity to discuss taking part in this research with a family member or friend.

Participant's signature…….Date……..

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name…….....

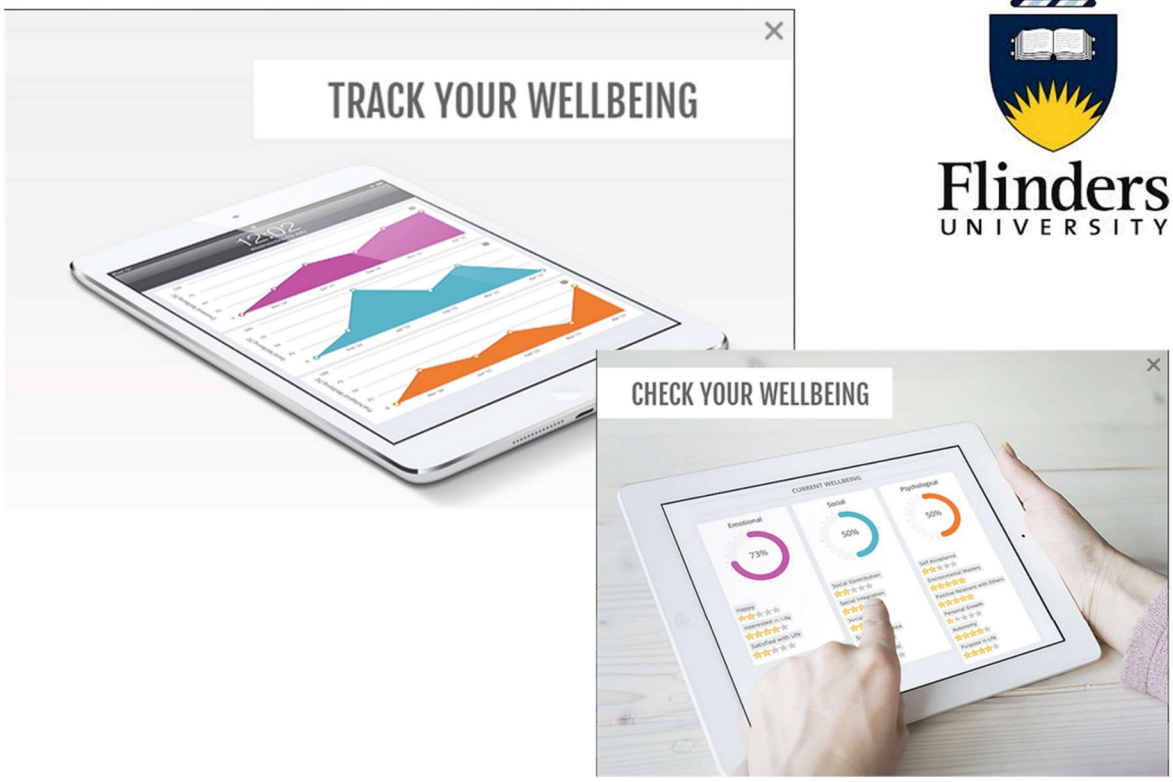
Researcher's signature……..Date…….

Appendix I – Interview Guide – Chapter 7 – Study 4

Interviews/ themes and questions

Theme	Questions
usage	What app do you use the most, why?
	What health/wellbeing apps do you use, why?
	What benefits do you get from these apps?
	What would motivate you to keep using these apps?
	What would make you cease to use these apps?
	How often would/do you use these apps?
	Does using apps help you reach your goals?
Identity	Does any of your friends use health apps?
	Would you recommend any of the apps you use to your friends?
	Does any of your friends use the same apps you do?
	Do you connect to a community/group online by using these apps?
	Would you be able to the same type of activities if you didn't have any of these apps?
	What makes a "good" app?
	Are there any apps that are "more cool" than others?
Imagination	Would you be able to do the same type of activities if you didn't have any of these apps?
	What features do you enjoy/dislike the most?
	What aspects are more important to you when using apps?:(explore: entertainment, customisation, interactivity, engagement, relevance, appropriateness, functionality, performance, ease of use, aesthetics, information quality, content)
Intimacy	Do you worry about confidentiality when using health apps
	Are you comfortable sharing your personal information when using health apps/ communities

Appendix J– Recruitment Adds – Chapter 7 – Study 4



Flinders UNIVERSITY

Are you aged 16 to 25? Are you interested in technology and health? Help us understand how and why young people use wellbeing apps.

Your costs of participation will be reimbursed with a $20.00 voucher for a chat with a researcher.

For more information contact Gaston today at: gaston.antezana@flinders.edu.au or 042 3624 970.

This is a research project co-funded by Flinders University, CHSA and Young and Well CRC. You can find more information about the Young and Well CRC here: www.youngandwell.org.au

Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au	**Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au**	**Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au**	**Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au**	**Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au**	**Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au**	**Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au**	**Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au**	**Health apps interview: 0423624970, Gaston.antezana@flinders.edu.au**

Facebook Add:

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Recruitment letter for FlindersONE

Hi ,

I would like to enquire the possibility of promoting a study among FlindersONE users to recruit participants for the Young and Well Towns Project. This project is jointly funded by Young and Well CRC, Flinders University and Country Health SA. A description of the Young and Well Towns project can be found at the following address: http://www.youngandwellcrc.org.au/research/safe-supportive/young-and-well-towns/

We are hoping to recruit young people aged 18-25 to contribute by exploring innovative ways to use technology to support young their wellbeing. Essentially we need young people's help to understand how they use health apps.

We are attaching a study information sheet for your information. If you think this is a good idea we would be happy to discuss the best way to advertise our study.

Please don't hesitate to contact us on the below phone number to discuss

Kind Regards,

Young and Well Towns

Appendix K – Study 4 – Response to reviewers Submitted to the Journal of Child and Family Studies

Dear Editor,

Thank you for providing us with the opportunity to submit a revised version of our study titled *"Understanding what we know so far about young people's engagement with wellbeing apps. A scoping review and narrative synthesis"* to the Journal of Child and Family Studies. We greatly appreciate the time and effort that went into the valuable feedback provided by the reviewers. We have been able to make changes to our manuscript to address the suggestions and concerns provided by the reviewers.

Below, we have outlined responses and/or actions taken related to each of the reviewers' specific comments. These are highlighted in yellow in the revised manuscript.

Kind regards

REVIEWER 1

- ***The introduction could benefit from a further elaboration of research and theories that support the use of apps in promoting behavioural change.***

Following this suggestion, we have introduced two new paragraphs in the introduction that do just this (3rd and 4th paragraphs).

- ***More information is also needed on what qualitative approach was used.***

We have clarified this observation at the top of the Methods section by including a sentence outlining that the methodology used is consistent with qualitative description (Bradshaw et al., 2017).

- ***I am curious about the type(s) of apps the participants brought up (e.g., how many brought up wellbeing apps vs health and lifestyle apps? Were they primarily apps that document/improve sleep, diet, etc.?).***

We appreciate the suggestion and have added Table 2 accordingly. This table is presented at the end of the document after the reference section

- ***As the participants ranged from 16 to 25 years of age (i.e., adolescence and emerging adulthood), their needs/concerns might be quite different. Could the authors say more about this?***

Thank you for this observation, given that this is an exploratory study we focused more on the information offered by the participants without bringing too many assumptions into the analysis. Having said that, we acknowledge the importance of considering the differences in needs and concerns of the participants of different ages. Accordingly, we have added a sentence in the first

paragraph of the introduction to help define the age range, and a sentence in the last paragraph of the conclusion to outline the lack of specificity in analysis as a limitation also.

- ***In terms of the actual codes, I am curious as to why certain quotes were listed under some categories, e.g., p. 12 "Social risk" – not sure if the participant actually described "social risk"? This points back to what qualitative approach was used and how the data were synthesized.***

Thank you for the observation. In order to clarify this code, we have added an extra quote that helps to contextualise it under the subheading social risk:

REVIEWER 2

- ***APA Formatting:***

All the formatting observations outlined have been addressed have been addressed where possible (note running Heads will be inserted by the journal)

- ***Notes:***

The reviewer commented if the title was a complete sentence and that the abstract was clearly written. Thank you for the comment on the abstract, however need further clarification on the comment regarding the title as we feel this accurately captures the study.

- ***Highlights - Would it be possible to consider simplifying these bullet points? For example, "Future research in this area could focus in trying to establish in what ways apps could contribute to a healthy identity that is closer to the "real-self" and presented in ways to encourage productive interaction with others and the world" is a great implication, however the structure of the sentence is complex and takes away from the point. The first two bullet points are good examples to follow.***

Following this comment, we have modified the highlights as suggested

- ***Introduction - I like the introduction paragraph. It is clearly written. The use of "there is an app for that" quote is a great way to set the stage. In the first sentence of the paragraph, "use of technology-based approaches to target and assist young people who are not receiving help has gained prominence" should be supported by a citation.***

Thank you for your comment, the relevant citation is now included

- ***I'm interested to hear more about the body of research that supports the use of apps to promote health behaviour change. Could you synthesize some of this research and present it as a supporting agent?***

This is consistent with the suggestion from reviewer 1. Accordingly, we have introduced two new paragraphs in the introduction that do just this (3rd and 4th paragraphs).

- ***Page 3 Lines 30 - 33: "Given the incipient state of wellbeing apps and their use in research, this study merges both: health and lifestyle apps and wellbeing apps and the terms will be used indistinctly." Perhaps, you could split this up to be two sentences. The multiple "ands" makes it difficult to read.***

Thank you, we have restructured that sentence (end of 6th paragraph in introduction).

- ***Methods - Is there additional participant information that could be included? You identified that participants include those with diverse cultural backgrounds. That information would provide further context for considerations when interpreting the results.***

Following this observation, we have added information under the *Participants* section to further outline the information obtained regarding cultural backgrounds, and a sentence in the last paragraph of the conclusion to outline this as a limitation also.

- ***Did the analysis occur from the notes or from the audio recordings? Were they transcribed? Additional information about this process potentially strengthens the rigor of this study.***

This process was explained originally in the Analysis section. However, to clarity this further the information provided in the analysis section has been expanded.

- ***Analysis / results- I appreciate the coding outline and inclusion of the actual codes, and The inclusion of the example is a nice touch to help the reader understand the structure of the section***

Thank you

- ***Line 46, Page 6, missing a period.***

Thank you. This has now been included.

- ***Line 44 - 46, Page 6 Journal guidelines indicate no one sentence paragraphs. This continues under each theme.***

These sentences are introductory and included to define the themes as the starting point. Having said that these have been expanded

- ***Discussion and Conclusion - Are there additional limitations to this study that should be considered?***

We have included comments on limitations including cultural background, gender and individual differences related to age as not being emphasised enough in the analysis. This is included in the last paragraph of the discussion.

- ***Page 13, line 33 "are tending" -> tend?***

Thank you this has now been corrected

REVIEWER 3

- ***The sample is quite small (n=13 with a wide age range 16-25 years).***

The sample size was determined by saturation, however we acknowledge this comment and have pointed it out as a limitation in the last paragraph of the discussion.

- ***No rationale (e.g., saturation) is presented for the sample size.***

Thank you for the observation, the criteria for saturation has now been included in the procedure section:

- ***It is unclear what qualitative approach is used, but it appears to be qualitative description.***

We have now clarified the approach used at the top of the Methods section.

- ***The paper needs careful editing for grammar.***

Thank you for this observation, editing was completed as suggested

- **The data are not presented clearly, but rather many generalizations are used instead of the data.**

Thank you for this comment. While we believe the data has been presented critically, and the other reviewers acknowledged the same, we have tried to add elements to sentences to further clarify how the data is presented. These appear at the start of each theme.