

UNIVERSITY OF WINCHESTER

Development and Evaluation of a Digital Sleep Intervention (SleepWise) aimed at Adolescents

Shokraneh Oftadeh Moghadam

ORCID 0000-0001-7868-9598

Doctor of Philosophy

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University of Winchester

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ABSTRACT

Development and Evaluation of a Digital Sleep Intervention (SleepWise) aimed at Adolescents

Shokraneh Oftadeh Moghadam

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While it is recommended that adolescents gain 8-10 hours of sleep per night, most adolescents do not sleep for the recommended amount. Poor sleep among adolescents is associated with weight gain, reduced physical activity, increased risk-taking behaviours, and increased levels of depression and anxiety, making this a significant public health concern. Current interventions targeting adolescent sleep are often reported by users as being non-interactive and do not address age-specific needs. They are also often time-consuming and lack a theoretical foundation. Innovative sleep interventions, that apply a systematic and evidence-based approach to intervention development, are needed.

This PhD aimed to design, develop, and evaluate the feasibility of an evidence-theory-and-person-based digital intervention targeted at adolescents, using the Person-Based Approach (PBA) to intervention development. This was achieved by conducting the following studies:

Study 1: involved the development of an evidenced-based digital (website) prototype intervention (SleepWise). A scoping review was conducted to identify effective intervention ingredients, which were then mapped to key features of the intervention (guiding principles). From this, causal and logic models were developed, bringing together evidence-based barriers and facilitators and the necessary intervention components.

Study 2: involved the optimisation of the prototype intervention, to ensure that it was as feasible and acceptable as possible. Think-aloud interviews were undertaken with adolescents to explore perceptions of the prototype intervention. Participant feedback provided insight into the likely intervention implementation and identified features of relevance, or influence, on participant engagement.

Study 3: involved two 2-arm randomised controlled trials to test the feasibility of the optimised intervention. A process evaluation was carried out to investigate usage with and feedback about the intervention.

This PhD highlights the utility of the PBA to intervention development, and demonstrates that SleepWise is a feasible digital intervention to target adolescent sleep, and a pragmatic solution to an important public health issue.

Keywords: [Digital Health Interventions; Sleep; Adolescence; Behaviour Change; Person-Based Approach]

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LIST OF ABBREVIATIONS

BCT	Behaviour Change Technique
BCTv1	Behaviour Change Taxonomy Version 1
BCW	Behaviour Change Wheel
BNF	British Nutrition Foundation
BPS	Biopsychosocial Model / British Psychological Society
CBT	Cognitive Behaviour Therapy
CBT-I	Cognitive Behaviour Therapy for Insomnia
COM-B	Capability, Opportunity, Motivation, and Behaviour
CONSORT	Consolidated Standard of Reporting Trials
eCBT-I	Digitalised Cognitive Behaviour Therapy for Insomnia
INVOLVE	Public Involvement Body
MI	Motivational Interviewing
MoSCoW	Must have, Should have, Could have, Would like to have
MRC	Medical Research Council
NDNS	National Diet and Nutritional Survey
NETSCC	National Institute for Health Research's Evaluation, Trials and Studies Coordinating Centre
NHS	National Health Services
NIHR	National Institution for Health Research
PBA	Person-Based Approach
PBC	Perceived Behavioural Control
RCT	Randomised Control Trial
SCT	Social Cognitive Theory
SDT	Self-Determination Theory
SPSS	Statistical Package for the Social Sciences
TPB	The Theory of Planned Behaviour
TTM	The Transtheoretical Model
UK	United Kingdom
WHO	World Health Organisation

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Thesis Foreword: My role in the design and development of SleepWise

I took an active role in designing and developing SleepWise, an interactive four-week sleep intervention targeted at adolescents. With the help of a non-commercial web-developer (a friend named Owen Gayle), it took me approximately 3-6 months to design and develop SleepWise.

I took an iterative approach to developing SleepWise, which consisted of moving back and forth between the evidence-base, participant feedback, and face-to-face meetings with Owen. This approach ensured that the design and development phases of the intervention were informed by theory and evidence and, importantly, the voices of adolescents were at the heart of the development process. As part of the design phase (study 1), I wrote content for each weekly session and with Owen's help, transferred the content onto the website.

During the development phase (study 2), interviews were undertaken with target users to gain insight into adolescents' perspective and experience with SleepWise. Adolescent feedback helped address barriers to engaging with SleepWise. A key theme that emerged from participant feedback was the need for more imagery to accompany text information. To address this, I approached a digital illustrator to help design images for SleepWise. The illustrator was a friend who agreed to help on a donation basis. Together, we designed personalised images for SleepWise and incorporated them throughout each weekly session. These modifications were liked by participants in later interviews, as they deemed the illustrations as interesting and a unique characteristic of SleepWise.

While transferring content and improving the website's aesthetics were simple procedures, incorporating behaviour change tools, such as goal setting and sleep diary entries, were more challenging, as these tools required computing programming expertise, which was unaffordable. While I did not possess funds to hire an expert programmer, Owen and I utilised already existing features of the website to meet our needs. For example, an already existing feature of the website included a 'feedback' tool, which we utilised as a tool for setting goals. While this approach was time-consuming and complex, it ensured that a cost-effective method was undertaken to meet users' needs, ensuring optimal functionality and compatibility. On reflection, however, an expert programmer would have been useful during the development phase of the intervention, as they could have personalised the intervention to optimally meet users' needs and improve the intervention's acceptability.

Chapter 1: Introductory Overview and Thesis Aims

The main aim of this PhD was to design, develop, and evaluate the feasibility of a digital sleep intervention aimed at adolescents. This introductory chapter presents a comprehensive overview of the literature regarding the importance of sleep for adolescents, its effects on health, and a scoping review of interventions targeting adolescent sleep. To begin, a review of the literature will discuss the relevance of sleep for adolescents, followed by its effect on adolescents' mental and physical health. An introduction to interventions aimed at adolescents and adolescent sleep will be discussed next, followed by the use of using theory within intervention development. A scoping review of the literature will then provide insight into interventions that specifically target adolescent sleep. Lastly, the aims and research questions of this PhD will be outlined.

Relevance of Sleep for Adolescents

Sleep is a state in which the body and the nervous system rest and recover (Chen et al., 2006; Spiegel et al., 2009). Sleep plays an important role in cognitive, psychological, and somatic processes, including emotion regulation (e.g., stress-related coping strategies) and metabolic, immune, cardiovascular, and respiratory functions that regulate the brain and body homeostasis (Gujar et al., 2011; Krueger et al., 2008; Nishida et al., 2008; Siegel, 2005, 2009; Tononi & Cirelli, 2006; van der Helm et al., 2010; Wagner et al., 2001).

Poor sleep quality among adolescents is an important public health problem (Office of Disease Prevention and Health Promotion, 2011; Owens & Adolescent Sleep Working Group, 2014; Roeser et al., 2012), as the scope of this problem appears to be significant. Recent findings from a meta-analysis and adolescent sleep survey show that 53% of adolescents gain less than 8 hours of sleep per night, and do not sleep for the recommended amount of 8-10 hours, especially on school nights (Blake et al., 2017a; Gradisar et al., 2011; Hirshkowitz et al., 2015; Keyes et al., 2015; National Sleep Foundation, 2011). Additionally, at least 36% of adolescents experience difficulty falling asleep, with 59% waking up feeling tired during the week (Blake et al., 2017a; Gradisar et al., 2011; Hirshkowitz et al., 2015; Keyes et al., 2015; National Sleep Foundation, 2011). A key innate reason for poor sleep during adolescence may be due to the changes that take place to adolescent's circadian and homeostatic mechanisms of sleep, as adolescence is associated with the lengthening of the endogenous circadian oscillator (the inner clock system that regulates the day-to-day, 24-hr rhythmic cycle), which can lead to later sleeping times (Brand et al., 2010; Carskadon et al., 2004; Colrain & Baker, 2011; Dahl & Lewin, 2002; Tarokh & Carskadon, 2010). Later sleep time is explained by the production of melatonin, a hormone released by the body in the evening in preparation for sleep, which is released later in the evening for adolescents, meaning that adolescents experience a delay in evening sleepiness, and thus sleep later in the evening and wake later in the morning (Blake et al., 2018; Carskadon, et al., 1993). This puts adolescents at greater risks of experiencing poor sleep, as

they are biologically inclined to sleep later, but required to wake early in the morning (e.g., for school), with little to no flexibility to change their sleeping hours (e.g., due to early school start times).

There are also several external contributing factors that could exacerbate poor sleep among adolescents (Gruber et al., 2014), including parental control, participation in extra-curricular activities, increased intake of caffeinated drinks, early school hours, and night-time media use (Gruber et al., 2014; Lang et al., 2016a; Maume, 2013; Owens et al., 2014; Perkinson-Gloor et al., 2013). Night-time media and its effects on poor sleep could be explained by exposure to artificial light, which is emitted from digital devices (Gruber et al., 2014; Lang et al., 2016a). While results from studies regarding the effects of television (Gaina et al., 2005), computer use (Gaina et al., 2005; Weaver et al., 2010), gaming (Weaver et al., 2010), mobile phone use (Yang et al., 2010) and internet use (Van den Bulck, 2004), have not consistently or entirely shown that all media outputs have negative effects on adolescents' bedtime, sleep duration or latency, or that such effect is large (Bartel et al., 2015), media usage and sleep among adolescents cannot be ignored. Evidence suggests that the use of electronic media is strongly associated with poor sleep in adolescents, and its effects on health may be mediated through the circadian hormone melatonin, which is suppressed by exogenous factors, particularly natural and artificial light (Gooley et al., 2011). While the relationship between light exposure and melatonin levels in adolescents is not well understood (Hersh et al., 2015), many electronic devices that adolescents use emit light that can suppress melatonin (Cajochen et al., 2011; West et al., 2011; Wood et al., 2013), which could, consequently, lead to later and poorer sleep among adolescents.

Other external factors that may encourage late night wakefulness include adolescents' attempts at becoming more independent from parental control (Gruber et al., 2014; Lang et al., 2016a; Maume, 2013; Owens et al., 2014; Perkinson-Gloor et al., 2013). Adolescence marks a reduction in control from parents, as adolescents attempt to become more independent and decide on their own sleeping times and leisure activities (Lang et al., 2016a,b), yet, adolescents whose bed-times are controlled by their parents, indicate longer hours of sleep (Randler et al., 2010; Short et al., 2011, 2013). However, factors such as an increase in hobbies and responsibilities, such as socialising and increased academic demands, often encourage late night wakefulness among adolescents (Maume, 2013), which parents may or may not have control over. Lastly, early school times is also an important contributing factor to poor sleep among adolescents, as it is strongly associated with having less or poor sleep in adolescents (Perkinson-Gloor et al., 2013). Although evidence suggests that delaying school start times by as little as 30 minutes (Owens et al., 2010) may improve mood and reduce fatigue, implementing changes to the school system is often an extensive process (Hersh

et al., 2015), thus understanding modifiable behavioural factors, such as reducing night-time light exposure, may present more immediate sleep and health benefits among adolescents.

While innate and external factors may contribute to poor sleep among adolescents, it is also important to acknowledge that adolescence (13-19 years) is a particularly susceptible developmental period, during which many biological and cognitive functions mature (e.g., changes in hormones, emotional and executive functions) (Brand & Kirov, 2011; Ernst et al., 2006; Romeo, 2010; Uhlhaas et al., 2009). These physiological changes that take place during adolescence make adolescents susceptible to mental health problems, such as depression and anxiety (Angst et al., 2010; Beesdo, et al., 2009), which can be exacerbated by sleep disturbances and poor sleep (Brand & Kirov, 2011). As well as mental health problems, poor sleep quality is also harmful to physical health, as it exacerbates low levels of physical activity, and unhealthy eating behaviours among adolescents, which could lead to poor health (e.g., obesity) in adulthood (Arora & Taheri, 2015; Tarokh, et al., 2010). To further understand the impact of poor sleep on adolescents' health outcomes, the effect of poor sleep on adolescents' mental and physical health is discussed below, followed by an introduction to interventions that are targeted at adolescents and adolescent sleep.

Mental and Physical Health and Sleep in Adolescents

Mental Health: Depression and Anxiety

Depression and suicidal ideation are closely associated with short sleep duration and later bedtimes in adolescents, with evidence indicating that sleep disturbances during adolescence may exacerbate and preserve several emotional and behaviour problems into later adulthood (Dahl & Harvey, 2007; Gangwisch et al., 2010). For example, adolescents who experience symptoms of depression also display high rates of sleep disturbances, likewise, those who report poorer sleep quality show higher rates of depression, highlighting the bidirectional association between sleep and depression (Chorney et al., 2008). The relationship between suicidal ideation and poor sleep in adolescents may be explained by the risk of suicide increasing during adolescence (Gould et al., 1996), and the effects of poor sleep interacting with multiple cognitive and emotional components to increase the risk of suicide (Brand & Kirov, 2011; Roberts et al., 2008). Additionally, chronic partial sleep deprivation is a potential risk factor for depression among adolescents, with cross-sectional studies indicating an association between inadequate sleep and higher levels of depression among adolescents (Dahl & Lewin, 2002). As may be expected, sleep disturbance in adolescents is one of the most common symptoms of adolescent depression (Goodyer et al., 2017; Orchard et al., 2017), and is associated with the severity of depressive episodes (Liu et al., 2007), as well as the risk of suicidal behaviour and self-harm (McCall et al., 2010; Singareddy et al., 2013).

Among UK adolescents specifically, research shows that 12.1%-17.8% of mental health variance is explained by sleep quality in a non-clinical cohort of older adolescents (Husted & Naylor,

2020). Non-restorative sleep (non-refreshing sleep; Wilkinson & Shapiro, 2013) and daily impact (sleep disturbances that cause distress or impairment to daily functioning; Bastien et al., 2001) also predict depression, anxiety and stress level, with poor sleep maintenance and early waking being associated with anxiety and stress respectively (Husted & Naylor, 2020). Moreover, another recent study, which derived data from a large longitudinal study of UK based adolescents, found that adolescents (aged 15) who experience depression, also experience problems with both sleep pattern and quality, and those with anxiety also report similar problems with sleep quality (Orchard et al., 2020). This study also demonstrated that several sleep variables (e.g., less total sleep) at age 15, predict the severity of anxiety and depressive symptoms and diagnoses of anxiety and depressive disturbances in later adolescence and early adulthood (Orchard et al., 2020). These findings suggest that sleep behaviours could provide an indication for early identification of poor mental health (Cukrowicz et al., 2009; Husted & Naylor, 2020), and evidence the need for early intervention to address sleep problems among adolescents, which, in turn, could have long-term mental health benefits (Orchard et al., 2020).

Physical Health: Physical Activity and Eating Behaviours

The World Health Organisation (WHO) (2010) recommends that adolescents gain 60 minutes of moderate to high intensity physical activity, including activities that strengthen muscles and bones, at least three times per week. According to the WHO (2010), physical activity for adolescents includes sports, physical education, or planned exercise (i.e., organised activity such as a sport club), which can be in the context of family, community, or school activities. However, physical activity is categorised as 'very low' among adolescents, as under 50% of adolescents meet the current physical activity guidelines (WHO, 2010, 2016). This is alarming, as physical inactivity is known to be harmful to health, being among the top five leading risk factors for global mortality (6% of deaths globally), and can result in increased risk of long-term adverse effects on body mass and related morbidity such as obesity (Beebe et al., 2013; Hogenkamp et al., 2013; Kruger et al., 2014). Research suggests that improving adolescents' sleep could in turn improve physical health (and vice versa) (e.g., Brand et al., 2010). This further highlights the need to implement healthy behaviours during adolescence, as gaining good sleep and taking part in regular physical activity can help towards improved wellbeing and psychological functioning among adolescents and through into adulthood (Biddle & Mutrie 2008; Faulkner & Taylor 2005; Paruthi et al., 2016).

While research suggests that improving sleep outcomes during adolescence could in turn help improve physical health (Brand et al., 2010), the association between physical activity and sleep is not clear. Research on physical activity and its effects on sleep among adolescents is limited by cross-sectional designs (Kalak et al., 2012; Lang et al., 2013), which cannot determine cause and effect and further limits understanding. Nevertheless, research shows that regular physical activity is

associated with enhanced psychological functioning (Pfeiffer et al., 2006; Stein et al., 2007) and leads to improvements in sleep quality among adolescents (Gerber et al., 2014; Kalak et al., 2012). For example, findings from Kalak et al. (2012) indicate that participants who took part in regular physical activity significantly improved sleep quality ($p < .05$) when compared to a non-physically active control group. In line with these findings, Brand et al. (2010) also found that weekly regular physical activity is associated with fewer awakenings after sleep onset ($r = -0.39, p < .05$), and with increased slow wave sleep ($r = 0.88, p < .001$). Findings from Brand et al.'s (2010) study also show that regular physical activity is associated with lower scores for depressive symptoms and somatosensory amplification (all r values $> -0.45, p < .01$), and with greater psychological curiosity ($r = 0.51, p < .01$), indicating improved psychological functioning.

In addition to the above, increased levels of physical activity also help predict subjective and objective improved sleep quality, as well as lower stress levels and sleep complaints among adolescents (Brand et al., 2010; Lang et al., 2013; Sigfusdottir et al., 2011). One explanation for the association between regular physical activity and improved sleep could be due to a 'dose-response relationship' between increased physical activity and slow wave sleep patterns. This relationship was demonstrated in Brand et al.'s (2010) study with adolescents, which showed that increased moderate physical activity is associated with increased slow wave sleep and decreased rapid eye movement (REM), indicating a deeper and more restful state of sleep. This suggests that moderate physical activity could help improve sleep quality. While there is some confusion regarding timing of physical activity before sleep, a recent systematic review revealed that exercising in the evening does not negatively affect sleep, but may impair sleep if performed vigorously an hour (or less) before sleep (Stutz et al., 2018).

In terms of adolescents' eating behaviours, more nutrients are needed during this critical developmental period, due to brain maturation and biological and psychological changes during puberty (Dahl & Lewin, 2002). As outlined by the Eatwell Guide, adolescents in the UK need to consume a healthy and varied diet (e.g., consume five portions of fruit and vegetables per day) to maintain sustained energy levels, a healthy weight, and lower the risk of chronic disease (e.g., heart disease, diabetes) (British Nutrition Foundation (BNF), 2016). However, according to the National Diet and Nutritional Survey (NDNS), 2014), adolescents in the UK are not meeting the recommended nutritional guidelines, as they indicate low intakes of dietary fibre, calcium, iron, vitamin A, zinc, and iodine, which could lead to nutrient deficiencies if not treated. The NDNS (2014) also indicates that adolescents have an intake of saturated fatty acids, salt, and added sugars above the recommended amount, which could lead to future adverse health problems such as cardiovascular disease, cancer, diabetes mellitus, obesity, and osteoporosis (Lytle & Kubik, 2003). This is problematic as health implications such as cardiovascular diseases and cancer are among the leading causes of morbidity

and mortality in the UK and present a significant burden to costs and health (Bhatnagar et al., 2015). This is alarming given that 34% of male and 39% of female adolescents in the UK are already overweight or obese (BNF, 2016), which could contribute to increased number of health problems in later adulthood.

Poor sleep can impact eating behaviours that contribute to negative health implications, such as obesity, as sleep deprived adolescents indicate poor appetite regulation and cravings for highly calorific foods (Garaulet et al., 2011; Weiss et al., 2010). Indeed, Beebe et al. (2013) found that sleep-deprived adolescents report being hungrier, consume larger portion sizes, and show higher intakes of calories from foods with a high glycaemic index, such as sweets and desserts. Insufficient sleep also increases vulnerability to overeating, which may be due to having more opportunities for eating when awake (e.g., night-time eating), and access to palatable foods (e.g., foods high in refined sugar) (Weiss et al., 2010).. In line with these findings, intake of foods with a high glycaemic index, such as sweets and desserts, as well as fast foods, repeatedly show negative associations with sleep duration in adolescents (Ferranti et al., 2016; Gong et al., 2017; Kruger et al., 2014). For example, Min et al. (2018) examined the relationship between sleep duration and quality and food consumption among adolescents and found that short sleep duration (<6 hours) was associated with higher intake of soft drinks and confectionaries when compared to long sleep duration (9+ hours) (for ≥ 5 times a week for soft drinks: Adjusted Odds Ratio (AOR) = 1.73 (95% Confidence intervals (CIs) = 1.57 to 1.91) and for confectionaries: AOR = 1.32 CI = 1.20 to 1.46; each $p < .001$). In addition, poor sleep quality was associated with a lower intake of fruits and vegetables (for ≥ 5 times a week for fruits: AOR= 0.71 (CIs = 0.65 to 0.77) and vegetables: AOR= 0.66 (CIs = 0.58 to 0.75); each $p < .001$). Similarly, Gong et al. (2017) found that longer sleep in adolescents was significantly associated with the increased probability of healthy eating behaviours, such as the consumption of fruits (AOR = 1.13, 95% CIs = 1.126 to 1.143; $p < .001$) and vegetables (AOR= 1.10, 95% CIs = 1.089 to 1.113; $p < .001$). The relationship between poor sleep and eating behaviour is best explained by changes in hormone regulation, as sleep loss is associated with higher circulation of the hormone ghrelin (an appetite stimulant) and lower levels of leptin (a satiety signal) (Benedict et al., 2011, 2012; Nedeltcheva et al., 2009; St-Onge et al., 2012; Taheri et al., 2004). For example, Spiegel et al. (2004) found that sleep restriction is strongly associated with lower levels of leptin (decrease by 18%; $p < .05$), elevation in ghrelin (increase by 28%; $p < .05$), and increased hunger (increase by 24%; $p < .01$) as well as appetite (increase by 23%; $p < .01$), especially for calorific foods with a high carbohydrate content (increase by 33% to 45%; $p < .05$). Consequently, these hormonal changes can lead to the stimulation of appetite, which can result in higher food intake and consumption of bigger portion sizes (Schmid et al., 2009; St-Onge et al., 2012).

The detrimental effects of poor sleep on adolescents' eating behaviours (e.g., consuming more calories from foods with a high glycaemic index), coupled with reduced physical activity and

energy expenditure, significantly heightens the risk for obesity and can lead to long-term adverse effects on dietary patterns, body mass and related morbidity, which risk continuation into adulthood (Beebe et al., 2013; Hogenkamp et al., 2013; Kruger et al., 2014). It is therefore important that the relationship between physical activity, eating behaviours and adolescent sleep is acknowledged when designing sleep interventions, as understanding this relationship helps develop targeted interventions that address sleep related behaviours that could directly or indirectly influence sleep and health outcomes.

Interventions for Adolescents and Adolescent Sleep

Given that poor sleep quality is detrimental to healthy functioning among adolescents (Roberts et al., 2009), it is vital to identify how best to intervene during this critical developmental period. In this section, an introduction to interventions aimed at adolescents and adolescent sleep will be discussed, before discussing the findings of a scoping review of interventions aimed at improving sleep among adolescents.

Research shows that sleep quality in adolescents can be improved through several non-pharmacological approaches (Blake et al., 2019), however, considerable challenges remain in maximising the impact of these interventions on health outcomes (Blake et al., 2019; Cassoff et al., 2014). For example, school-based education programmes indicate promising findings for improving sleep knowledge, but are less useful for improving sleep behaviour or mental health, as attainment of information is rarely enough in itself to change behaviour and/or guarantee positive sleep and health outcomes (Blunden et al., 2012; Blunden & Rigney, 2015; Gruber, 2017; Tobler, 2000).

In contrast to school-based education programmes, interventions that target specific behaviours (e.g., reducing screen time before sleep) have proven successful for improving sleep problems and behaviours among adolescents (Irish et al., 2015; Rohde, 2015). In support of this, several meta-analysis and systematic reviews have indicated that cognitive behaviour therapy (CBT) for sleep improves sleep and mental health outcomes in adults, with medium to large effect sizes (Ballesio et al., 2017; Taylor & Pruiksma, 2014; Trauer et al., 2015; Van Straten et al., 2017). CBT for sleep consists of information and behavioural techniques that target specific sleep behaviours, including information and instruction about stimulus control, relaxation techniques, and strategies to identify and overcome unhelpful cognitions and attitudes that contribute to poor sleep quality (Edinger & Means, 2005). Findings from a recent meta-analysis showed that CBT sleep interventions targeted at adolescents produced significant improvements in both objective and subjective sleep outcomes (Blake et al., 2017b). However, the interventions were limited by small sample sizes, lack of control groups, high dropout rates, and lack of follow-up data (Blake et al., 2017b). Further, interventions solely targeting sleep within adolescents are often reported (by users) as being

mundane, non-interactive, time-consuming, and are typically costly, and lack a strong theoretical foundation (Moran & Everhart, 2012; Yoong et al., 2016).

To overcome some of these limitations, researchers have strongly urged the trialling of digital sleep interventions among adolescents (Cassoff et al., 2014; Chung et al., 2014). Digital interventions can be an attractive method to involve and encourage adolescents in behaviour change, as they are cost-effective, easily accessible, can reach numerous individuals, and require limited human resources (Cummins et al., 2004; Gradisar & Richardson, 2015; Kohl et al., 2013; Spek et al., 2006). In support of this, evidence suggests that over 90% of adolescents in developed countries such as the UK have access to the internet, with digital interventions being the most effective and acceptable platform for intervention delivery among adolescents (Dobbins et al., 2009; Lau et al., 2011; Poushter, 2016; Straker et al., 2014). This may be due to adolescents viewing the internet as a trustworthy and reliable source of health information (Cassoff, et al., 2014). When given the choice, adolescents also choose to receive internet-based treatment over face-to-face, showing a clear preference for a more digitalised method of therapy (de Bruin et al., 2015). This may be explained, in part, by adolescents' disposition to not seek help for mental health related issues, due to stigma, and a preference to manage problems independently (Gulliver et al., 2010). In addition, digital interventions commonly include social support components in the form of social networking, which helps improve health outcomes and adherence among adolescent users (Condon & Coulson, 2017; Lakey et al., 2002; Richardson et al., 2010; Williams & Bond, 2002).

Digital interventions have shown success in improving adolescent behaviour change, including improvements in weight loss, eating behaviours, and physical activity levels (Aguilar-Martinez et al., 2014; Payne et al., 2015; Stephens & Allen, 2013). A recent meta-analysis found that the effects of digitalised CBT programmes for insomnia (eCBT-I) are similar to those for face-to-face, as results indicate improvements in insomnia severity, sleep efficiency, subjective sleep quality, wake after sleep onset, sleep onset latency, total sleep time, and number of nocturnal awakenings (Zachariae, et al., 2016). These effects were comparable to those found with face-to-face CBT-I programmes and were commonly maintained at 4-48 weeks follow-up (Zachariae et al., 2016). Similarly, in a more recent RCT study, de Bruin et al. (2018) concluded that internet and face-to-face CBT-I resulted in long-term improvements in adolescent affective and anxiety problems by reducing insomnia symptoms.

Despite the benefits associated with using digital interventions for adolescent behaviour change and sleep, it is important to note that electronic media and excessive exposure to light in the evening, also termed as screen-use, could negatively affect sleep regulation among adolescents (Gruber et al., 2014). A clear challenge for interventions is how to minimise this effect, without reducing the benefits associated with digital delivery. One way to do this is to provide supportive and evidence-based intervention features and recommendations to help adolescents regulate their use

of electronic media and sleep. This is more important if researchers are creating application (app) based interventions (e.g., Werner-Seidler et al., 2019), as research suggests that newer forms of media (such as smartphone apps) can have more detrimental effects on sleep among young people, given the interactive nature of mobile media and apps (Carter et al., 2016). While this PhD did not aim to develop a mobile phone app, evidence-based methods to help users manage excessive exposure to media were carefully considered during the design process of the intervention, including phone cut off points prior to sleep (Bartel et al., 2018) and dimming of colour temperature and brightness of screens (Czeisler et al., 1989) (discussed further in Chapters 2 and 3).

While some researchers have responded to poor adolescent health by developing digital health interventions (e.g., Grech & Allman-Farinelli, 2015), digital interventions targeted specifically at adolescent sleep have received little attention, as only one recent digitalised CBT-I intervention (a smartphone app called 'Sleep Ninja') has investigated the feasibility, acceptability, and preliminary effects of a smartphone application among Australian adolescents experiencing mild insomnia. Findings from this pilot study showed that the app was acceptable and feasible (i.e., successful ease of use, amount learnt, usefulness, changed behaviour), with exploratory effect size analysis indicating improvements in insomnia, sleep quality, depression and anxiety (Werner-Seidler et al., 2019). These findings suggest that a digital sleep behaviour change intervention can be an effective, acceptable, easily accessible, and cost-effective method to intervention delivery among adolescents and thus warrants further attention.

Using Theory in Digital Sleep Interventions

According to meta-analysis and systematic review findings, current sleep interventions targeted at adolescents commonly lack a strong theoretical foundation (Moran & Everhart, 2012; Yoong et al., 2016). Theory is an important aspect of successful intervention development, as applying theory to behaviour change interventions provides a useful framework for defining and predicting variables that could influence health behaviours and outcomes (Mohr et al., 2014). In this sense, theory helps understand the mechanisms of action (mediators) and moderators of change and hypothesises about how an individual may behave, and what may influence their behaviour.

A theory-based approach is advocated by the UK Medical Research Council's guidance for developing and evaluating complex interventions for several reasons (Campbell et al., 2000, 2007; Craig et al., 2008; Glanz & Bishop, 2010). Firstly, predictors of behaviour and the determinants of change can be identified and targeted by the intervention and appropriate intervention components and behaviour change techniques (BCTs) can be determined, refined and tailored (Michie et al., 2008; Michie & Prestwich, 2010; Rothman, 2004). Second, theoretical moderators can help understand how the intervention brings about its desired effect (Michie & Abraham, 2004; Rothman, 2004, 2009). This helps researchers identify whether interventions that have not achieved desired

outcomes have not done so because the intervention had no effect on the hypothesised mediators, or due to the hypothesised (and successfully influenced) mediators showing no effect on behaviour (Davis et al., 2015; Michie & Abraham, 2004; Rothman, 2004, 2009). Third, theory encapsulates the collective knowledge regarding how behaviour change occurs across different populations, behaviours, and contexts (Davis et al., 2015), which could help target the intervention more accurately at its intended users. Fourth, interventions that apply theory to development provide an opportunity for theories to be tested, and thus aid the development of more useful theories, which, in turn, could help towards intervention optimisation (Michie et al., 2008; Rothman, 2004). Lastly, application of theory and evidence-based BCTs (e.g., self-monitoring, real-time feedback, goal setting) allow replication of interventions, shared language amongst researchers, and help optimally design interventions and understand how different components work together or independently to effect intervention and health outcomes (Dennison et al., 2013; Martin et al., 2013; Michie et al., 2014).

While it is not feasible to cover all theories and models within the scope of this introduction, some of the most recognised and widely applied models and theories of behaviour change to intervention development in UK health psychology are discussed below. These theories and models have been used extensively to address many health behaviours, including physical activity, smoking cessation, and eating behaviours, and can be combined with research evidence and user view to design behaviour change interventions (Conner & Norman, 2017; Heath et al., 2015).

The Transtheoretical Model (Stages of Change) (Prochaska & DiClemente, 1983)

The transtheoretical model (TTM) focuses on the decision-making progress of individuals and is a motivational model of intentional change (Prochaska & DiClemente, 1983). TTM proposes that individuals move through six stages of change and assumes that individuals face certain types of barriers to behaviour change within each stage (LaMorte, 2019). These stages include the pre-contemplation (the individual does not intend to take action), contemplation (the individual intends to start the desired behaviour), preparation (the individual is ready to take small steps towards the desired behaviour), action (the individual intends to keep moving forward with their behaviour change), maintenance (the individual has sustained their behaviour for more than 6 months and intends to maintain it going forward), and termination stage (the individual has no desire to return to their past behaviour and is certain that they will not relapse).

Intervention developers apply this theory to their interventions by tailoring their intervention to a certain stage of behaviour change, such as interventions targeted at weight loss (Riebe et al., 2005) and smoking cessation (Cabezas et al., 2011). Specific to sleep behaviours, the TTM has been applied to sleep interventions to understand participants' level of motivation to change sleep behaviour, as they move through the various stages of change (Cain et al., 2011). However, the TMM

has been criticised for a lack of evidence supporting the existence of the six stages (De Nooijer et al., 2005), and for having arbitrary lines between each stage of change, with no set criteria of how to determine an individual's stage of change (LaMorte, 2019). Lastly, the model assumes that individuals make rational plans in the decision-making process, which is not always the case (LaMorte, 2019) as, for example, individuals may face unprecedented barriers and challenges, or simply change their mind (De Nooijer et al., 2005).

Social Cognitive Theory (Bandura, 1991)

Social cognitive theory (SCT) proposes that individuals learn behaviour in a social context, and behavioural outcomes are determined by the reciprocal influence between personal factors, behavioural, and environmental factors (Bandura, 2002). Personal factors include attitude, knowledge, and outcome expectations from performing a certain behaviour, which is an important factor for predicting behaviour (Ogden, 2012). Behavioural factors consist of an individual's skills, practice, and self-efficacy to perform a given behaviour. Self-efficacy is a key component of the SCT, as it refers to individuals' perceived ability to carry out a certain behaviour (Ogden, 2012; Williams & French, 2011). Environmental factors refer to individuals' representation of their social environment and how this factor can influence their behaviour (Ogden 2012). The SCT suggests that outcome expectations, self-efficacy, and the environment are crucial to forming intentions and through intention carrying out a behaviour (Bandura, 2002). Assessing variables based on the SCT could help intervention developers decide whether an intervention is likely to change behaviour, as these variables may act as precursors to behaviour change. SCT variables could also be used as a proxy for behaviour change in studies which are not able to have long-term follow-ups. In regard to sleep, interventions aimed at improving sleep disorders have applied the SCT to intervention development by predominantly basing intervention components on SCT variables (increased perceived self-efficacy, outcome expectations, and social support), including components such as relaxation techniques, goal setting, and addressing unhelpful sleep-related thoughts (Bartlett et al., 2013; Richards et al., 2007).

While a breadth of research provides evidence for the existence of the SCT's theoretical variables (e.g., see Jackson et al., 2020), the SCT has been criticised for not considering outcome expectations about future outcomes as being a causal determinant of self-efficacy beliefs (William & Rhodes, 2016). Also, the SCT diminishes the importance of the direct effect of the social environment on human behaviour (unmediated by self-efficacy), as well as factors other than self-efficacy (e.g., autonomy) that could explain the effect of the social environment on behaviour (Beauchampa et al., 2019).

The Theory of Planned Behaviour (Ajzen, 1991)

The theory of planned behaviour (TPB) (Ajzen, 1991) is an extension of the theory of reasoned action (Fishbein & Ajzen, 1975) and predicts that an individual's intention to engage in a desired behaviour depends on the intention and ability of an individual. In short, the TPB proposes that voluntary human behaviour is inclined by the intention to perform the given behaviour and perceived behavioural control (PBC) over the behaviour (Sniehotta et al., 2014). Intention is theorised to be a function of attitudes towards the desired behaviour, and the subjective norms associated with, and perceived behavioural control over, the behaviour. The influence of PBC on the behaviour directly (instead of indirectly through intention) is thought to depend on actual control over the behaviour (Sniehotta et al., 2014). Researchers have applied the TPB in research that aims to understand sleep hygiene behaviour among young people, with findings indicating that subjective norm is the strongest predictor of intention, suggesting the importance of normative influence in sleep hygiene behaviour among young people (Kor & Mullan, 2010).

While variables such as intention and subjective norm from the TPB are reliable predictors of sleep hygiene and behaviour change (Kor & Mullan, 2010; McEachan et al., 2011), the TPB has been criticised heavily for a number of reasons. Firstly, the TPB has been criticised for its assumption and focus on rational thinking and reasoning, excluding the role of unconscious influences (such as bias) and emotional outcomes on human behaviour (Conner et al., 2013; Sheeran et al., 2013). Second, the static nature of the TPB does not account for the effect of behaviour on cognition and future behaviour (McEachan et al., 2011; Sutton, 1994). Third, research has indicated conflicting findings with the assumptions of the TPB (e.g., null relationships between variables hypothesised to be highly associated) (Ogden, 2003). Fourth, the TPB has been criticised for its limited predictive validity, with the majority of variance in observed behaviour not explained by variables from the TPB (Sniehotta et al., 2014). Lastly, a systematic review found 24 studies that applied the TPB during intervention development and/or evaluation and established that their findings were unsatisfactory to ensuring a strong conclusion regarding the usefulness of the TPB (Hardeman et al., 2002).

Self-Determination Theory (Deci & Ryan, 2012)

Self-determination theory (SDT) is an empirical theory of human motivation and behaviour in social contexts that differentiates motivation in terms of being autonomous and controlled (Deci & Ryan, 2012). According to Deci and Ryan (2012), humans have three basic needs: competency (i.e., individual's feelings of efficacy to carry out behaviour), autonomy (to carry out behaviour), and (social) relatedness (i.e., support provided by peers, professionals and/or parents), which are strongly related to positive health outcomes (e.g., see Ng et al., 2012 for a review). The SDT suggests that more intrinsic motivation (i.e., engagement in activity due to inherent satisfaction) is strongly related to individuals' behaviours (Deci & Ryan, 2012), and that high levels of perceived competency

and autonomy often lead to intrinsically motivated behaviour, whilst relatedness acts as an additional factor for intrinsic motivation. The SDT believes that behaviour change would be more successful if people are intrinsically motivated, i.e., wanting to change due to an internal drive rather than external pressures (Deci & Ryan, 2012).

Effective interventions that apply the SDT to development aim to encourage individual's basic needs. For example, effective interventions aim to promote perceived autonomy to changing behaviour by encouraging participants to set their own goals or choose their own schedule for receiving reminders (Dennison et al., 2013). This could help participants feel in control of their own choices over their use of interventions and behaviour change. Perceived competency might be promoted by positively framed tailored feedback based on progress towards an individual's personal goal, which could help encourage perceived mastery of the desired behaviour (Morrison, 2015). Relatedness could be promoted by helping individuals feel supported, for example, by implementing intervention tools that ensure that the individual feels understood and listened to (Morrison, 2015). For example, components from the STD could be applied to interventions to help adolescents experience competency, autonomy, and social relatedness over their sleep behaviours (e.g., Vollmer et al., 2014).

Given the SDT's focus on autonomy, its application to intervention development may be ideal for interventions aimed at adolescents, as adolescents actively seek and work towards gaining autonomy (e.g., autonomy over sleep and leisure activities; Lang et al., 2016a,b). Whilst this theory could be useful for application in interventions aimed at adolescents, the SDT may not be sufficiently comprehensive on its own and might need an additional approach to understanding adolescents more directly and on a personal level (e.g., via user feedback). Additionally, some researchers argue that the SDT is not applicable cross-culturally, as, for example, it is argued that 'autonomy' is not a universal psychological need, and that collectivistic Eastern cultures do not value experiencing autonomy the same as individualistic Western cultures (Jang et al., 2009; Markus & Kitayama, 2003). However, Jang et al. (2009) argue that the SDT is cross-culturally relevant, as it puts universal (i.e., cross-cultural) needs at the centre of its explanatory model and therefore allows generalisability. Jang et al. (2009) further argue that valuing collectivistic principles (e.g., harmony) does not equate to under-valuing principles that are shared in more individualistic cultures, such as autonomy, and that collectivistic cultures could also benefit from having their autonomy supported (e.g., see Chirkov et al., 2003).

Dual Process Theories (Strack & Deutsch, 2004)

Many theories have an underlying assumption that individuals consciously and critically observe the pros and cons of a desired behaviour and thus plan how to change behaviour toward a more favourable and desired behaviour. However, research shows that unconscious influences such

as implicit attitudes and motivations, and past behaviour, need to be accounted for in newer theories of behaviour change (Ouellette & Wood, 1998; Sniehotta et al., 2014). Dual processing theories contrast reflective processes, such as conscious awareness about self-efficacy, with sub-conscious impulsive processes based on implicit associations (Strack & Deutsch, 2004). Research shows that implicit thoughts and attitudes (e.g., attentional bias) can influence behaviour (Sheeran et al., 2013). For example, in a study by Calitri et al. (2010), researches controlled for factors such as physical activity, stress, and emotional eating among students who showed attentional bias towards healthy foods, and showed that these students indicated a larger reduction in body mass scores one year later. Interventions have also shown to change behaviour by teaching participants to re-learn attentional bias to threatening or maladaptive stimuli, which does not necessarily translate from an experimental setting to the real world (Jones et al., 2018). Research suggests that non-conscious processes could help understand health-related behaviour change (Hollands et al., 2016). For example, Papies (2016) suggests that intervention developers could use tools such as implicit health goal priming to initiate behaviour change. The application of health goal primes consists of identifying a motivated target group and activating their specific reasons to perusing a certain goal, while using effective cues to attract attention at the decision point (Papies, 2016). Papies (2016) proposes that this principle can be extended to various health-related behaviours, including sleep behaviours.

Although research shows that short-term behaviour can be changed by re-association, there is little evidence to show how long this shift in implicit processes can last for, in terms of maintenance of behaviour change, or their implementation in the real world. Additionally, researchers have criticised dual-process theories as having multiple and vague definitions (Churchland, 2002), and lack adequate empirical evidence (Keren & Schul, 2009). However, Evans and Stanovich (2013) argue that critics wrongly classify dual process theories as one category, and that recent scientific research, which supports dual-processing theories, does exist (for a thorough review, see Evans & Stanovich, 2013).

Theoretical Domains Framework

The theories discussed so far demonstrate strengths but also criticism and limitations. Indeed, research by Michie et al. (2005), synthesising 33 different theories of behaviour, found that there is an overlap between constructs proposed to predict behaviour across different behaviour change theories, and brought together fundamental constructs from existing models into 14 different domains (Michie et al., 2005). This synthesis aimed to provide a means to explain cognitive, social, environmental, and affective perspectives to better understand behaviour, and help with the implementation of behaviour change interventions (Atkins et al., 2017). This framework has been applied to inform the systematic development of a range of health interventions (Atkin et al., 2017),

and a simpler representation has been formed as the behaviour change wheel (BCW) model (Michie et al., 2011). This model is a psychological model of human behaviour and includes psychological components to explain human behaviour. The BCW is often used in intervention development to help characterise interventions and will be discussed in more depth in Chapter 2 of this thesis.

The Person-Based Approach to Intervention Development

In contrast to the theories referred to earlier, the Person-Based Approach (PBA) proposes a method to support the application of theory and evidence to intervention design, and puts an understanding of user perception and experience at the core of the development process (Yardley et al., 2015a). This is achieved through collecting extensive feedback from target users and modifying the intervention based on feedback during the development phase of a digital intervention (Yardley et al., 2015a). The PBA helps developers gain in-depth insight into target users' experience and implementation of an intervention, which ensures that the intervention is acceptable, engaging, and helps improve adherence (Yardley et al., 2015a).

The PBA involves using mixed methods research to systematically investigate the beliefs, attitudes, needs and situation of the people who will use the intervention. Mixed methods research refers to using both qualitative and quantitative methods to explore a certain topic, and has become increasingly common in recent years (Dures et al., 2011; Östlund, et al., 2011; Tashakkori & Teddlie, 2011), including in health psychology research (e.g., Dures et al., 2011). Using a mixed methods approach as part of the PBA is an informative, complete, and balanced methodological approach, as it is pragmatic and practice-orientated, and can help gain detailed understanding of user perspective (Johnson, 2009; Johnson et al., 2007). A mixed methods approach further enables intervention developers to design or modify their intervention to make it relevant, persuasive, accessible, and engaging to users (Yardley et al., 2015a).

The PBA has been widely used within many behaviour change interventions, such as public health interventions (e.g., managing weight and stress, promoting physical activity) and illness-management interventions (e.g., dizziness, hypertension), with evidence showing that these interventions are successful and effective in changing behaviour and improving health outcomes (Little et al., 2013; Yardley et al., 2015a). While the focus of the PBA might be on intervention planning and development, it is also a relevant approach to apply at later stages of intervention research, to evaluate and further optimise the intervention.

Thus far, it is clear that digital interventions offer an attractive, feasible, and effective means to health management, including the management of sleep behaviours among adolescents (e.g., see Werner-Seidler et al., 2019). However, interventions aimed at adolescent are often limited by lacking a strong theoretical foundation, being mundane, non-interactive, time-consuming, costly, and include short follow-ups (Moran & Everhart, 2012; Yoong et al., 2016). Therefore, to thoroughly examine effective interventions that address adolescent sleep, and which apply psychological theory

as part of intervention development, a scoping review was carried out, which later informed the design and development of a digital sleep intervention targeted at adolescents (discussed later in this chapter).

Scoping Review

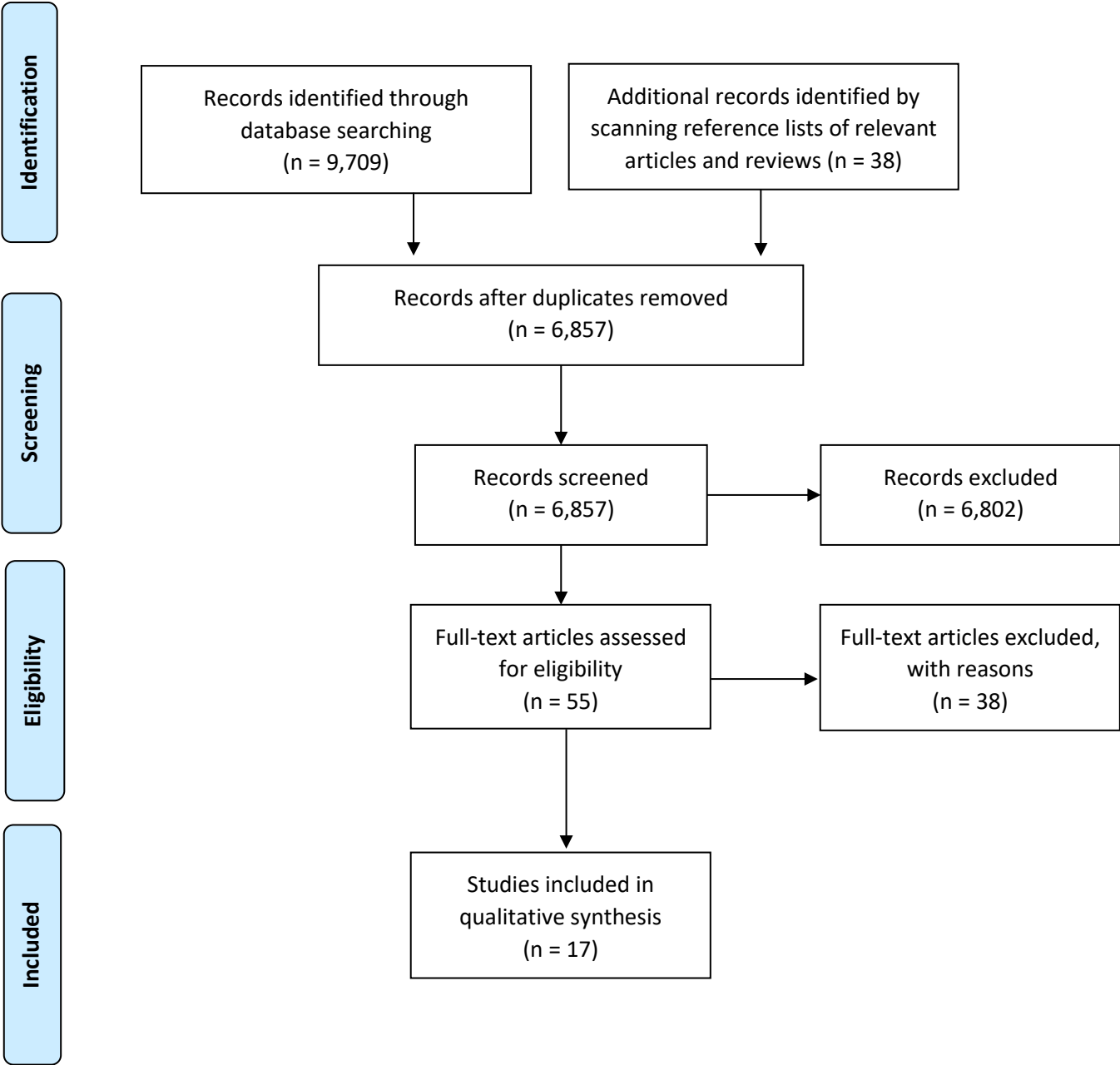
Methods

This review aimed to answer the following question: “What (non-pharmacological) interventions currently address adolescent sleep quality and use psychological theory?” The following databases were searched from the years (January) 1983 to (June-September) 2018: MEDLINE, PsycINFO, CINHALL, AMED, eBook Collection, and OpenDissertations. See Figure 1.1 for a PRISMA flow diagram of study data collection. Title and abstracts were searched using the following search terms: (ADOLESCEN* OR TEENAGERS OR YOUNG ADULTS) AND (SLEEP QUALITY). The inclusion criteria included studies whose participants were both male and female aged 13 to 19 years, with no pre-existing physical and/or mental health conditions, which was important as the intended intervention was targeted at adolescents with no existing or pre-existing mental or physical health conditions. Studies that did not include sleep quality or sleep related outcomes, or were pharmacological in nature, were excluded. Correlational study designs were excluded, as causation, and thus likely effectiveness, could not be ascertained from these study designs. Publication type included peer reviewed articles and dissertations/theses. Review papers were also included if within the last five years, as recent findings best help demonstrate current knowledge (Winchester & Salj, 2016). Refer to Appendix A for a summary of the inclusion and exclusion criteria.

The interventions that were identified in the selected studies were diverse and the research was heterogeneous; therefore, a narrative synthesis of the results was conducted. Overall, the analysis undertaken identified 17 papers for inclusion. Reasons for exclusion are presented in Appendix B. The number of papers identified, included, and excluded are presented in Figure 1.1, and the extraction of evidence-based studies are presented in Table 1.1.

Figure 1.1

PRISMA Flow Diagram of Study Selection



Note. Screening review was based on abstracts.

Table 1.1						
<i>Extraction of Evidence-Based Studies</i>						
First Author (Year)	Design	Successful and/or Facilitating Intervention Components	Use of Theory or Framework	Sleep Measure/s	Other Outcomes	Results/Findings
Baldursdottir et al. (2017)	Intervention vs control (RCT)	<ul style="list-style-type: none"> A pedometer and diary based physical activity intervention 	No clear use of theory	Subjective sleep quality using four individual items (sleep onset latency, nightly awakenings, sleep quality, and sleep sufficiency)	Daily weekday steps using Yamax CW-701 device	<p>Successful intervention:</p> <p>The intervention group had significantly higher average step-count compared to the control group post-intervention. Subjective sleep quality improved over time in the intervention group but not in the control group.</p>
Blake et al. (2017)	Systematic Review and Meta-analysis	<p>Successful interventions included:</p> <ul style="list-style-type: none"> Cognitive behavioural sleep interventions that are short-term, multicomponent, goal-oriented psychotherapeutic treatments Aim to modify the patterns of thinking and behaviour that may be underlying sleep disturbance, such as poor sleep hygiene, 	Cognitive-behaviour therapy framework	<p>Main sleep outcomes: subjective (sleep diary/questionnaire) and objective (actigraphy) total sleep time (TST), sleep onset latency (SOL), sleep efficiency (SE), and wake after sleep onset (WASO)</p> <p>Secondary sleep outcomes included global sleep quality and daytime sleepiness (see</p>	Depression and anxiety (see text for various scales used)	<p>There were a small number of randomized controlled trials and a high risk of bias across the RCTs; therefore, within sleep condition meta-analyses were examined.</p> <p>Across interventions, subjective TST improved by 29.47 min, SOL by 21.44 min , SE by 5.34% ,</p>

		<p>irregular sleep–wake schedules, delayed bedtimes, pre-sleep hyperarousal, and maladaptive sleep related cognitions</p> <ul style="list-style-type: none"> • Mindfulness, anxiety and depressive specific components within interventions 		Blake et al., 2017 for measures used)		<p>and WASO by a medium effect size.</p> <p>Objective SOL improved by 16.15 min, and SE by 2.82%. Global sleep quality, daytime sleepiness, depression, and anxiety also improved.</p> <p>Gains were generally maintained over time (ranging from 2-12 months).</p> <p>Preliminary evidence suggests that adolescent cognitive–behavioural sleep interventions are effective, but further high-quality RCTs are needed.</p>
Bonnar et al. (2015)	Intervention(s) vs control (RCT)	<p>Evaluated school-based motivational sleep education programs (SEPs) with adjunct bright light therapy (BLT) and/or parental involvement (PI): SEP = 4 x 50 minute classes (over 4 weeks) based on Cain et al.'s (2011) intervention.</p> <p>Conditions included:</p>	Motivational interviewing framework	<p>Sleep knowledge using a quiz adapted from Cain et al. (2011)</p> <p>Sleep patterns (typical bedtime, light-out time, sleep onset latency, total sleep time, wake-time and out of bedtime)</p>	<p>Depression using the Short Mood and Feelings Questionnaire</p> <p>Motivation using the Behavioural Intentions Questionnaire</p>	<p>Successful intervention:</p> <p>Improvements in sleep knowledge, sleep onset latency and mood were observed in all intervention groups.</p> <p>Increased motivation to regularise out of bed-</p>

		SEP + BLT SEP + PI SEP + BLT + PI				<p>times, obtain morning bright light (for those in bright light therapy groups), and avoid sleeping-in on weekends occurred.</p> <p>Similar improvements were observed in a sub-group of participants identified as having delayed sleep time.</p>
Cain et al. (2011)	Intervention vs control (RCT)	<ul style="list-style-type: none"> • 4 x 50 minute classes (over 4 weeks) adapted from Moseley and Gradisar (2009) but tailored to fit a Motivational Interviewing framework • Lessons included: psychoeducation to raise adolescents' awareness of sleep health, decisional balance sheets and role-plays to raise ambivalence and motivate adolescents towards changing their behaviour, a behavioural experiment to engage adolescents in changing their sleep behaviours, and discussion on maintaining healthy sleep behaviours and relapse prevention 	Motivational Interviewing framework/ mention of transtheoretical model (TTM) of change but not clear if or how it was used within the intervention	<p>Sleep patterns using a Sleep Patterns Questionnaire</p> <p>Daytime sleepiness using the Paediatric Daytime Sleepiness Scale</p> <p>Sleep knowledge using an adapted quiz from Moseley and Gradisar (2009)</p>	<p>Depression using the depression subscale of the Depression Anxiety Stress Scale-21</p> <p>Motivation using the Behavioural Intentions Questionnaire developed by Moseley and Gradisar (2009)</p>	<p>Partially successful:</p> <p>Significant increases in participants' knowledge. Improvement in motivation to regularise out of bed-times and a trend towards improved motivation to increase average total sleep time.</p> <p>Despite improvements in sleep and daytime functioning for adolescents in the programme group, these changes were not significantly different from the control group.</p>

Moseley et al. (2009)	Intervention vs control (RCT)	<ul style="list-style-type: none"> • 4 x 50 minute classes (administered at schools) across a 4-week period • Classes included information about wellbeing and a healthy lifestyle, outlining behavioural and cognitive strategies that students were encouraged to implement to improve their general wellbeing • Goal setting in order to maintain gains beyond the programme • Sleep related components included instruction on: adolescent sleep needs and practices, consequences of poor sleep practices, good sleep hygiene practices, regularisation of sleep/wake schedule and early morning bright light exposure, stimulus control, and sleep-compatible cognitive and behavioural strategies 	Cognitive-behaviour therapy framework	<p>Sleep patterns using a Sleep Patterns Questionnaire as used by Gradisar et al. (2008)</p> <p>Daytime sleepiness using the Paediatric Daytime Sleepiness Scale</p> <p>Sleep knowledge using a brief 25-item quiz to assess wellbeing knowledge (included 13 items assessing sleep knowledge). Statements were judged as either true or false or don't know</p>	<p>Depression and anxiety using the Depression Anxiety Stress Scale (short form)</p> <p>Intentions using the Behaviour Intentions Questionnaire based on the five stages of change in the TTM of change</p>	<p>Partially successful:</p> <p>The programme increased sleep knowledge; however, analyses revealed no significant effects on target sleep variables as compared. For delayed sleep timing adolescents, there was a significant interaction for reducing the discrepancy between school and weekend out of bed-times.</p> <p>There was no impact on other sleep parameters or depressed mood.</p>
Chung et al. (2017)	Systematic review and meta-analysis	<ul style="list-style-type: none"> • The most common intervention format was 4 weekly x 50 minute sessions consisting of information about sleep 	One study used a Motivational interviewing framework	Sleep hygiene, sleep knowledge, sleep onset latency, sleep pattern, sleep problems, time in	Behaviour intentions questionnaire, co-education, depression anxiety stress scale,	Seven studies were included, involving 1876 students receiving sleep education programme

		knowledge, weekend sleep behaviour, and sleep hygiene	(Bonnar et al., 2015)	bed, total sleep time, wake up time	education, general health questionnaire	<p>and 2483 attending classes-as-usual.</p> <p>Four weekly 50-minute sleep education classes were most commonly provided.</p> <p>Methodological quality was only moderate, with a high or an uncertain risk of bias in several domains.</p> <p>Compared to classes-as-usual, sleep education programmes produced significantly longer weekday and weekend total sleep time and better mood among students at immediate post-treatment, but the improvements were not maintained at follow-up.</p>
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Vollmer et al. (2014)	Intervention vs control (unclear if randomly assigned)	<ul style="list-style-type: none"> • Short sleep educational programmes (1.5h each) on sleep (delivered in a school setting). The intervention covered physiological facts about sleep, morningness-eveningness, and good sleep practice • Teachers started the lessons with reading parts of a book or listening to a play, followed by a plenary discussion, work in small groups, learning circuits (or workstations, and a concluding plenary discussion. Pupils worked together in groups of 3-4. 	Self-determination theory	Cognitive achievement in sleep knowledge using 6 items, knowledge about good sleep practices using 10 items, and intended/actual sleep practices using 10 items (as adapted from LeBourgeois et al., 2005)	Chronotype using Composite Scale of Morningness (CSM),	Partially successful: Participant's theoretical sleep knowledge and knowledge about good sleep practices improved. However, their actual sleep practices only improved in a short-term period and then became worse.
Kalak et al. (2012)	Intervention vs control (RCT)	<ul style="list-style-type: none"> • As part of a running intervention, consisting of 3 consecutive weeks, during the 5 school days per week, participants met every morning at 7 AM at school • Participants went running for between 30 and 37 minutes. Running was cross-country; after two laps on the school's running track, running continued in the forest close to school. 	No clear use of theory	Daily sleep using a sleep log to log sleep and mood. In the evenings, participants answered questions on an 8-point visual analogue scale about sleepiness during the day, concentration and mood at bedtime. In the mornings, questions asked about sleep quality and mood on awakening Objective Sleep Electroencephalographic	Perceived stress using the Perceived Stress Scale Coping with stress using an 18-item questionnaire assessing positive and negative coping strategies Somatosensory amplification using the Somatosensory Amplification Scale Curiosity and exploratory behaviour using the	Successful intervention: Objective sleep (slow-wave sleep increased; sleep onset latency decreased) improved in the running group compared with the control group. Subjective sleep quality, mood, and concentration during the day improved, whereas sleepiness during the day decreased.

				(EEG) recordings using a sleep EEG device Subjective assessment of sleep using the Insomnia Severity Index	Curiosity and Exploration Inventory	
Wing et al. (2015)	Intervention vs control (RCT)	<ul style="list-style-type: none"> • A set of structured educational materials including leaflets, brochures, and access to a self-developed sleep educational website were offered to all participants, teachers, and parents to enhance participants' accessibility to the sleep knowledge and information – education material included information on the importance of sleep, the consequences of sleep deprivation, factors contributing to insufficient sleep, and good sleep practice • A slogan design competition was also held during the intervention period • Participants were asked to create a slogan, with the goal of raising awareness regarding the importance 	No clear use of theory	<p>Sleep issues (e.g., sleep-wake pattern) using the General Sleep Questionnaire (HKCSQ)</p> <p>Sleep duration calculated as the difference between wakeup time and bedtime. An additional question was added to understand participants' perception about whether they had adequate sleep</p> <p>Daytime sleepiness using the Paediatric Daytime Sleepiness Scale</p> <p>Sleep knowledge using the Chinese version of the Sleep Knowledge Questionnaire</p> <p>Sleep quality using information from, for example, sleep latency</p>	<p>Emotional problems, conduct problems, peer relationships, hyperactivity/inattention, and pro-social behaviours using the Strengths and Difficulties Questionnaire</p> <p>Caffeine beverage and energy drink intake and smoking and alcohol habits using the General Sleep Questionnaire</p>	<p>Partially successful:</p> <p>The intervention group significantly improved sleep knowledge. Weekday sleep duration was reduced in both control and intervention groups, but the significant difference in weekday sleep duration was lost in the intention-to-treat analysis.</p> <p>In addition, the intervention group had a lower incidence of consuming caffeine containing energy drinks and had better behavioural and mental health outcomes.</p>

		<p>of sleep and healthy sleep practices</p> <ul style="list-style-type: none"> • Parents and teachers were separately invited to attend a 1-hour sleep education seminar 		and insomnia symptoms (HKCSQ)		
Sousa et al. (2013)	Intervention vs control (unclear if randomly assigned)	<p>Sleep education programme held during five meetings (across 5 days) during usual school class time:</p> <ul style="list-style-type: none"> • 1st day: the day-to-day of adolescents: A slide presentation was prepared, based on data collected in by the health and sleep questionnaire, demonstrating the most frequent sleep patterns and habits of students in the intervention group • 2nd day: Why am I so tired during the day? The researcher recorded on cardboard the number of students who reported to exhibit one of the following problems: sleepiness, tiredness, memorisation difficulties, concentration difficulties and bad mood. This activity helped students recognise the 	Ausubel's learning theory	<p>Subjective sleep quality using a sleep diary</p> <p>Sleep knowledge and habits using the Health and Sleep Questionnaire</p> <p>Sleep-wake cycle assessed by the sleep diary</p> <p>Sleepiness using the Karolinska Sleepiness Scale</p>	Chronotypes using the Horne and Otsbeg Questionnaire, adapted for a Brazilian population	<p>Partially successful:</p> <p>Increased percentage of correct responses in 63% of the sleep knowledge questions.</p> <p>On weekdays, participants increased time in bed by 26 min, woke up 11 min later and showed a tendency to go to bed 18 min earlier.</p> <p>On weekends, participants advanced bedtime and wake up times.</p> <p>These changes were associated with decreased irregularity at bedtimes and wake up times (these results were not observed in the control group, except the</p>

		<p>consequences related to sleep deprivation, such as the high incidence of daytime sleepiness</p> <ul style="list-style-type: none"> • 3rd day: Discovering sleep: In this activity, prepared in the form of a dialogic lesson, the nature, characterisation and functions of sleep, daily sleep needs and individual differences in sleep times were discussed • 4th day: Discussing doubts: This day was set aside for students to discuss any doubts that may have arisen in the previous activities • 5th day: “Measures of sleep hygiene” contest: To consolidate the discussion and evaluate learning, a “measures of sleep hygiene” contest was held 				<p>advance on wake up time on weekends).</p> <p>The frequency and duration of naps and daytime sleepiness levels did not differ.</p>
Gruber (2017)	Review	<p>Successful interventions:</p> <ul style="list-style-type: none"> • Developed a strategy for adapting an intervention to the needs/situation of the target audience 	Emphasis on a knowledge-to-action framework	Sleep habits, sleep knowledge, daytime sleepiness, sleep duration, sleep (wake) patterns, sleep beliefs, sleep hygiene, morning-eveningness, sleep duration, intended/actual	Psychomotor performance, mood motivation, depression, anxiety, behavioural intention to change sleep behaviour, chronotype, daytime behaviour	N/A

		<ul style="list-style-type: none"> • Tailored the intervention to the developmental needs of the participants • Incorporated feedback from the knowledge users • Adapted the transferred information to the users' initial level of knowledge <p>Facilitators for successful intervention components: Engaging; tailoring knowledge to participant's daily life, interactive nature</p> <p>Barriers: boring, time consuming, non-interactive, insufficient information, insufficient parental involvement, difficult to understand, difficulty engaging teacher, scepticism from school head teachers, inadequate knowledge of sleep benefits by school staff, sleep not compatible with school curriculum, ceiling effect on student's sleep knowledge measure, high dropout rate, not addressing beliefs, habits and norms regarding sleep, programme duration too short, mixed view on objective vs</p>		<p>sleep practices, insomnia symptoms, sleep efficacy</p>		
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		subjective measures as both were barriers				
Zelic (2018, PhD Thesis)	Intervention vs control (RCT)	<ul style="list-style-type: none"> • Provided participants with an mp3 player that contained a recording of mindfulness-based exercises based on Kabat-Zinn's (1990) Mindfulness-Based Stress Reduction (MBSR) programme • Participants were instructed to listen to the mindfulness-based relaxation exercise prior to sleep each evening for six nights • The length of the exercise was approximately four minutes. Instructions in the mindful relaxation exercise encouraged breathing awareness and to instruct thoughts and feelings to "come and go" 	No use of theory	<p>Sleep quality using The Pittsburgh Sleep Quality Index and The Adolescent Sleep-Wake Scale</p> <p>Objectively measured sleep through actigraphy for the total duration of the seven days</p> <p>Subjectively measured sleep using an online sleep diary to complete daily questionnaires at night before sleep and upon waking in the morning</p>	<p>Depression using the Centre for Epidemiological Studies Depression Scale</p> <p>Anxiety using The Screen for Child Anxiety Related Disorders</p> <p>Affect using the Positive and Negative Affect Scale-Expanded Form</p> <p>Rumination using The Response Style Questionnaire Rumination Scale</p> <p>Worry using The Penn State Worry Questionnaire</p> <p>Mindfulness using The Five-Facet Mindfulness Questionnaire</p> <p>Perception of extracurricular activities using the Measure of Perceived Overscheduling</p>	<p>Not successful:</p> <p>No significant differences were found between the mindfulness and control conditions on any objective or subjective sleep indices including sleep efficiency, sleep duration, sleep time, sleep onset latency, number of awakenings, feeling rested, and sleep quality.</p> <p>Differences were not significant for the immediate effects model or the growth effects model across all sleep indices.</p>

John et al. (2016)	Intervention vs control (Pilot RCT)	<ul style="list-style-type: none"> • A 2-week sleep promotion programme consisting of three components designed to be delivered in a classroom setting • The programme consisted of a sleep hygiene education session, including a 50-minute educational session, followed by two sessions of visualization or imagery training, carried out as video based progressive sessions for stress reduction and relaxation, and a short session consisting of tips for time management 	No use of theory	<p>Sleep using a sleep questionnaire consisting of questions on sleep and activity (e.g., average sleep duration on weekdays and weekends, problems at home or other factors affecting sleep, and engagement in the activities other than studies such as sports, music, games etc)</p> <p>Sleep hygiene using the Sleep Hygiene Index</p> <p>Sleep Quality using the Pittsburgh Sleep Quality Index</p> <p>Sleepiness using the Cleveland Adolescent Sleepiness Questionnaire</p>	Anxiety, sadness, anger, worry, fatigue and pain using the Present Functioning Visual Analogue Scale	<p>Partially successful:</p> <p>The programme revealed a significant effect in overall sleep quality, sleep onset latency, sleep duration, daytime sleepiness, and emotional and overall distress.</p> <p>No significant effect was observed in sleep hygiene and other sleep parameters. All target variables showed significant correlations with each other.</p>
Brown et al. (2006)	Intervention vs control (RCT)	<ul style="list-style-type: none"> • Sleep Treatment and Education Programme for Students (STEPS) included a one-off 30-minute oral presentation and handouts that included sleep hygiene guidelines, stimulus control instructions, and information about substances with caffeine 	No use of theory	<p>Sleep quality using Pittsburgh Sleep Quality Index (PSQI)</p> <p>Sleep hygiene using The Sleep Hygiene Awareness and Practices Scale (SHAPS)</p>	None	<p>Successful intervention:</p> <p>Participants in the treatment group reported significantly improved sleep quality and sleep hygiene behaviours at 6 weeks post-treatment.</p>

		<ul style="list-style-type: none"> The oral presentation was a script that was read verbatim to groups of college students It began by explaining the purpose of STEPS, followed by a brief summary describing the impact sleep difficulties can have on mood and academic performance. The script then reviewed the Sleep Hygiene Guidelines, Substances with Caffeine, and Stimulus Control Instructions handouts 		Sleep habits using The Sleep Habits Survey (SHS)		
Paavonen et al. (2016)	Pre-post design (no control group)	<p>The intervention consisted of seven steps:</p> <ol style="list-style-type: none"> 1. Estimate the average acquired sleep on the basis of the sleep log 2. Discuss the potential symptoms of sleep deprivation the participant may have 3. Discuss and estimate the adolescents' sleep need 4. Discuss his or her circadian preference 5. Discuss the regularity of the rhythms and its impact on sleep quality 	No use of theory	Sleep difficulties using a self-administered screening questionnaire for sleeping difficulties in adolescents. The questionnaire consisted of 12 items which measured the frequency of sleeping difficulties, daytime tiredness and attention problems, regularity of sleep-wake rhythms, sleep quality, and sleep duration separately during weekdays and weekends	<p>Daily stress using the Perceived Stress Scale</p> <p>Anxiety using the State-Trait Anxiety Inventory</p> <p>Caffeine exposure measured by questioning the consumption of coffee, tea, and various kinds of soft drinks</p> <p>Depression using the Finnish modification of the short form of the Beck Depression Inventory</p>	<p>Partially successful:</p> <p>Improvements were observed on self-reported and actiwatch-registered sleep duration, self-reported sleep quality and sleep latency, perceived stress and anxiety. However, objectively measured sleep efficiency and sleep latency did not change.</p>

		<p>6. Find a regular sleep-wake rhythm that reflects the adolescent's sleep need and circadian preference</p> <p>7. Discuss the participant-reported factors that can impair sleep quality (caffeine, alcohol, rigorous exercise, media exposure, lack of bedtime routines, stress/anxiety/depression)</p> <ul style="list-style-type: none"> • The intervention was carried out in a school setting at the beginning of the second study week • The session took approximately 30–45 min • The intervention was tailored on the basis of a sleep log and the time 1 questionnaire that the adolescents had filled in prior to the intervention session • The time 1 questionnaire was developed to recognise risk factors for sleeping difficulties (such as irregular rhythms, evening chronotype, alcohol or caffeine use, depression or stress) 		<p>Sleep-wake patterns using the Munich Chronotype Questionnaire</p> <p>Sleep Quality using actiwatches (wristwatch devices that monitor and record body movement)</p> <p>Daytime tiredness using the Epworth Sleepiness Scale</p> <p>Insomnia using the Athens Insomnia Scale</p>	<p>Alcohol consumption using the Alcohol Use Disorders Identification Test</p> <p>Circadian preference in daily activities using the Morningness–Eveningness Questionnaire</p>	
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		<ul style="list-style-type: none"> • The intervention was individually delivered by a trained school psychologist, a school social worker, or a medical doctor • The interventionists were trained by a medical doctor (the principal investigator of the study) who is specialized in treating sleep problems in children and adolescents 				
Bei et al. (2013)	Pre-post design (no control group)	<p>Six session programme (based on Bootzin & Stevens, 2005).</p> <p>Each 90-min session followed a two-part format:</p> <ul style="list-style-type: none"> • The first part (50–60 min) began with a sleep-fact quiz and, from session 3, a breath-awareness mindfulness exercise, followed by weekly content • The second part (20 min) consisted of guided mindfulness practice • Sessions ended with debriefing and concluding comments from the facilitators 	Cognitive-behavioural principles and mindfulness based cognitive therapy	<p>Objective sleep using Actigraphy</p> <p>Subjective sleep using the Pittsburgh Sleep Quality Index (PSQI)</p>	<p>Psychopathology using Spence Children’s Anxiety Scale (SCAS) and Schedule of Affective Disorders and Schizophrenia Children’s Version (K-SADS)</p> <p>Acceptability using Participant feedback within 2 weeks of programme completion, and the perceived usefulness and benefits of the programme (assessed on a 7-point scale, 1 = ‘not helpful at all’ to 7= ‘very helpful’)</p> <p>Information on the frequency and duration of</p>	<p>Successful intervention:</p> <p>The programme demonstrated high acceptability, with a completion rate of 90%. Based on effect-size analysis, participants showed significant improvement on objective sleep onset latency (SOL), sleep efficiency and total sleep time; actigraphy data also showed significantly earlier bedtime, rise time and smaller day-to-day bedtime variation.</p> <p>Post-intervention global PSQI scores were</p>

		<ul style="list-style-type: none"> Participants were given weekly home tasks. Apart from session-specific content, all home tasks from session 2 onwards included personalised goals based on sleep scheduling, and encouragement of daily mindfulness practice 			mindfulness practice was also collected as part of participant feedback	<p>significantly lower than that of pre-intervention, with significant improvement in subjective SOL, sleep quality and sleep related daytime dysfunction.</p> <p>There were small improvements on some subscales of the SCAS, but change on its total score was minimal.</p>
Moran (2014, PhD thesis)	Pre-post design pilot study (no control group)	<ul style="list-style-type: none"> 4-week group school-based intervention called SIESTA (School-based Intervention to Establish Sleep Skills Tailored to Adolescents) aimed at improving sleep habits, sleep duration, and daytime sleepiness among adolescents Participants attended four 75-minute group sessions on a weekly basis for 4 weeks at school SIESTA followed a Treatment Manual, which was approximately 20 pages and included four sessions of material to support psychoeducation 	Intervention utilised techniques from CBT-I frameworks and motivational interviewing	<p>Sleep quality using the Adolescent Sleep Wake Scale (ASWS)</p> <p>Daytime sleepiness using Pediatric Daytime Sleepiness Scale (PDSS)</p> <p>Sleep duration, quality of sleep, and napping duration, using a sleep log (participants were asked to keep daily sleep logs for 2 weeks prior to the first session of the intervention to obtain baseline data, and for 2 weeks immediately after treatment was complete, to obtain change in sleep</p>	<p>Adolescent egocentrism using the Imaginary Audience Scale (IAS)</p> <p>Personal fable using The New Personal Fable Scale (new PF scale)</p> <p>Preferred timing of activities (e.g., bedtime, rising time) using the Morningness-Eveningness Scale-Children</p> <p>Depression, anxiety and stress using the Depression Anxiety Stress Scale-21 item</p>	<p>Successful intervention:</p> <p>Intervention participants showed a significant improvement in daytime sleepiness and increase in school-night sleep duration.</p> <p>They also demonstrated a significant improvement in reaction time and processing speed after the intervention.</p> <p>There was a large, positive correlation between estimated intelligence and increase</p>

		<p>during each session, guide activities, prompt reflection on educational topics and personal feelings, and included space for directed self-monitoring and goal setting</p> <ul style="list-style-type: none"> • Much of the information was supported by visual presentation, such as visual mood and sleepiness ratings, and included attractive illustrations appropriate for adolescents 		<p>duration and sleep patterns)</p>	<p>Group cohesion using the Group Cohesion Questionnaire</p> <p>General intellectual ability using the Wechsler Abbreviated Scale for Intelligence</p> <p>Digit modality using the Symbol Digit Modalities Test</p> <p>Psychomotor vigilance using the Psychomotor Vigilance Test</p>	<p>in sleep duration across the intervention.</p>
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Notes. RCT= Randomized controlled trial; MI= Motivational interviewing; CBT= Cognitive behavioural therapy; CBT-I= Cognitive behavioural therapy for insomnia.

Results

Included Papers

Findings from the selected studies in this review showed that intervention components that were identified as successful, or partially successful (i.e., improved some but not all sleep outcomes), consisted of: regular physical activity, such as running for 30 minutes on weekdays, information about sleep hygiene and consequences of poor sleep, information about stimulus control, cognitive strategies to overcome sleep problems, sleep education tailored to adolescents (e.g., user friendly language), mindfulness exercises, homework tasks, parental involvement, bright light therapy, information about risk factors for sleep difficulties, and goal setting activities (Baldursdottir, et al., 2017; Bei et al., 2013; Blake et al., 2017b; Brown et al., 2006; John et al., 2016; Kalak et al., 2012; Moran, 2014; Paavonen et al., 2016; Zelic, 2018) (see Table 1.1 above for full details of components identified). The success of these intervention components could be due to educating and promoting an active approach to behaviour change. For example, encouraging users to actively regulate their sleep behaviours (e.g., reducing screen time) by engaging in problem solving and action planning activities. This approach may have helped users overcome sleep barriers as it is often more effective at changing sleep behaviour when compared to solely educating users about sleep (Irish et al., 2015).

Among successful interventions, cognitive behaviour therapy (CBT) was commonly used to deliver interventions. Cognitive behavioural sleep interventions are often short-term, multicomponent, and goal-oriented psychotherapeutic treatments (Blake et al., 2017b). They aim to challenge and change thinking patterns and behaviours that may lead to underlying sleep disturbances, such as poor sleep hygiene, irregular sleep-wake patterns, pre-sleep hyperarousal, and dysfunctional sleep related cognitions and behaviours (Blake et al., 2017b). Components of CBT sleep interventions include sleep hygiene advice (e.g., psychoeducation about healthy sleep behaviours), stimulus control (e.g., behavioural instructions aimed at reducing arousal), sleep restriction to improve homeostatic sleep drive, relaxation techniques, and cognitive therapy aimed at addressing negative thought processes (Blake et al., 2017b).

CBT is one of the most common strategies for addressing sleep difficulties among adolescents (Aloia et al., 2004; Chung et al., 2017; Martins & McNeil, 2009). However, unlike the adult literature, research on adolescent cognitive-behaviour sleep interventions is limited and studies on such interventions are often restricted by the lack of control groups, short follow-ups, a lack of applying a strong theoretical foundation, and importantly, exclusion of adolescent feedback as part of intervention development (Moran & Everhart, 2012; Yoong et al., 2016). As information regarding adolescents' views on or experiences with the identified interventions in this review were scarce, a firm conclusion regarding why or how these interventions were successful for this age group could not be confidently ascertained. However, to help overcome this barrier, studies that provided adolescent feedback, but did not meet the inclusion criteria, are discussed later in this chapter

(under the heading 'Relevant Supplementary Papers'), which helped gain insight into user experience with similar sleep interventions.

In terms of theory, while some studies in this review applied theory to intervention development or delivery, the majority did not (see Table 1.1). This is in line with previous research indicating that the use of theory to inform interventions supporting adolescent health is often limited or overlooked (Schmied & Tully, 2009). Only three studies from the 17 identified studies attempted to apply theory to intervention development or delivery. Firstly, Vollmer et al. (2014) applied Deci and Ryan's Self-Determination Theory (2012) to help participants experience competency, autonomy and social relatedness over their learning experience of sleep behaviours.

The intervention in Vollmer et al.'s (2014) study was partially successful, as participants' sleep knowledge improved, but their actual sleep behaviour only improved in the short term (see Table 1.1 for further details). Secondly, Sousa et al. (2013) evaluated the effectiveness of a 5-day sleep education programme targeted at adolescents, using Ausubel's Learning Theory (Iviev, 1998), an approach to teaching higher order thinking skills. Although this theory was not aimed at predicting health behaviour, findings from this study showed that the sleep programme increased sleep knowledge and contributed to positive changes in adolescents' sleep wake-cycle. However, daytime sleepiness remained unchanged, which authors believed was due to the lack of reduction in sleep deprivation among participants (Sousa et al., 2013). The third example comes from Cain et al. (2011), who applied motivational interviewing (MI) principles to delivering a sleep education intervention, while measuring intention to change behaviour using the transtheoretical model of change (TTM) (Prochaska & DiClemente, 1982). Cain et al. (2011) believed that the TTM had the potential to help understand participants' motivation to change sleep behaviours, as they moved through various stages of change towards a desired behaviour. Cain et al.'s (2011) intervention was partially successful, as participants showed an increase in sleep knowledge, but despite improvements in sleep and daytime function, these changes were not significantly different from the control group.

Overall, the partial success of these interventions could be due to the common finding that psychoeducational interventions on their own improve participants' knowledge about sleep but are less effective at improving actual sleep behaviour (Blake et al., 2017a). While adolescents may acknowledge the importance of sleep behaviour change (e.g., regulating sleep times; Moseley & Gradisar, 2009), they may not feel confident or motivated to implement these changes (Bonnar et al., 2015). This highlights the importance of gaining user feedback and understanding user perspective when developing sleep interventions, as this could help understand adolescents' level of motivation, and barriers and limitations, to engaging with sleep interventions and behaviour change.

To better understand adolescents' motivation to changing sleep behaviour, Deci and Ryan's (2012) SDT could be applied to interventions in order to demonstrate precursors and/or factors that contribute to adolescent's levels of motivation. The SDT suggests that more intrinsic motivation (i.e.,

engagement in activity due to inherent satisfaction) is strongly related to individuals' behaviour (Deci & Ryan, 2012), and that high levels of perceived competency and autonomy often lead to intrinsically motivated behaviour, whilst relatedness acts as an additional factor for intrinsic motivation. As the SDT accounts for motivation and relatedness, this theory could help support adolescents' drive to act in pursuit of important values when they are shared with their peers (Bryan et al., 2016; Crone & Dahl, 2012). While findings from Vollmer et al.'s (2014) study indicated no improvement in sleep practice, due to methodological limitations and the short length of their intervention (see Vollmer et al., 2014), constructs from the SDT could facilitate successful sleep behaviour change among adolescents (Deci & Ryan, 2000). One way intervention developers could apply the SDT to facilitate sleep behaviour change is through targeting constructs from the SDT during the design process of interventions (Davids et al., 2017). For example, motivational barriers that prohibit the development of healthy sleep behaviours, such as the benefits and enjoyable experiences associated with later sleep times (e.g., watching television, social media use, and playing computer games), could be addressed by targeting users' autonomy, competency and/or relatedness to overcome such barriers (e.g., through autonomy-supportive language, goal setting activities etc) (discussed and exemplified in Chapter 2) (Cassoff et al., 2013).

Two main problems exist with the limited studies that applied theory or framework in this review. Firstly, theory or framework was applied to either deliver an adapted version of a previously developed intervention, or to explain or describe participants' level of motivation and/or stages of learning (e.g., Cain et al., 2011). These methods of applying theory to intervention development could be problematic, as, when a strong theoretical foundation is not applied during intervention development (e.g., use of evidence-based techniques), interventionists may lack insight into precursors of behaviour change, shared language among researchers, and the replication of study findings (Dennison et al., 2013; Martin et al., 2013; Michie et al., 2014).

Secondly, using theory on its own does not account for the complexity of adolescent behaviour change. This is because current and well-known health psychology theories, like those described earlier in this chapter, are mostly aimed at adults and are static and therefore do not consider relevant behavioural, biological, psychological, and contextual issues impacting health-related behaviours during adolescence. This is challenging, as adolescence is a dynamic period of development, whereby several factors influence and shape adolescents' ability and readiness to engage in behaviour change. Coupled with this is adolescent's susceptibility to situational emotional and social influences (e.g., peer influences) (Fuhrmann et al., 2015). The problem arises when a theory or framework does not address or recognise the complex interaction of factors that contribute to behavioural choices and actions of adolescents, and acknowledge that the quality and influence of these factors change over time. As well, adolescence is a period whereby adolescents

learn to assert their growing independence (e.g., decide on their own leisure activities and bedtimes; Lang et al., 2016a), yet they may also remain dependent on their parents, peers, and social structures to support their behaviours and needs (e.g., financially). In acknowledging these complexities and understanding their variance across different individuals, intervention developers could seek feedback from their target users, as this could help align the intervention with adolescents' specific needs, values, and priorities.

Relevant Supplementary Papers

As mentioned earlier, on inspection of the studies identified, three additional papers were selected for review, as they included adolescent feedback about using (or the hypothetical use of) sleep interventions. These studies also contained information about common barriers and facilitators that adolescents face when attempting to change sleep behaviour.

The first supplementary paper (Werner-Seidler et al., 2017) adopted a cognitive-behavioural approach to developing a mobile phone (game-based) application (app) for improving sleep behaviours among adolescents. Though this study did not meet the inclusion criteria (refer to Appendix B for reasons), it gained user feedback about the app, and found that adolescents were most interested in sleep information that was personalised to their age group, inclusion of useful sleeping tips (e.g., relaxation techniques), and information about teenagers' body clock. Results also showed that adolescents were attracted to elements of game playing and highly valued flexibility of use, which could be due to the fact that adolescents lead busy lifestyles and want more independence over their leisure activities (Lang et al., 2016a). Adolescents also reported that they found consistent reminders about sleep/wake patterns irritating and felt that trusting intervention developers was important to engaging with the app, as this may add credibility to information and advice provided. Therefore, it might be useful for intervention developers to include, for example, a 'meet the team/about us' page as part of their intervention, to help build trust and credibility between users and the intervention. Lastly, Werner-Seidler et al.'s (2017) findings also showed that, while some adolescents showed interest in using an accelerometer to track sleep, some were concerned about having accelerometers (embedded in their mobile phone) under their pillow, as it could be uncomfortable. Some participants reported that they were not allowed a mobile phone overnight (due to parental control over child's mobile phone usage), and therefore would not be able to use the accelerometer to track sleep.

In terms of aesthetics, findings from Werner-Seidler et al. (2017) showed that adolescents wanted the app to be aesthetically attractive, easily navigable, and free of charge. It is important to highlight that Werner-Seidler et al. (2017) developed a sleep app and not a web-based intervention, and therefore the two modalities (i.e., website vs app) may differ in levels of functionality and visual compatibility (e.g., mobile based short-cuts, push notifications). Werner-Seidler et al.'s (2017) findings were however useful for understanding intervention features that adolescents found

acceptable – for example, game playing, which could be implemented as a means to intervention delivery, as using gamification in non-gaming contexts is a successful method for improving user experience and engagement (Deterding et al., 2011).

The second supplementary paper, by Blunden and Rigney (2015), reviewed sleep education programmes targeting sleep knowledge, hygiene, and patterns. Blunden and Rigney (2015) outlined the ‘Do’s and Don’ts’ of sleep education programmes aimed at adolescents and identified key areas for improvement. According to Blunden and Rigney (2015), sleep interventions should not exclude parents, or dismiss community, cultural, and societal factors. Furthermore, interventions should not rely on didactic methods of delivery alone, expect behaviour change through the use of information alone, or ignore participant feedback and adopt a one-size-fits-all strategy (Blunden & Rigney, 2015). Suggested facilitators (Do’s) included interactive and engaging content, incorporation of behaviour change theory when designing and developing interventions, teacher engagement (ensure training), and the involvement of parents, peers, and the education setting (Blunden & Rigney, 2015). These findings are in line with the studies identified in this review, as interventions that were identified as successful included interactive features, tailored and modified information, and the use of non-didactic methods of delivery (Brown et al., 2006; Gruber, 2017; John et al., 2016; Lang et al., 2016a,b; Moran, 2014; Sousa et al., 2013; Wing et al., 2015). Blunden and Rigney’s (2015) findings can help ensure that the identified barriers from their study are not repeated in the development of newer sleep interventions for adolescents.

The third supplementary paper, by Paterson et al. (2017), explored adolescents’ barriers to sleep behaviour change. Findings from this study indicated that time constraints, technology use (e.g., social media, sense of “missing out”), struggle switching off (due to worries associated with workload and employment), and unpredictable habits, particularly eating foods high in carbohydrates and sugar before sleep, were common barriers to implementing healthy sleep behaviours among adolescents. These barriers were present even when participants were willing to change sleep behaviours (including changes to waking function, sleep onset, and improvements in sleep habits) (Paterson et al., 2017). Findings from this study are in line with the notion that adolescents may be aware of the consequences of their health behaviours, yet barriers and other priorities may compete for their attention (Basset et al., 2008). Findings from Paterson et al.’s (2017) study could ensure that barriers to sleep behaviour change are addressed in future interventions, for example, by developing intervention tools that help reduce arousal before sleep (e.g., mindfulness exercises).

Overview of Findings

Overall, findings from this scoping review indicate that sleep education, parental involvement, interactive intervention components, content tailored to adolescents, practical solutions (e.g., bright light exposure), and addressing adolescents’ needs, context, values, and

barriers to sleep behaviour change are essential for successful behaviour change and/or improved sleep outcomes among adolescents. These findings suggest that active sleep interventions that incorporate CBT and/or motivational principles (e.g., problem solving, goal setting), with a strong theoretical foundation, demonstrate more effectiveness than those that are not targeted or simply educational in nature (Blake et al., 2017b).

Identifying how to support behaviour change among adolescents, and align interventions with competing priorities and adolescents' values and needs, still remains an important barrier to overcome. Research recommends that future adolescent sleep interventions should combine digital platforms with a more personalised and systematic methodological approach to treating sleep problems among adolescents, and that the feasibility of such interventions are evaluated before proceeding to a main trial, as this helps reduce research waste and time (Blake et al., 2019; Blatch-Jones et al., 2018; Cassoff et al., 2013; Eldridge et al., 2016).

Research Aims and Questions

Given the problem of poor sleep among adolescents, its negative effects on their mental and physical health, and the shortcomings of current research, the overall aim of this PhD was to overcome the limitations of previous adolescent sleep interventions, by designing, developing, and evaluating a digital sleep intervention using the Person-Based Approach (PBA) to intervention development (Yardley et al., 2015a). The PBA has not been previously applied to developing a digital sleep intervention targeted at adolescent users, which makes this PhD the first to apply this approach to designing, developing, and evaluating a digital sleep intervention for adolescents.

Three studies were undertaken to achieve the overall aim of this PhD. The first study (Chapter 2) involved the design of a prototype digital sleep intervention (a website called SleepWise) aimed at adolescents, and answered the following research question: "How can the PBA be applied to designing a digital sleep intervention targeted at adolescents?". The second study (Chapter 3) undertook the optimisation of the prototype digital sleep intervention, based on an iterative approach between gaining feedback from target users and subsequently making modifications to the intervention. Study 2 answered the following research questions: "Do target users think that the prototype intervention is acceptable, feasible, accessible, persuasive, motivating, and crucially likely to change sleep behaviour?" and "What are target users' barriers/facilitators to engagement with the prototype intervention?". In the final study (Chapter 4), two 2-arm randomised controlled feasibility trials were undertaken to investigate the feasibility of the optimised intervention. An embedded process evaluation was also carried out to investigate intervention usage and perception of user experience with the intervention. Questions regarding the acceptability and feasibility of recruitment (e.g., uptake, attrition), study procedures (e.g., randomisation, incentivisation), and trial outcomes (e.g., exploratory effect size), were answered.

In this thesis, a pragmatic approach to combining the qualitative and quantitative findings was undertaken. Pragmatism suggests that methods most useful and appropriate to addressing a research question, or most practical for explaining a particular phenomenon, should be implemented (Creswell, 2003; Morgan, 2007; Yardley & Bishop, 2007). Throughout this PhD, both quantitative and qualitative data were collected and analysed separately, and integrated to answer key research questions. By using this paradigm, neither qualitative nor quantitative research were viewed as superior, instead, the methods which best matched the research questions were undertaken (Creswell, 2003; e.g., see Bradbury et al., 2015).

Conclusion

In sum, this chapter indicated that poor sleep is a growing concern among adolescents. Current interventions targeting sleep among adolescents are often limited by being non-interactive, time-consuming, costly, include short follow-ups, and lack a strong theoretical foundation (Moran, & Everhart, 2012; Yoong et al., 2016). Additionally, research recommends that digital platforms should be combined with a more personalised and systematic methodological approach to treating sleep problems among adolescents. The feasibility of such interventions should also be evaluated before proceeding to a main trial, to reduce research waste and time (Blake et al., 2019; Blatch-Jones et al., 2018; Cassoff et al., 2013; Eldridge et al., 2016). Due to the breadth of mental and physical health problems resulting from poor sleep among adolescents, and the need for more innovative and methodologically sound interventions, this PhD aimed to overcome the shortcomings of previous research by designing, developing, and evaluating the feasibility of a digital sleep intervention, using the PBA to intervention development (Yardley et al., 2015a). The next chapter of this thesis presents the first study, which undertook the design process of the prototype digital sleep intervention.

Chapter 2: Designing a Digital Sleep Intervention Targeted at Adolescents using the Person-Based Approach (PBA) to Intervention Development (Study 1)

This chapter presents the first study of this PhD, which aimed to design a prototype digital sleep intervention aimed at adolescents, using the Person-Based Approach (PBA) to intervention development (Yardley et al., 2015a). As part of this study, a digital prototype intervention (called SleepWise) was designed on an open-source content management system (WordPress). Through this study, the following research question was addressed: “How can the Person-Based Approach be applied to designing a digital sleep intervention targeted at adolescents?”. This chapter will firstly discuss the PBA methodology to intervention development and provide an overview of the design process. This will be followed by undertaking each step of the design process and the creation of a web-based prototype intervention.

Person-Based Approach to Intervention Development

The PBA is embedded within the discipline of health psychology and intended for application to health-related behaviour change interventions (Yardley et al., 2015a). The biopsychosocial (BPS) model is the main theoretical perspective of health psychology, and was adopted by this PhD, as the BPS aims to understand individuals’ subjective experiences of a health issue/management (e.g., sleep) by understanding their unique biological, psychological, and social dimensions when thinking about treatment (Borrell-Carrio et al., 2004; Engel, 1981). As briefly discussed in Chapter 1, the PBA proposes a systematic method to understand users’ perceptions and experiences of an intervention, which is achieved through collecting extensive feedback from target users and modifying the intervention based on their feedback (Yardley et al., 2015a). Further, the PBA aims to understand users’ subjective experiences of both the target behaviour and the intervention, which are vital to developing targeted interventions for improved health outcomes (Yardley et al., 2015a). Therefore, the PBA is a useful method to optimise interventions and ensure that they are as acceptable as possible, and encourage engagement and implementation of the intervention and its behaviour techniques (Yardley et al., 2015a).

Theory and evidence-based interventions are recommended by best practice guidelines for developing complex interventions (Craig et al., 2013). Theory-based interventions are useful for predicting various influences on health behaviours (e.g., screening uptake) (Mohr et al., 2014), however, they do not have an effective method for choosing which behaviour change techniques should be used in particular contexts (Yardley et al., 2015a). The PBA overcomes this barrier, as it adopts a systematic approach to intervention development, which includes gaining feedback from target users. This helps intervention developers understand behaviour change techniques that are most feasible to users. The PBA is not designed to replace theory and evidence-based methods to intervention development, but to complement these approaches by adopting a person, theory and

evidence-based framework (Yardley et al., 2015a). Lastly, the PBA is a useful approach to addressing low adherence and improve acceptability of an intervention, as this approach includes the opinions of its target users as part of intervention development, while retaining all the important components that theory and evidence suggest as being effective in maximising behaviour change (Bradbury et al., 2018; Yardley et al., 2015a). Specific to this PhD, the PBA works particularly well for the development of a digital sleep intervention targeted at adolescents, as the PBA is rooted in understanding users' subjective experiences, and emphasises the importance of user autonomy, which is in line with adolescents' attempts at becoming more independent and autonomous in their choices and behaviours (Dobbins et al., 2009; Lang et al., 2016a; Poushter, 2016).

Design Process of a Prototype Digital Sleep Intervention using the PBA

The steps in the PBA may be undertaken iteratively, simultaneously, or in a different order, and are not compulsory or always possible to undertake for every intervention (Yardley et al., 2015b). In this thesis, the following process was followed:

The first recommended step in a PBA methodology is the examination of relevant theory and evidence from previous studies. As such, the intervention design process in this study was based on the results from the scoping review in Chapter 1, which synthesised previous studies of adolescents' experiences of sleep interventions, identifying specific objectives that the intervention must address. These specific objectives are referred to as the intervention's guiding principles, which address important behavioural needs and challenges identified from the scoping review, and help identify key features of the intervention that address each objective. At this stage, qualitative research can also be carried out to elicit user views on the planned behaviour changes (Yardley et al., 2015). However, as this process was time-intensive (6-9 months; Yardley et al., 2015) and did not fit within the time scope of this PhD, it was not implemented, instead the activities described above were undertaken, which helped identify key behavioural issues, needs, and challenges that the intervention must address (discussed further in Chapter 5).

After guiding principles and key intervention features were identified, theoretical modelling was undertaken to help map behaviour change techniques to theory and framework (i.e., behaviour determinants), referred to as a causal model. A logic model was then created to bring together the mechanisms of action, i.e., how the intervention was thought to bring about behaviour change and desired health outcomes. On completion of these activities, a prototype version of the intervention was created.

In relation to this thesis, the prototype intervention's guiding principles, causal model, and logic model were undertaken in consecutive order, and the results of each step in this process is presented below with examples provided from the prototype website.

Intervention’s Guiding Principles

A summary of the guiding principles can be found in Table 2.1.

Table 2.1

Guiding Principles for Intervention Development

Intervention Guiding Principle	Key Intervention Features
1) To ensure that content and delivery of the intervention is fun and engaging for adolescent users	<ul style="list-style-type: none"> • Focus on creating fun and engaging activities and aesthetics throughout the intervention (e.g., quizzes, game playing, colourful/engaging content) to encourage engagement with the intervention and behavioural elements of the intervention
2) To ensure that intervention sessions are not time consuming for adolescent users	<ul style="list-style-type: none"> • Deliver information in small bite-sized chunks to help users stay engaged with the intervention (e.g., graded exposure to intervention –reveal different parts of the intervention on a weekly basis)
3) To reduce confusion about information on sleep quality	<ul style="list-style-type: none"> • Provide information that was suggested by users e.g., more sleeping tips, such as information about the benefits of good sleep and problems with lack of sleep • Keep language simple and use images and/or videos to explain where appropriate • Keep website navigation simple • Make more information available through click-through options or access to external sources
4) To provide sleep information that is in line with adolescents’ norms and beliefs about sleep	<ul style="list-style-type: none"> • Ensure that intervention content and any behavioural elements are communicated using positive autonomy-supported language (i.e., non-directive) e.g., “some people find it helpful to”/ congratulations/well done” • Provide explanation of scientific rationale or supportive evidence suited to age group, then invite users to decide whether the suggestions will be beneficial- this will help promote trust and less likely to provoke resistance • Use stories from other users to ensure social, cultural, and maturational factors known to affect adolescent sleep patterns/quality are addressed
5) To ensure that healthy eating behaviours are encouraged, with focus on reducing snacking behaviours such as drinking/eating high in sugar/caffeine drinks and foods before sleep	<ul style="list-style-type: none"> • Provide users with information to motivate change in eating behaviours • Provide opportunity to set goals for changing eating behaviours by stopping or swapping their food/drink choices • Provide information about healthy eating habits or snack ideas, specifically in the evening/night
6) To ensure unpredictable habits are addressed including night- time technology use, regular physical activity, managing studies/work, and relaxation techniques	<ul style="list-style-type: none"> • Encourage users to plan a sleep and/or self-care routine (encouraged on weekends also) • Provide information about physical activity throughout the day to help body wind down at night • Provide tips and encourage the use of relaxing activities before bed as part of bed-time routine (e.g., mindfulness exercises)
7) To acknowledge that not all users like reminders	<ul style="list-style-type: none"> • Make reminders optional for users • Explain that some people might find reminders useful to help them achieve goals or improve sleep behaviour

8) To ensure that sleep diary entries are flexible to users

- Encourage the use of sleep diaries, using non-directive language
- Provide information about why keeping track of sleep (i.e., self-monitoring) is important for sleep behaviour change

The scoping review findings in Chapter 1 highlighted that sleep interventions often lack engaging, interactive, and fun elements to content and delivery, which could lead to mundane interventions, lower levels of engagement with interventions, and low levels of motivation to change sleep behaviour (Gruber, 2017). Therefore, the first proposed guiding principle for this intervention was to ensure that content and delivery of the intervention was engaging and allowed users to interact with the intervention in a fun and enjoyable way. For example, one way this guiding principle was addressed was through the use of quizzes and/or games embedded within the intervention (see Figure 2.1).

Figure 2.1

SleepWise Quiz Page Example

Sleep Knowledge Quiz

This is a quick and fun quiz to help you learn more about sleep. Don't worry if you get the answers wrong, you will only learn from them. Give it a go and see how you get on! Once finished, make sure you click "complete" to collect your points.

Using things like phones and iPads and watching TV can make you...

Stay awake for longer and feel tired when you wake up

Help you sleep better and feel good the next day

Make you sleep really well but wake up a bit tired

Your body clock shifts when you're a teenager by two hours, so this means...

You can happily go to sleep and wake up early

You struggle to sleep early and wake up early

You can happily wake up early but struggle to sleep early at night

Eating sugary and heavy foods late at night is...

Good for you because you will have lots of energy to sleep

Note. From SleepWise.org.uk © 2020 SleepWise.

Further, the scoping review indicated that adolescents did not want interventions to be time-consuming, which could be due to adolescents leading busy lifestyles. Adolescents also believed that interventions contained insufficient information about sleep or tips for better sleep, which could lead to lower levels of interest and/or engagement with the intervention (Gruber, 2017). Therefore, guiding principle 2 ensured that the intervention delivered sleep information and tips in bite-sized chunks, meaning that the intervention was less time-consuming and more manageable within a busy timeframe, helping users stay engaged with the intervention. For example, short bullet points were used to help deliver sleep information and tips relevant to adolescents (see Figure 2.2 for an example).

Figure 2.2

SleepWise Bite-Sized Information Example



Note. From SleepWise.org.uk © 2020 SleepWise.

A key finding from the scoping review was that adolescents wanted interventions to address their beliefs and norms around sleep (e.g., see Gruber 2017). Thus, guiding principle 3 ensured that information about sleep was communicated clearly and simply, for example, by providing age appropriate advice and information when describing the importance of sleep during adolescence (Figure 2.3).

Figure 2.3

SleepWise Age-Specific Content Example

The screenshot shows a webpage with an orange header containing the title "Why is sleep important as a teenager?". Below the title is a paragraph explaining that during teenage years, emotions, thoughts, and behaviors change, and good sleep helps the body and mind rest and grow healthily. A section titled "As a teenager:" follows, containing three bullet points: 1) "Your body clock tends to shift towards later sleeping hours – this means it's natural to go to bed after 11pm or find it difficult to wake up early"; 2) "You should aim to sleep for around 8 to 10 hours per night but most teens don't sleep for these amounts"; 3) "Not getting enough sleep can get in the way of your ability to perform well, making you forgetful, clumsy and sluggish". Below the text is a decorative orange bar with a white diagonal line. At the bottom, there are three buttons: "Complete" (orange), "Prev" (with subtext "Sleep Is Important"), and "Next" (with subtext "How Do You Feel?").

Note. From SleepWise.org.uk © 2020 SleepWise.

Guiding principle 4 ensured that adolescents' beliefs and norms were acknowledged by ensuring that social, cultural, and maturational factors known to affect adolescents' sleep patterns and quality were addressed (for example, see Figure 2.3 above), and motivational tools such as vignettes demonstrated the benefits of good sleep quality among adolescents (for example, see Figure 2.4). Also, findings from the scoping review showed that trusting intervention developers was valued by adolescent users, thus, an 'About Us' page (e.g., researcher, supervisory team) was added as an optional feature of the website (for example, see Figure 2.5), in order to help build credibility and trust with participants.

Figure 2.4

SleepWise Vignette Example

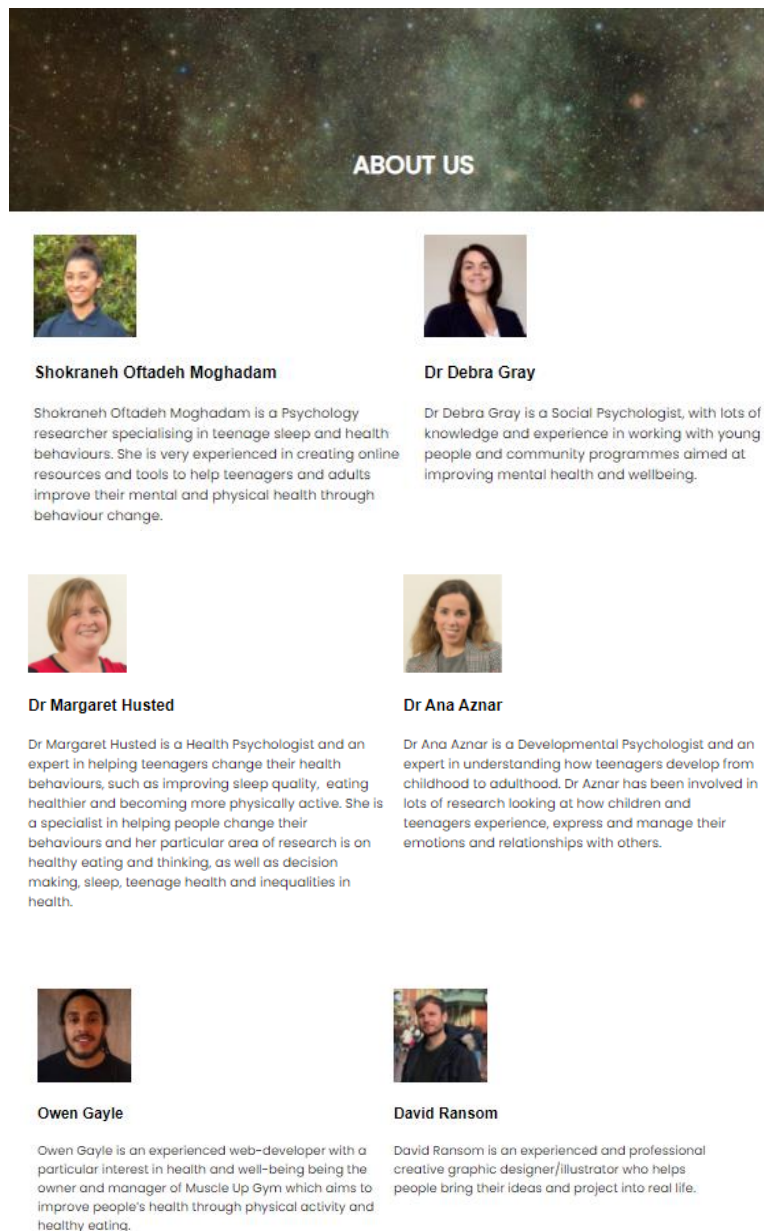
Ella:

“When I sleep well I feel energetic and can study much better than when I don’t sleep well. I also feel happier and calmer and can control my moods better”

Note. From SleepWise.org.uk © 2020 SleepWise.

Figure 2.5

SleepWise ‘About Us’ Page Example



ABOUT US

Shokraneh Oftadeh Moghadam

Shokraneh Oftadeh Moghadam is a Psychology researcher specialising in teenage sleep and health behaviours. She is very experienced in creating online resources and tools to help teenagers and adults improve their mental and physical health through behaviour change.

Dr Debra Gray

Dr Debra Gray is a Social Psychologist, with lots of knowledge and experience in working with young people and community programmes aimed at improving mental health and wellbeing.

Dr Margaret Husted

Dr Margaret Husted is a Health Psychologist and an expert in helping teenagers change their health behaviours, such as improving sleep quality, eating healthier and becoming more physically active. She is a specialist in helping people change their behaviours and her particular area of research is on healthy eating and thinking, as well as decision making, sleep, teenage health and inequalities in health.

Dr Ana Aznar

Dr Ana Aznar is a Developmental Psychologist and an expert in understanding how teenagers develop from childhood to adulthood. Dr Aznar has been involved in lots of research looking at how children and teenagers experience, express and manage their emotions and relationships with others.

Owen Gayle

Owen Gayle is an experienced web-developer with a particular interest in health and well-being being the owner and manager of Muscle Up Gym which aims to improve people's health through physical activity and healthy eating.

David Ransom

David Ransom is an experienced and professional creative graphic designer/illustrator who helps people bring their ideas and project into real life.

Note. From SleepWise.org.uk © 2020 SleepWise.

The scoping review highlighted that adolescents often struggle to predict their own habits, such as snacking at night, and find it challenging to switch off at night, due to worries and pressures associated with academic workload and employment (Paterson et al., 2017). In addition, adolescents reported that the use of technology at night was a barrier to sleep, due to feelings of “missing out” when not engaging with social media. Thus, guiding principle 5 ensured that risks and problems associated with eating foods high in carbohydrates and sugar before sleep, and methods to address these behaviours, were provided in the intervention (see Figure 2.6 for an example).

Figure 2.6

SleepWise Eating Sugary Snacks and Sleep Example

The image is a screenshot of an educational slide from SleepWise.org.uk. The slide has a white background with orange accents. At the top, the title "Eating and Drinking Food and Drinks" is displayed in white text on an orange rectangular background. Below the title, there are four bullet points, each starting with a blue right-pointing triangle. The first bullet point states: "Not sleeping well can make you want to eat unhealthy foods that are high in sugars and bad fats, which can lead to unhealthy weight gain". The second bullet point states: "When you don't sleep well, too much of the hunger hormone is released, making you feel hungry and crave sugary foods. At the same time, less of the 'full up' hormone is released – meaning you won't feel full up. This means you might end up eating more than usual". The third bullet point states: "Craving sugary drinks and snacks is also common because of releasing too much of the stress hormone called cortisol, which can make you feel tired, sluggish and could lead to putting on unhealthy amounts of weight". The fourth bullet point states: "Not sleeping well might also lead to drinking caffeinated energy drinks, like coke or red bull, to help you stay awake. These drinks are high caffeine and sugar and can disturb your sleep". Below the text, there is a decorative orange and white geometric shape. At the bottom left, there is an orange button with the word "Complete" in white. At the bottom center, there is a "Prev" button with "Physical Activity" written below it. At the bottom right, there is a "Next" button with "Your Mind" written below it.

Eating and Drinking Food and Drinks

- ▶ Not sleeping well can make you want to eat unhealthy foods that are high in sugars and bad fats, which can lead to unhealthy weight gain
- ▶ When you don't sleep well, too much of the hunger hormone is released, making you feel hungry and crave sugary foods. At the same time, less of the "full up" hormone is released – meaning you won't feel full up. This means you might end up eating more than usual
- ▶ Craving sugary drinks and snacks is also common because of releasing too much of the stress hormone called cortisol, which can make you feel tired, sluggish and could lead to putting on unhealthy amounts of weight
- ▶ Not sleeping well might also lead to drinking caffeinated energy drinks, like coke or red bull, to help you stay awake. These drinks are high caffeine and sugar and can disturb your sleep

Complete

Prev
Physical Activity

Next
Your Mind

Note. From SleepWise.org.uk © 2020 SleepWise.

Guiding principle 6 ensured that the risks associated with excessive night-time media use, and methods for relaxing before sleep (e.g., mindfulness exercises), were also outlined (for an example, see Figure 2.7).

Figure 2.7

SleepWise Relaxing Before Sleep Example

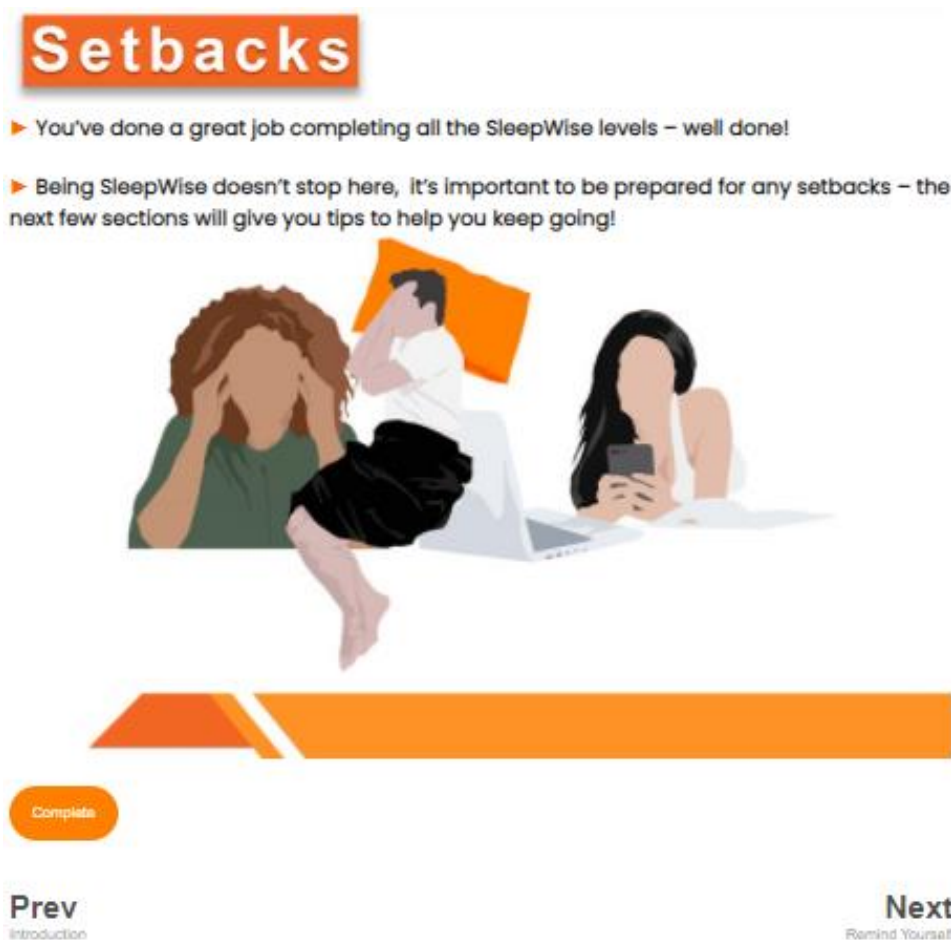


Note. From SleepWise.org.uk © 2020 SleepWise.

Results from the scoping review showed that participants found consistent reminders about sleep/wake patterns irritating (Werner-Seidler et al., 2017). This could be due to adolescents' attempts at becoming more autonomous and independent and thus a desire to engage with non-directive instructions, or language, when engaging with behaviour change interventions. Therefore, guiding principle 7 aimed to limit reminders and ensured that reminders were made optional for users, and that the intervention used autonomy-supportive and non-directive language. For example, the intervention addressed 'set-backs' to continued behaviour change (i.e., barriers to behaviour change) through using supportive and non-directive language such as "well done" and "tips to help you keep going" (see Figure 2.8).

Figure 2.8

SleepWise Supportive/Non-Directive Language Example



Note. From SleepWise.org.uk © 2020 SleepWise.

Participants in Werner-Seidler et al.'s (2017) study also reported that sleep diaries were a useful method to track sleep patterns, however, they valued flexibility (i.e., complete diary entries in their own time), which further highlights adolescents' attempts at becoming more independent and autonomous. Therefore, the final guiding principle, guiding principle 8, ensured that users could complete their diary entries at a time that best suited them (i.e., did not implement a time restriction for sleep diary entries).

The next activity which required undertaking as part of the design process of the prototype intervention was the production of a causal model, to bring together the barriers and facilitators and necessary intervention components to help address the barriers, using theory and framework.

Causal Modelling

The next step in the PBA intervention design was the creation of a causal model. The causal model brought together the barriers and facilitators to sleep behaviour change and the necessary intervention components to address them (as informed by the scoping review findings and guiding principles). During the creation of the causal model, behaviour change frameworks and psychological theory were drawn upon to systematically describe the content of the intervention, and help understand and ascertain potential determinants of behaviour (i.e., what behaviours need to change for the targeted behaviour to occur), which were then mapped onto the evidence base from the scoping review. The causal model helped to describe the functions of the intervention and provided important information for replication, implementation, and data extraction of the intervention, which could be useful for future researchers interested in the replication of the intervention and its functions (Craig et al., 2013; Michie & Abraham, 2004; Moore et al., 2015).

In terms of theory, the Self-Determination Theory (SDT) (Deci & Ryan, 2012) was chosen as the theoretical foundation of this prototype intervention (as discussed in Chapter 1). Additionally, the Behaviour Change Wheel (BCW) (Michie et al., 2011), which is a simpler representation of the Theoretical Domains Framework (as discussed in Chapter 1) (Michie et al., 2005), and the Behaviour Change Technique Taxonomy version 1 (BCTv1) (Michie et al., 2013), were integrated in the causal model and drawn upon to systematically classify, describe, and identify determinants of behaviour change and the intervention's active 'ingredients' (Band et al., 2017).

The BCW (Figure 2.9) is a proposed framework for the development of interventions, and combines evidence-based behaviour change frameworks (Condon & Coulson, 2017; Michie et al., 2011), which consists of the following three domains: sources of human behaviour (inner circle), functions of behaviour change interventions (middle circle), and guidelines and policies regarding behaviour change interventions (outer circle) (Michie et al., 2011). The core of the BCW consists of a psychological model of human behaviour (B), which integrates psychological components associated with behaviour change, including capability (C), opportunity (O), and motivation (M) (COM-B) (Michie et al., 2011). Each component of the COM-B model interacts with one another and directly influence behaviour (Condon & Coulson, 2017). This framework can help intervention developers understand the components and functions of interventions and identify barriers that prevent behaviour change.

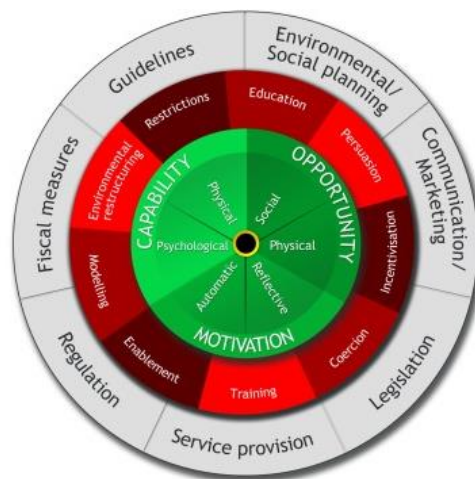
The BCW was drawn upon as a theoretical framework in the causal model as it is commonly used to characterise interventions, link characteristics to intervention functions (e.g., ways in which the intervention can change behaviour, such as 'education'), and identify corresponding behaviour change techniques (BCTs) (Michie et al., 2013; 2015). Likewise, the SDT helped predict users' intrinsic motivation to engage with and adhere to the intervention, as well as support users' autonomy, sense of competency, perceived relatedness (e.g., through the use of autonomy-supportive language), and

identify how and where the intervention addressed potential barriers to implementing behaviour change (Deci & Ryan, 2000).

Lastly, each BCT was mapped using the BCT taxonomy (v1) (Michie et al., 2013) to systematically describe components of the intervention. The BCT taxonomy (v1) is an extensive taxonomy of 93 distinct and consensually agreed BCTs that offer a method for reporting and describing behaviour change interventions (Michie et al., 2013). The application of theory and framework as part of causal modelling helps the standardisation of the intervention and ensures shared language between researchers. For example, this method can help avoid confusion when using different terminology for the same intervention techniques, or when different techniques are referred to when using the same terminology (Michie et al., 2015).

Figure 2.9

The Behaviour Change Wheel



Note. From The behaviour change wheel: A new method for characterising and designing behaviour change interventions by S. Michie, M. van Stralen, & R. West (2011). *Implementation Science*, 6(1), p.7. Creative Commons Attribution License 2.0.

Causal Model

To begin the causal modelling process, target behaviours identified from the scoping review were drawn upon, which included: reducing unhealthy eating behaviours (with focus on night-time snacking), encouraging physical activity, encouraging engagement with the intervention (e.g., interactive), utilising strong understanding of sleep information (e.g., user-friendly language), and facilitating recording of sleep. Once target behaviours were identified, barriers and facilitators that were relevant to the target behaviour were identified and recorded for each target behaviour. The scoping review showed that barriers/challenges to behaviour change were more prominent than facilitators within the literature. Thus, behaviour change techniques and intervention components to

address barriers to behaviour change were drawn upon within the model. While facilitators to behaviour change were not as prominent as barriers, they were still drawn upon as they helped inform methods to facilitate behaviour change. Once the intervention components were determined, each component was coded using the BCW (Michie et al., 2011) and SDT (Deci & Ryan, 2012) to highlight potential determinants of change and the relevant mechanisms and constructs that these components mapped on to. The causal model that was developed, as a result of this process, is presented in Table 2.2.

Table 2.2						
<i>Causal Model</i>						
Target Behaviour	Barriers/ <i>Facilitators</i> to Target Behaviour	Intervention Components	Target Construct (BCW)	Intervention Function (BCW)	Target Construct (SDT)	Behaviour Change Technique (using BCTv1)
Reducing unhealthy eating behaviours (specifically snacking on foods high in carbohydrates and sugar, for example before sleep)	<ul style="list-style-type: none"> • Having more opportunities for eating when awake 	<ul style="list-style-type: none"> • Provide information about how night-time eating contributes to poor sleep • Provide information on the likelihood of poor eating behaviours when sleep deprived • Invite users to set goals for stopping or swapping night-time snacks/drink 	Psychological capability; Physical opportunity	Education; Persuasion	Autonomy Competence	5.1. Information about health consequences 1.1 Goal setting (behaviour)
Becoming more physically active	<ul style="list-style-type: none"> • Leading a busy lifestyle 	<ul style="list-style-type: none"> • Suggest fun ways to become more physically active and how this can help sleep • Invite users to set physical activity goals 	Psychological capability; Physical opportunity	Education; Persuasion	Autonomy Competence	5.1. Information about health consequences 1.1 Goal setting (behaviour)
Staying engaged with the intervention	<ul style="list-style-type: none"> • Boredom/<i>interactive elements such as gaming</i> 	<ul style="list-style-type: none"> • Provide information in a fun and interesting way- such as quizzes/games about sleep and health 	Psychological capability; Reflective motivation	Education; Persuasion	Autonomy Competence	5.1. Information about health consequences 5.2. Salience of consequences 5.3. Information about social and environmental consequences 10.7. Social-incentive (in form of getting

						verbal reward e.g., congratulations and access to next weekly session)
	<ul style="list-style-type: none"> • Non-interactive 	<ul style="list-style-type: none"> • Provide information in a fun and interesting way (see above) • Invite and encourage users to set own plans (sleep routine) and goals – providing a printing option • Ensure that users congratulate success in goal achievement (e.g., self-incentive) and provide helpful advice to help users continue with behaviour • Invite users to take part in problem solving activities by identifying personal barriers (and solutions) to changing sleep behaviours 	Psychological capability; Physical opportunity Reflective motivation	Education; Persuasion; Training; Environmental restructuring	Autonomy Relatedness	1.1 Goal Setting (behaviours) 1.2 Problem Solving 1.4 Action planning 1.5 Review behaviour goal(s) 10.7 Social-incentive
	<ul style="list-style-type: none"> • Lack of time/busy lifestyle 	<ul style="list-style-type: none"> • Provide and deliver information in small chunks through graded exposure- i.e., users will need to complete one section of intervention to gain access or upgrade to the next section • Invite users to reward self for completing sections 	Psychological capability; Automatic Motivation	Enablement; Education	Competence	5.1 Information about health consequences 5.6 Information about emotional consequences 14.5 Rewarding completion 10.7 Self-incentive
Understanding information	<ul style="list-style-type: none"> • Insufficient and confusing information/ <i>information tailored to age group</i> 	<ul style="list-style-type: none"> • Ensure information is in simple and user-friendly language throughout intervention 	Psychological capability;	Education; Training	Autonomy Competence	5.1 Information about health consequences

		<ul style="list-style-type: none"> • Use pictures/diagrams/ videos where appropriate to demonstrate an idea • Provide click-through pages for further information/access to external sources • Provide an “ask a question” box (or a contact email) if users want something clarified • Provide an ‘About Us’ page, to ensure users have a sense of trust/connectedness with developers • Provide information about how to continue with healthy sleep behaviours 	Reflective motivation			<p>5.6 Information about emotional consequences</p> <p>5.2. Saliency of consequences</p> <p>5.3. Information about social and environmental consequences</p> <p>9.1 Credible source</p>
	<ul style="list-style-type: none"> • Lack of context specific/relevant problems 	<ul style="list-style-type: none"> • Invite users to action plan and ask them to identify solutions to barriers • Include theoretical stories from teenagers who experience good sleep through changing various behaviours • Include expert explanation and rationale • Provide information using positive autonomy-supported language (i.e., non-directive) e.g., some people find it helpful to/ you can try 	Psychological capability; Reflective motivation; Social opportunity	Education; Persuasion; Training Modelling	Relatedness	<p>5.1 Information about health consequences</p> <p>9.1 Credible source</p> <p>15.2. Mental rehearsal of successful performance</p>
Recording sleep quantity/quality	<ul style="list-style-type: none"> • Worry about using phone accelerometers/ <i>having an</i> 	<ul style="list-style-type: none"> • Use expert information to explain about the health and 	Psychological capability; Reflective	Education; Persuasion; Modelling	Autonomy Competence Relatedness	5.1 Information about health consequences

	<i>alternative method of recording sleep</i>	<p>safety issues around using phone accelerometers</p> <ul style="list-style-type: none"> • Provide stories of people who have used objective measures and the pros and cons • Let users know that using accelerometers is an optional choice and provide an alternative method to record sleep (e.g., sleep diary) this information will most likely be and included in study information sheet 	<p>motivation; Social opportunity; Physical opportunity</p>			<p>9.1 Credible source 9.2 Pros and cons</p>
	<ul style="list-style-type: none"> • Sleep diary entries/ <i>flexibility to diary entries</i> 	<ul style="list-style-type: none"> • Provide guidance about how sleep diaries can be filled in at times that suit each user • Encourage use of sleep diaries and advice to find the best way to do this i.e., computer, or phone if necessary • Encourage users to plan a suitable time for diary entries (encourage immediately upon waking with evidence showing why this is more effective) • Provide information about why keeping track of sleep/ having a sleep diary is important 	<p>Psychological capability; Reflective motivation; Physical opportunity</p>	<p>Enablement; Education; Persuasion;</p>	<p>Autonomy Competence</p>	<p>1.1 Goal setting (behaviour) 2.3 Self-monitoring of behaviour 5.1 Information about health consequences 9.1 Credible source</p>

Note. BCW= Behaviour Change Wheel; SDT= Self-Determination Theory; BCTv1= Behaviour Change Taxonomy Version 1.

Overall, the casual modelling process shows that the prototype intervention targeted six behavioural sources included in the BCW (physical and psychological capability, reflective and automatic motivation, and physical and social opportunity), and used six different intervention functions from the COM-B model (Michie et al., 2011, 2013) (Education, Persuasion, Modelling, Training, Enablement, and Environmental Restructuring) and employed 14 different BCTs. The prototype intervention also addressed barriers identified from the SDT constructs, for example, by using goal setting activities, the target constructs *autonomy* and *competence* were addressed. See Figure 2.10 for an example from the goal setting page, where participants were encouraged to set goals that were specific and realistic to implement in practice.

Figure 2.10

SleepWise Goal Setting Example

Goal Setting
Sleep and Health Goals

- ▶ Setting yourself goals can help you stay motivated to make healthy changes. By setting yourself goals you make sure you are in charge of your health and well-being
- ▶ It's really important that you set these goals now, and put them somewhere noticeable, so you remind yourself daily and stay motivated
- ▶ Try and come up with 3 goals to help you sleep well. These can be things like putting your phone away at night or trying to be more active in the day
- ▶ Before you set your goals make sure you read the tip below

Tip: When setting your goals make sure you are very specific about when and how you will do something. For example, if you're going to switch your phone off and put it away before bed, then say WHEN and HOW. For example, switch phone off at 9pm (WHEN) and put it away in draw (HOW).

[Click here](#) to see examples of goal setting using the tip above.

Set your goals below:

[ultimatemember form_id=7013]

Complete

Prev
Quiz

Next
Level 1 Complete

Note. From SleepWise.org.uk © 2020 SleepWise.

Intervention components that indicated a mixed response from users, as indicated by the scoping review, were made optional. For example, the scoping review indicated that the use of accelerometers in mobile phones showed a mixed response from users, as some participants found them uncomfortable (see Werner-Seidler et al., 2017 for further detail). While participants were not asked to use mobile phone accelerometers, optional features of the intervention (e.g., reminders) allowed target users to have more control over how the prototype intervention (or aspects of it) were used – this further addressed the target constructs *competence* and *autonomy* from the SDT.

Logic Model

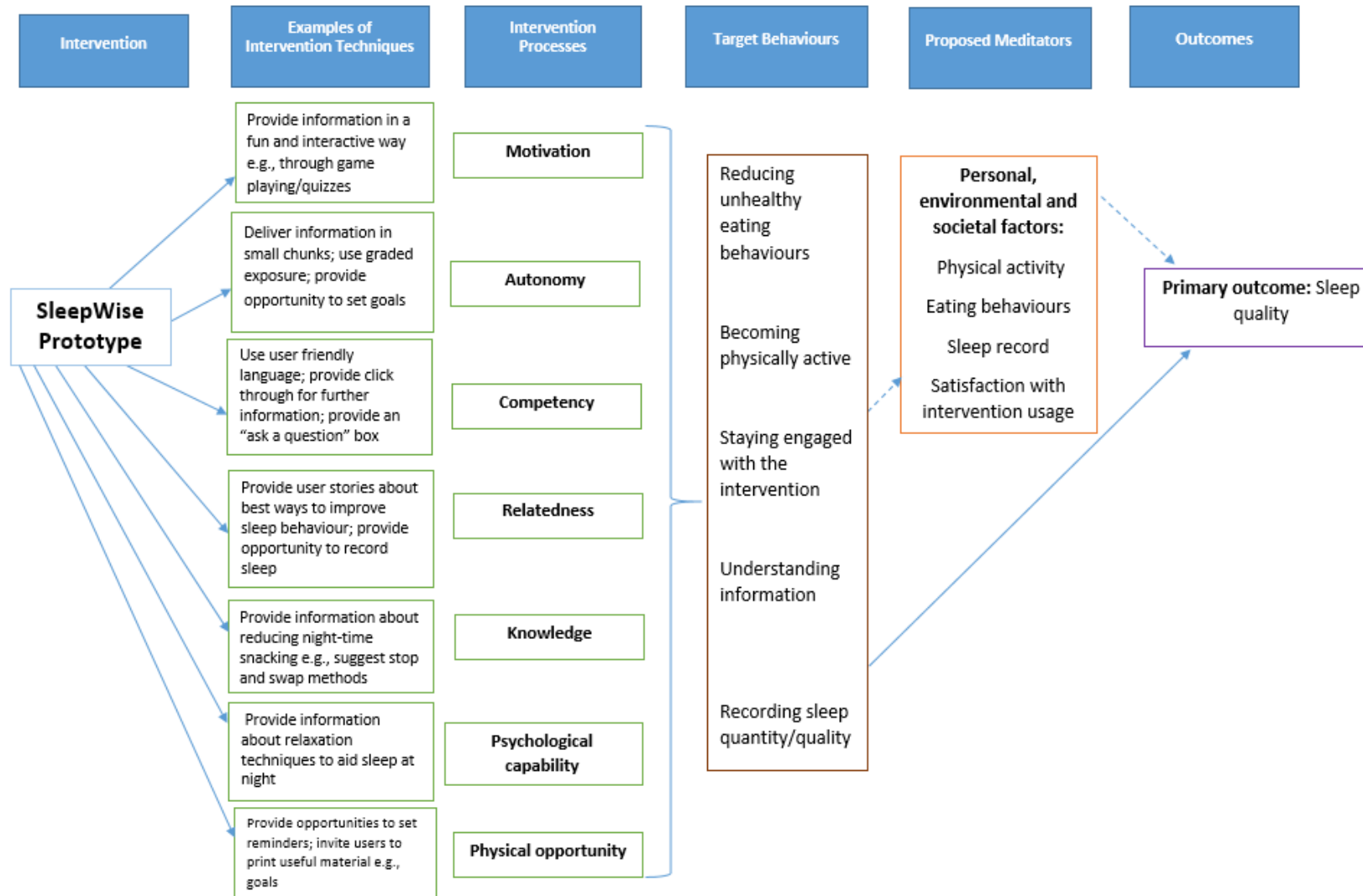
Following the creation of the causal model, the final step in the design process was to create the logic model. The purpose of the logic model was to understand and model the hypothesised mechanisms of action of the intervention (i.e., how it is thought to work/change behaviour). The logic model detailed the mechanism of action and behaviour change of the intervention (i.e., how the intervention will bring about behaviour change and its desired health outcomes). It did this by drawing together findings from the previous steps in to a testable model, which specified how the intervention components were hypothesised to impact on subsequent intervention components, and the mechanisms which could affect participants' sleep quality.

Originally, logic models were used in the field of programme evaluation and include diagrams or flow charts that indicate relationships between contextual factors, inputs, processes, and outcomes (Schmitz & Parsons, 2004). Logic models help to provide a clear visual explanation for influences between different elements of an intervention (Baxter et al., 2010), and strategically address features of the intervention that influence the desired health outcome/s (Schmitz & Parsons, 2004). Logic models have been previously used in successful health intervention planning and are effective in synthesising large bodies of data and succinctly describing the processes and outcomes of an intervention (Band et al., 2017; Baxter et al., 2010).

The prototype intervention's logic model is explained in three parts below, including: intervention techniques and components, proposed mediators, and outcomes (Figure 2.11).

Figure 2.11

Intervention Logic Model



Intervention Techniques and Components

As can be seen above in Figure 2.11, the intervention techniques of the model outline the BCTs drawn upon from the causal model, and indicate the seven processes that they were thought to affect, including: motivation, autonomy, competency, relatedness, knowledge, psychological capability, and physical opportunity. Here, the logic model shows that every intervention technique was hypothesised to predominantly affect only one of these processes, which then addressed one or more of the intervention's target behaviours. These processes were organised in hierarchical order, with the most important processes being those that were consistently identified as key processes from the scoping review, and the less important processes at the bottom, indicative as being less important to behaviour change, such as the optional features of the intervention. The processes discussed here are important to the logic model, as they highlight how the intervention techniques could directly or indirectly (through proposed mediators) affect sleep quality.

Proposed Mediators

The proposed mediators are a set of personal, environmental, and societal factors thought to affect sleep quality in the long-term and to be a target for the intervention. The proposed mediators enabled the model to synthesis a set of important factors that could mediate the effects of the intervention, which could help identify the intervention's mechanisms of change. Physical activity and eating behaviours were proposed as mediators due to their strong relationship with sleep quality (see Chapter 1). Sleep record (e.g., sleep diary entries) and satisfaction with the intervention were also proposed as mediators as they were identified, via the scoping review, as personal and environmental factors that could affect users' sleep quality.

Outcomes

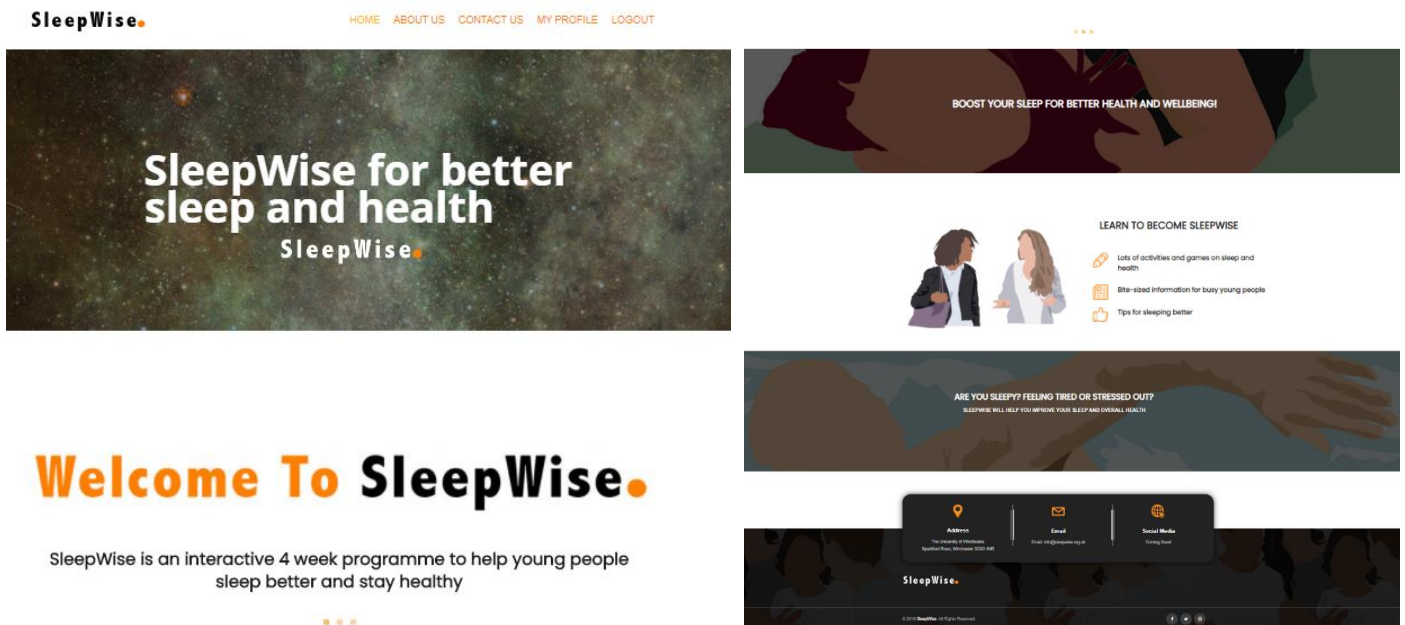
As seen in Figure 2.11, the logic model detailed one main (primary) health outcome (sleep quality) that the intervention aimed to change and/or improve. Sleep quality was determined as the key outcome in the logic model, as all other key processes ultimately lead to, and were a chain for, improvement and/or change in sleep quality. The logic model was subject to change to reflect participant experiences and feedback in the evaluation stage of the optimised intervention (study 3, Chapter 4).

The Prototype Digital Intervention – 'SleepWise'

The prototype intervention that was designed after undertaking the above activities (e.g., guiding principles, causal model, logic model) was created on WordPress as a 4-week interactive website called 'SleepWise'. See Figure 2.12 for an example from the home page of this website.

Figure 2.12

SleepWise Homepage Example



Note. From SleepWise.org.uk © 2020 SleepWise.

Previous research has shown that 4-5 weeks is an optimal period for improving sleep and other health outcomes within sleep interventions aimed at adolescents (Moran & Everhart, 2012). Given this, SleepWise was split across four week-long sessions (see Appendix C), to be completed across 5-weeks, and included content about: Sleep Knowledge (session 1), Sleep Problems and Solutions (session 2), Sleep Boost (session 3), and Sleep Future (session 4). Each session contained between nine to 21 lessons, including a quiz and weekly goal setting activities (maximum of three goals per weekly session), as well as a sleep diary section for recording sleep quality. Each session was referred to as a “level” for the purpose of gamification. By using gamification in a non-gaming context, the aim was to improve user experience and engagement and provide an incentivising process for participants. This approach has shown success in a previous app-based sleep intervention aimed at adolescents (see Werner-Seidler et al., 2019). Gamification was implemented in the form of collecting ‘points’, but only when a session was complete, which granted participants access to the next consecutive session. Points were collected by clicking a ‘complete’ button on every page of SleepWise (see Appendix D). If points were not collected, the next weekly level/session was not released. As SleepWise was a prototype intervention, participants needed access to all SleepWise session when providing feedback during qualitative interviews in study 2 (Chapter 3). For this reason, the point system was hypothetical in the optimisation stage of the intervention (study 2).

Conclusion

In sum, a prototype sleep intervention targeted at adolescents (SleepWise) was designed on a digital platform, based on the scoping review findings (Chapter 1) and the design process discussed in this chapter. As per the PBA methodology, the guiding principles indicated design objectives and described important features of the intervention required to achieve each objective. Causal modelling was undertaken to help map BCTs to theory and framework, and the components of the intervention. Lastly, the mechanisms of action and behaviour change of the intervention (i.e., how the intervention brings about behaviour change and desired health outcomes) were demonstrated via the prototype intervention's logic model. The next step in this PhD was to optimise the prototype intervention by gaining insight into target users' perspective and engagement with the intervention via think-aloud interviews (study 2, Chapter 3).

Chapter 3: Optimisation of SleepWise (Study 2)

A prototype digital intervention (SleepWise) was designed and created as part of study 1 (Chapter 2), using the Person-Based Approach (PBA) to intervention development. As part of the PBA, once a prototype intervention is designed and created, it is then optimised by carrying out qualitative research with target users (e.g., think-aloud interviews, focus group interviews) and the prototype intervention iteratively modified based on user feedback. Thus, the aim of the second study in this PhD was to answer the following questions: “Do target users think that the prototype intervention is acceptable, feasible, accessible, persuasive, motivating, and crucially likely to change sleep behaviour?” and “What are target users’ barriers/facilitators to engagement with the prototype intervention?”.

At this point, it is important to highlight the difference between making person-based modifications to the intervention, versus making usability-based modifications, as the two share similarities in their approach but also have vital differences (Lin et al., 1997; Yardley et al., 2015a). Usability testing is rooted in the discipline of human-computer interaction and ensures that products are developed as part of a user-centred design (Yen & Bakken, 2012). Usability testing is primarily focused on format and the extent that users find a product easy and attractive to use. Here, some overlap exists between the PBA and evaluation of dimensions of the user perspective, such as acceptability and satisfaction (Cummins et al., 2003; Muylle et al., 2004; O’Brien & Toms, 2008; Yardley et al., 2015a). However, while usability, acceptability, and satisfaction are important objectives, the goals of the PBA are much more extensive, and the vital difference is the need to ensure that interventions are deemed motivating, enjoyable, informative, and most importantly, likely to change behaviour and/or improve health outcomes (Yardley et al., 2015a). In this chapter, the methodology undertaken in study 2 will be discussed first, followed by the results and a brief discussion of the findings. Lastly, conclusions will be presented.

Methods

Ethical approval for this study was received from the University of Winchester’s ethics committee (RKEEC17012; Appendix E).

Participants

As SleepWise was aimed at adolescents, the inclusion criteria in this study included males and females aged between 13-19 years.

Recruitment

Seventeen adolescents ($M_{\text{age}} = 15.65$ $SD = 1.58$ $\text{Median} = 16.0$ $\text{Range} = 5$) were recruited from schools, colleges, and youth clubs, from Hampshire and London (Table 3.1), via online and offline posters (Appendix F).

Table 3.1

Study 2 Participant Demographics

Demographics (N=17)	n, (% of group)
Gender	
Male	5 (29.4 %)
Female	12 (70.6 %)
Ethnicity	
White	15 (88.2 %)
Chinese/ South East Asian	-
Black African	-
Indian	-
Black Caribbean	-
Pakistani	-
Bangladeshi	-
Other – Kurdistan/Black and White Caribbean	2 (11.8 %)
School/College Year	
Year 9	3 (17.6 %)
Year 10	3 (17.6 %)
Year 11	1 (5.9 %)
1 st Year College	6 (35.3 %)
2 nd Year College	3 (17.6 %)
3 rd Year College	1 (5.9 %)

Note. N= total number of participants; n= total sample number.

Recruitment stopped when saturation was reached, i.e. when no new themes were identified from the latest interview transcripts (Green & Thorogood, 2018). Participants who expressed interest in taking part in an interview emailed the researcher and were then emailed the information sheet and consent form (Appendix G). Parental consent was sought for participants under the age of 16 years, as per the British Psychological Society's (BPS) ethical guidelines (BPS, 2017). Participants were asked to bring a signed copy of their consent form to the interview.

Procedure

Participants were invited to take part in a one-to-one think-aloud interview lasting approximately 60 minutes, either at their home, school, or college. Ten participant interviews were conducted at participants' colleges, three in participants' homes, and one focus group at a youth group setting. Think-aloud interviews allow participants to think out loud while performing a task, or recalling thoughts immediately after completing a task, which can help gain insight into participants'

thoughts about the given task (Eccles & Arsal, 2017). Think-aloud interviews are useful for the optimisation of interventions, as they help elicit users' immediate reaction to every part of the intervention and allow the researcher to observe how the intervention is used by target users (Van den Haak et al., 2007; Yardley et al., 2015a).

In addition to the think-aloud interviews, one focus group interview was conducted with four adolescents within a youth group setting. While focus groups are commonly defined as including seven to 10 participants (Ratnapalan & Hilliard, 2002), a minimum of four participants is deemed acceptable (Bender & Ewbank, 1994; Carlsen & Glenton, 2011; Krueger & Casey, 2009; Kitzinger, 1995; Stewart & Shamdasani, 2014). A focus group interview was carried out as data collection at the youth group had to be complete within a 1-hour time slot. Thus, conducting one-to-one think-aloud interviews with each participant was not feasible within the 1-hour time period. A focus group interview worked well in this context, as the aim of the interviews was to get as many participants as possible to provide feedback about their experience with the prototype intervention. Participants in the focus group were not required to think-out loud but asked about their opinions about the prototype intervention (detailed further below).

Before each interview, participants were given a brief introduction to the study and the opportunity to ask questions. Participants were also told that SleepWise was still in development and was not ready to use, therefore, they were not being asked to follow the advice on SleepWise. Subsequently, participants provided demographical information (Appendix H) and provided the researcher with a signed copy of their consent form. The SleepWise (prototype intervention) website was then presented on the researcher's laptop. As discussed in Chapter 2, SleepWise consisted of four sessions, including information about sleep knowledge (e.g., eating behaviours, physical activity levels), general sleep hygiene practices (e.g., screen-time, sleep environment), and goal setting activities. SleepWise also included a quiz and a sleep diary component. The interviews aimed to provide insight into users' experience of SleepWise, in order to help modify SleepWise to meet users' needs and overcome barriers to sleep behaviour change.

Participants were asked to work through the content of SleepWise and to say their thoughts out loud. An interview guide (Appendix I) was used to prompt and encourage the participants to share their thoughts with the researcher. In the focus group, the researcher presented SleepWise on a laptop and participants were asked to take it in turn to work through SleepWise, while collaboratively providing feedback. Participants were asked about their opinions about SleepWise using the same interview guide, however, unlike the one-to-one think-aloud interviews, the focus group was guided by the researcher, through a facilitated discussion between the participants

(Leung & Savithiri, 2009). The focus group worked well with the youth group participants, as focus group discussions improve participant's confidence to express their views (Yardley et al., 2015a). On completion of each interview, participants were debriefed and given the opportunity to ask questions. Participants were then thanked and given a £10 Amazon voucher.

Analysis

Interviews were transcribed verbatim. Analysis consisted of identifying potential barriers to engagement with SleepWise (i.e., the intervention's behaviour change techniques). The analysis process to investigating themes followed Braun and Clarke's (2006) six phases to thematic analysis and involved reading and re-reading the transcripts to become familiar with the data. Subsequently, a line-by-line analysis of each transcript was carried out, tabulating aspects of the data that indicated positive or negative perceptions of the different parts of the intervention, which helped identify themes regarding potential barriers to engagement, and informed modifications to optimise the intervention. Thematic analysis was undertaken as it offers a flexible approach to analysing qualitative data, and provides a rich and comprehensive account of the data (Braun & Clarke, 2012).

An iterative approach to data analysis was undertaken, which included moving back and forth between data collection, analysis (identifying potential modifications), modifying the intervention, and thereafter further data collection. Each potential barrier raised through the think-aloud interviews and focus group was assessed in terms of whether a modification to the intervention was needed to appropriately overcome the barrier. Modifications were made to the intervention if they potentially influenced behaviour change, or were a precursor to behaviour change. Modifications were given priority using the MoSCoW (Must have, Should have, Could have, Would like) criteria (see Table 3.2), which has been used successfully in previous intervention development research (Bradbury et al., 2014, 2018). The guiding principles of the intervention (see Chapter 2, Table 2.1) were also considered before making modifications, to ensure that modifications were in line with the intervention's objectives. Modifications that were uncontroversial and easy to implement (e.g., clarifications) were applied instantly. In some instances, a potential change was given higher priority even if only one participant suggested it, given that it could potentially affect behaviour change or be a precursor to behaviour change. For example, if words such as "you should" or "you must" were reported as off-putting, as such language is likely to stimulate resistance from participants, it was given high priority for change (Yardley et al., 2015a). In other instances, further data was collected to investigate the views of other participants before implementing a modification, which allowed the researcher to explore whether the modification was a shared view/experience. Where a modification was deemed necessary, a solution was undertaken and documented in a table (see Appendix J). The table in Appendix J shows all

modifications made to the intervention, from the beginning of the optimisation process, through to the end. Examples of modifications made to SleepWise are discussed in the results section below.

Table 3.2

Criteria for Making Intervention Modifications

Criteria for Choosing and Making Modifications		Criteria for Prioritising Modifications (MoSCoW)	
Uncontroversial and easy	Uncontroversial and easy to make solution that doesn't involve major design changes, such as shortening or clarifying a sentence that was not understood.	Must have	This modification must be made to make the intervention effective in changing a participant's behaviour (given what is known about the evidence).
Repeated by several participants	This point was made by more than one participant.	Should have	This modification should be made if possible, as it may affect effectiveness of the intervention, but it could be delivered in a different way, or is in some way less important than a Must have.
Consistent with Guiding Principles	In line with guiding principles of the intervention. For example, for this intervention, it should motivate participants to change sleep behaviours.	Could have	This modification would be useful, but it could be less important for behaviour change than a 'should have' and may be implemented if time and resources are available.
Consistent with Common Guiding Principles	In line with common guiding principles [Yardley et al., 2015]: to support autonomy, promote competence, and provide a positive emotional experience and sense of relatedness.	Would like	This modification is not essential to support behaviour change, but may be useful if time and resources are available.

Results

Overall, the qualitative results from the optimisation process indicated that, participants felt that SleepWise was a useful platform for helping adolescents with sleep behaviours. However, improvements were identified to encourage engagement with SleepWise and its behaviour change techniques. Participant feedback from interviews and subsequent modifications are discussed across three key themes, including: SleepWise Format (sub-themes: point system, general navigation, look and feel), SleepWise Content (sub-themes: sleep information and education, time consuming content, unrealistic dietary recommendations, vignettes and tips, wording), and SleepWise Behaviour Change Techniques (BCTs) (sub-themes: sleep diary, sleep routine template, reminders, goal setting). Participant number, gender, and age are included after each quote for informative purposes.

SleepWise Format

As discussed in Chapter 2, the format of SleepWise was split across four sessions, referred to as 'levels' for the purposes of gamification. Gamification was implemented in SleepWise in the form of collecting 'points' per session, which granted participants access to the next consecutive session. The total amount of points was only granted once the session was complete. While this was hypothetical, participants were informed that, in practice, access to the next session would be gained in the following week. If a session was not completed, and therefore points were not collected, the next level/session was not released. Points were collected by clicking on a 'complete' button on each page of the intervention session, before (or upon) navigating to the next page. The sub-themes below provide insight into participants' experience with this system and subsequent modifications.

Point System

Some participants liked the point system, as they found it incentivising: "I like that it has points to encourage you...So people can't just like skip through it, it will actually help them more" (Participant 5, Female, Age 17). However, participants reported that they did not like clicking the complete button (to collect points) each time they navigated to the next page, as they found the concept somewhat confusing:

"I think at first I was probably a bit confused about how it worked in terms of how you collect points to move on and how you click complete and then get a point for that and then you move on to the next level" (Participant 7, Male, Age 17)

The point system was commonly reported as a hindrance to users' experience and engagement with SleepWise, which was mainly due to the inconvenience of having to collect points

by pressing the complete button each time participants navigated to the next page. For this reason, the complete button and the point system were removed. However, given that gamification has been shown to be an important element of sleep interventions for adolescents, this aspect of the design was implemented in a different way. For example, in the first session, a series of word jumble games were implemented as an optional feature at the end of the session, to help participants revise learnt material (see Figure 3.1). Optional revision games were implemented at the end of every weekly session. Moreover, it was seen to be important that each SleepWise session was still released on a weekly basis, as 4-5 weeks is an optimal time period for improving sleep and other health outcomes within sleep interventions aimed at adolescents (Moran & Everhart, 2012).

Figure 3.1

Word Jumble Game Example

SleepWise.

[HOME](#) [ABOUT US](#) [CONTACT US](#) [MY PROFILE](#) [LOGOUT](#)

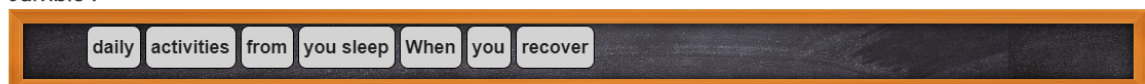
Welcome to the SleepWise Word Jumble Game!

All you have to do is move/tap the words into a sentence so they make sense! You will have come across these sentences when working through week 1, so it should all be familiar!

Hint: The first word has a capital letter!

Good luck!

Jumble 1



Note. From SleepWise.org.uk © 2020 SleepWise.

The above modification was deemed acceptable by subsequent participants, as participants in later interviews enjoyed the idea of working through each session on a weekly basis: “I think it’s good because it’s kind of something to do every week, something to - that’s kind of mandatory to do every week” (Participant 14, Female, Age 17). Participants also felt that completing each session on a weekly basis, without collecting points, meant that taking part in the intervention group did not feel like a ‘chore’: “...it’s not every day [that you are] doing it [engaging with SleepWise], otherwise it will become a chore, but this is more of something that you would enjoy doing and something you could look forward to” (Participant 14, Female, Age 17).

General Navigation

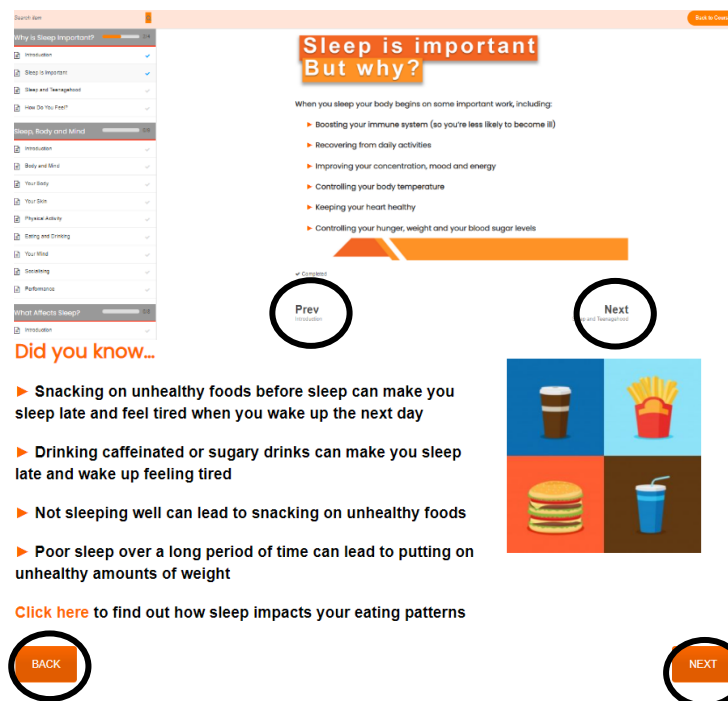
During earlier interviews, most participants reported that navigating SleepWise was simple. However, certain features of SleepWise were difficult to operate, as their purpose and function was not made clear. For example, the 'Next' button, which was expected to take participants to the next page, was not functional, instead, the word 'Next', placed underneath the 'Next' button, had to be clicked. The word 'Next' was a fixed feature of the software package (i.e., not editable). This un-editable feature meant that the word 'Next' (not the button) had to be clicked to enable participants to navigate to the next page, which participants found confusing:

"I would have thought you would have had to click next, the button, instead of the bit underneath it, so my immediate reaction is to click [the] next or back [buttons] 'cos I would think that's the next button instead of the bit under it" (Participant 5, Female, Age 17)

As this feature caused confusion among participants, SleepWise was restructured, and an upgraded version of the software purchased. After restructuring SleepWise and upgrading the software package, the next and back buttons were both modifiable and clickable, and their purpose was made clear (for example, see the 'before and after' version of this change in Figure 3.2). The software upgrade also meant that the theme of the website (e.g., aesthetics) was also updated to a more modern setting (e.g., inclusion of graphics) (discussed further below).

Figure 3.2

Back and Next Buttons Before (top) vs After (bottom) Modification



Note. From SleepWise.org.uk © 2020 SleepWise.

Look and Feel

Participants liked the aesthetics of the newly upgraded SleepWise website (e.g., refer to Appendix K to see a breakdown of each weekly session in the newly upgraded version), and felt that it was different to other websites that they had experienced before:

“It looks good, like the page and everything, it looks quite smart...It just looks quite cool ...Yeah smart – like it’s clear in everything that it says... And it’s good with the colour scheme and everything... A lot of websites are tacky, if you get what I mean...This isn’t like that” (Participant 3, Female, Age 16)

In particular, participants liked the graphics of SleepWise: “...I like the stars at the top, I like the sky... it’s kind of relaxing” (Participant 9, Female, Age 17) and the minimalist illustrations: “Yeah it’s really nice...it’s like a chill [character] illustration because it doesn’t have like the [human] face and like outlandish [facial] details” (Participant 2, Female, Age 18).

Participants also felt that the delivery of information on SleepWise was user-friendly and made the website feel more welcoming: “I think it [SleepWise] was very friendly, approachable erm it was quite easy to use, it wasn’t complicated” (Participant 16, Female, Age 13).

While most participants liked the aesthetics of SleepWise, some felt that more colour, which differed to the colour scheme of SleepWise (orange, black and white), was needed: “...I think make it more colourful and add some images...Because everything else is kind of the same colour scheme and that would be quite boring” (Participant 4, Male, Age 17). These participants also suggested that there was a need for more imagery to illustrate or accompany some of the text information: “...maybe just kind of adding some images or pictures, because a couple of slides [pages] were just some words and no image to draw attention...” (Participant 9, Female, Age 17).

Based on the feedback above, and to keep in line with the intervention’s guiding principles (guiding principle 1), more imagery and colour to text information was added to SleepWise. These changes were noticed and liked by participants in later interviews, as it helped motivate engagement with SleepWise: “I think it’s really rewarding, it’s colourful, it stands out, just feel motivated to do more and to try and reach those goals that you set” (Participant 14, Female, Age 17).

SleepWise Content

Sleep Information and Education

Participants felt that SleepWise provided interesting information about the importance of sleep and methods to overcome poor sleep behaviours: “...in reality you make the person [user] realise why sleep is important...like stating facts... I think it’s a good idea” (Participant 1, Male, Age

17). Participants also felt that information and advice on SleepWise was useful for raising awareness about how to recognise sleep problems, and the tools included in SleepWise were deemed useful for overcoming sleep problems: “I just like how, you know, it tells you all these things and then it gives you something that you could do about it, instead of just drawing your attention to it” (Participant 5, Female, Age 17).

Participants deemed information on SleepWise as interesting, as they felt that the content was scientific and included topics that are not commonly taught at school/college: “I think [SleepWise] gives you information - can give you advice - that you didn’t know or some scientific things that maybe don’t come up in a science lesson, maybe about hormones and erm like your body clock” (Participant 14, Female, Age 17). Participants felt that there is not enough focus on sleep-related topics at schools, even if pupils are experiencing poor sleep or the consequences of poor sleep (e.g., tiredness):

“There isn’t a lot of information on sleep, like school don’t focus on it as well – there has been like a lot of problems [at] like schools obviously – I know a lot of people who are continuously tired at school” (Participant 16, Female, Age 13).

Participants also felt that sleep education at school does not inform them about why sleep is important, which consequently, as one participant suggests below, makes them feel discouraged about engaging in good sleep behaviours: “There is a lot of people who say you should do this [improve sleep] but if there is no reasoning behind it then why [do it]?” (Participant 10, Male, Age 14).

While feedback about the quality of information on SleepWise was mainly positive (and thus no changes were made to the content of sleep information), these preliminary findings provide some understanding about the lack of societal priority given to sleep education, and why solely educating adolescents on good sleep (and not facilitating behaviour change) may not necessarily motivate engagement in healthy sleep behaviours (Blunden et al., 2012; Blunden & Rigney, 2015; Gruber, 2017; Tobler, 2000). This point will be expanded on later in the discussion section of this chapter, as well as in Chapter 5 of this thesis.

Time Consuming Content

Initially, participants felt that the first two sessions of SleepWise were time consuming and included an overwhelming amount of information. Feedback from the focus group (extract below) suggests that information on SleepWise should be gradually exposed to participants:

“P11: If your first one [session] is long, your first two are long, then the last two are short, it’s like by the third one you might be more involved in it but-

P10: I think it should be the other way

P11: Yeah, start short

P12/13: Progressively

P12: Gradually

P10: It needs to grab your attention at the beginning”

(Focus Group: P10, Male, Age 14; P11, Male, Age 14; P12, Female, Age 15; P13, Female, Age 15)

The participants in the focus group indicated that SleepWise would be better communicated when delivered in smaller chunks. While delivering information in small bite-sized chunks was a key guiding principle (guiding principle 2), and thus immediately implemented, feedback from this group also suggested that information would also be best delivered if key information was presented first, and additional information made optional. For example, one participant from the focus group suggested that having a ‘further information’ option would make their experience less daunting:

“I think potentially have like an expandable bit, so you’ve got keys points [first] and expand that into further information, so it’s less daunting when you load the page, if you want to see more... it’s like having the key information that you really want to get across [first]” (Participant 11, Male, Age 14)

In response to the above feedback, modifications were made to the prototype intervention so that key information within each weekly session was presented first (i.e., on the main page) and click-through (i.e., optional) buttons were embedded on every page of each session, so that participants could navigate to another page to find out more information if they wished (for example, see Figure 3.3).

Figure 3.3

Click-Through Example



Note. From SleepWise.org.uk © 2020 SleepWise

Participants were also given the option to explore more sleep information at the end of each weekly session (via links to external pages/videos) (see Appendix L for example). This information was provided at the end of each weekly session to ensure that users were not directed away (or distracted) from engaging with SleepWise. Additionally, implementing links to external videos had the added benefit of meeting the needs of participants who wanted information delivered more interactively.

These modifications were liked by participants in later interviews, especially having the option of exploring additional sleep information:

“I would definitely want to click on to them [click-through buttons] cos it gives extra information...I like the option that you've put like two click [click-through buttons] on each one [topic] cos like

some people might not want to click on either of them, or some might find it relevant for either one of them” (Participant 16, Female, Age 13).

Unrealistic Dietary Recommendations

Feedback from the focus group revealed that participants found food and drink recommendations (e.g., swapping caffeinated drinks for Jasmine flavoured tea) for gaining better sleep unrealistic when thinking about implementing them in practice, and felt that more feasible recommendations should be suggested. For example, participants in the focus group discussed why certain foods and drinks were deemed unrealistic for their age group:

“P12: Where’s PG tips [tea]?”

Researcher: PG tips - like decaffe [tea]?

P10: Yeah that’s [PG tips] the one

P12: That’s the only tea I drink...not some kind of Jasmin flavoured green tea...

P10: You need to give stuff that we all know of – cos I’m thinking quite a lot of these kids won’t be...they won’t kind of have all these healthy stuff”

(Focus Group: P10, Male, Age 14; P12, Female, Age 15)

Participants from the focus group also suggested that more information on the effects of sugary foods on sleep should be included, as they were not aware of this information, along with more tips on how to improve eating behaviours before sleep:

“P11: [SleepWise] said about sugary foods, but you might not necessarily think it’s a bad idea to eat like certain stuff before you go to sleep

Researcher: Ok that’s interesting - what did you think about that [pointing to information about sleep and food]?

P10: That is what there needs to be more of...

P11: ...if you had a small tip, like instead of eating sugary cereal before bed eat something different - I don’t know what you’d eat, eat some toast or something...”

(Focus Group: P10, Male, Age 14; P11, Male, Age 14)

Participants felt that the suggestions given on SleepWise about snacking less on sugary foods before sleep was a feasible behaviour to implement, as they deemed this behaviour ‘easy to follow’:

“P11: That [information on sleep and food] is pretty good

P12: 'Cos then you're like encouraging young people to make their own healthy choices –

P11: 'Cos sometimes when all you know is unhealthy food it's like the transition –

P13: 'Cos like it's easy to follow – it's not that hard to go to the shop and buy some grapes or whatever...because you know that's going to help''

(Focus Group: P10, Male, Age 14; P11, Male, Age 14; P12, Female, Age 15; P13, Female, Age 15)

Given the feedback from the focus group, food suggestions that felt unfamiliar and unfeasible to implement in practice (e.g., drinking fruit/herbal tea) were replaced with participants' ideas about more feasible and familiar foods/drinks (e.g., snacking less before sleep, swapping drinks with decaffeinated options), and the inclusion of more information on the negative effects of snacking on sugary snacks before sleep (for example, see Figure 3.4).

Figure 3.4

Sleep and Eating Extra Information


Did you know...

- ▶ Snacking on unhealthy foods before sleep can make you sleep late and feel tired when you wake up the next day
- ▶ Drinking caffeinated or sugary drinks can make you sleep late and wake up feeling tired
- ▶ Not sleeping well can lead to snacking on unhealthy foods
- ▶ Poor sleep over a long period of time can lead to putting on unhealthy amounts of weight

[Click here](#) to find out how sleep impacts your eating patterns

BACK NEXT

- ▶ When you don't sleep well, too much of the hunger hormone is released. This makes you feel hungry and crave sugary foods. At the same time, less of the 'full up' hormone is released. This means you won't feel full (even if you are) which might lead to eating more than usual
- ▶ Craving sugary drinks and snacks is common when you don't sleep enough. This is because your body releases too much cortisol (the stress hormone), which makes you feel tired and can lead to putting on unhealthy amounts of weight overtime
- ▶ Drinks like Coke and Redbull have caffeine and sugar in them. These drinks will make you stay up for longer at night, even when you are tired. Overtime, these drinks can also lead to unhealthy weight gain and damage your teeth



BACK

Note. From SleepWise.org.uk © 2020 SleepWise.

Vignettes and Tips

Participants suggested that more vignettes were needed throughout SleepWise, to add a personal element to their experience with the intervention: "...that's nice that you're able to hear other people's opinions of it...I think that's a good idea – you could even have more I think it just makes it more personal I think..." (Participant 7, Male, Age 17). Participants also liked tips and advice on sleep hygiene but wanted more practical techniques for implementation in practice (e.g., how to only use their beds for sleep and not for other activities):

"Try to be in bed only for sleep - maybe underneath that you could put some alternatives, like get a bean bag or something comfortable, 'cos quite often you know, if you want to relax by yourself, your bed is your only option" (Participant 5, Female, Age 17).

In response to this feedback, further modifications were made to the prototype intervention to include more practical suggestions and vignettes within each weekly session. For example, practical tools aimed at relaxing before sleep were included in session 4 of SleepWise (see Figure 3.5).

Figure 3.5

SleepWise Sleep and Mindfulness Tool (Session 4)



Note. From SleepWise.org.uk © 2020 SleepWise.

Wording

Participant feedback indicated that the wording of SleepWise was clear and easy to understand: “I just like the set out, it’s clear – the information is clear and it’s not confusing...” (Participant 7, Male, Age 17) / “Well it’s clear, it’s not all over the place...It’s nice and simple, I’m the kind of person that likes it nice and simple” (Participant 6, Female, Age 16). However, participants felt that, in places, wording felt repetitive: “...yeah with this – where it says feeling sluggish, erm that’s like kind of repeating what it said about being drowsy...” (Participant 5, Female, Age 17) and suggested that softer wording was needed in places to help improve the user-friendly tone of SleepWise: “...because “click here to see your problems” is kind of – maybe, click here to see what you wrote or something... identify what could be stopping [you] instead of what stops [you], maybe just a little bit softer” (Participant 6, Female, Age 16).

Participants also felt that some aspects of SleepWise, such as being offered a graduation certificate once participants had completed the intervention, were not appropriate for the age spectrum of users – for example, the wording of the graduation certificate felt ‘condescending’ to some older participants: “...so that might be condescending to the end age of the group – like the graduation certificate...” (Participant 4, Male, Age 17)

In response to the above feedback, framing of the graduation certificate was modified so that participants had the option to receive a certificate on completion of SleepWise if they wished (see Appendix M for the before and after modification process). Repetitive phrasing, such as the one mentioned above, was removed and friendlier wording was used throughout SleepWise, for example, “Click here to see your problems” was replaced by an optional problem solving activity when setting weekly goals (see Appendix N).

SleepWise BCTs

Overall, feedback indicated that participants enjoyed the behaviour change tools that SleepWise offered, as well as the interactive parts of SleepWise, such as the quizzes: “I like the quiz...I love how it’s quite short and snappy as well” (Participant 2, Female, Age 18). Participants also found the quizzes useful for revising learnt material: “It [quiz] is very easy to navigate...the questions related to what you’ve read, it like reinforces it” (Participant 5, Female, Age 17). However, some interactive BCT elements of SleepWise required modification to improve engagement with and acceptability of the intervention, as discussed further below.

Sleep Diary

Participants liked the idea of having a sleep diary for recording their sleep patterns, as a diary could help them better understand their sleep behaviours:

“If you write it [sleep patterns] in a notebook, you forget it’s there, but if you have something specific that you actually put information into ... a sleep diary, cos it would be easier to adjust sleep to fit like the, what I should be getting [recommended sleep hours], if I had something to base it off, sort of my own way of working around obstacles with sleep” (Participant 8, Female, Age 17)

However, participants felt that the sleep diary would be best accessed via a mobile phone, as this would make the diary more accessible. They also felt that the diary could be further improved by asking participants a smaller number of sleep related questions (as oppose to six to eight questions):

“Maybe it’s better to do it online, you can just sit on your bed in the morning and type it on your phone, and then that’s kind of logged...I think it’s a bit more convenient probably because it’s on a phone, for young people, they would probably stick to it a bit more. So like a little form...with 2 or 3 questions” (Participant 6, Female, Age 16)

Participants in the focus group also echoed the feedback above, and added that flexibility of use was an important aspect to engaging with the sleep diary:

“P11: ...have you got it [sleep diary] as an app?...I was going to say, like a small companion app for the sleep diary

P10: Why don’t you make it so you can do it [log sleep] whenever...because that way no one has to worry about oh I have to do it at a certain time”

(Focus Group: P10, Male, Age 14; P11, Male, Age 14)

While SleepWise did not restrict participants to logging their sleep during a specific time period, participants in the focus group suggested that answering the sleep diary questions only once a day, and preferably not in the morning, was better suited to them, as they felt that mornings are often a busy time for them:

“P13: You might forget to do it [in the morning], because if it’s in the morning and you’re trying to like get extra sleep in, for example, you might be late for something, you don’t know

P11: As long as you could back log time

P13: For example evenings [are] ok but it’s just, if it was me waking up, [it’d be] more stress

P11: You’ve got so much to do in the morning”

(Focus Group: P11, Male, Age 14; P13, Female, Age 15)

Participants in the focus group went further to suggest that the SleepWise website would benefit from being made into an app, or by including app like features (e.g., sleep diary accessed via their mobile phone), as they felt that young people do not often engage or interact with websites, as apps provide easier and more instant access to information:

“P10: [young people] are not using websites as much, everyone’s got phones nowadays so most people use them

P13: It’s just a lot easier to open an app. You’re already signed in, you can use it online, offline, on the go kind of thing”

(Focus Group: P10, Male, Age 14; P13, Female, Age 15)

Similarly, participants from earlier interviews also suggested that SleepWise would benefit from being made into an app, as they too felt that an app would be more instant and accessible:

“Apps might be a good way as well, cos these whole progress thing like they don’t have to log into a computer to kind of go through them, they can just kind of tap through, and then see how far they’re going... like because we’re just in such a big technology world at the moment - a phone app might be good... with the app as well you could do like iPhone app reminders as well”

(Participant 2, Female, Age 18).

In response to feedback regarding the sleep diary, the diary questions were shortened and made compatible with mobile phones (see Appendix O). However, participants were not encouraged to access or work through SleepWise on their mobile phones, as SleepWise was best experienced on non-phone devices (e.g., computer, laptop), as this helped reduce technological faults and improve the functionality and visual compatibility of SleepWise. Participants were also given the choice to complete their sleep diaries once a day in their own time, and encouraged to do this in the morning, as information about their sleep may be best remembered upon waking (e.g., see The Consensus Sleep Diary – Morning (CSD-M) in Carney et al., 2012). Lastly, developing SleepWise into an app was not feasible in this study, as it was a highly time consuming and costly process (discussed further in Chapter 5).

Sleep Routine Template

Participants felt that a printable template for writing down their sleep routine (e.g., step-by-step to do list before sleep) would be helpful for recording their night-time routine: “...[SleepWise] doesn’t actually give the person like a template to write the [sleep] routine, I think that would be good...and make the template printable” (Participant 4, Male, Age 17).

In response to this feedback, modifications were made to the prototype intervention so that a printable (optional) sleep routine chart was available (see Appendix P). Participants who took part in later interviews liked the idea of having a printable sleep routine template, as they found it accessible and a time-saving tool: “I like how it’s easy to print off the sleep routine chart and how it would help me because sometimes creating your own would be quite difficult or time consuming...” (Participant 14, Female, Age 17).

Reminders

Participants felt that the idea of text reminders was helpful for reminding them to stay engaged with SleepWise, with the added benefit of making SleepWise more interactive: “...If SleepWise itself gives reminders...It’ll make it much more interactive and you’ll know you’re actually doing something, you’re not just on SleepWise for fun, it will actually help you...” (Participant 4, Male, Age 17). In terms of preference for reminders, participant feedback indicated that text reminders were preferred over email, as they were deemed more noticeable and less likely to be dismissed:

“You could do like iPhone app reminder as well...I mean personally with me and my laptop I have reminders in the corner there, [I] just kind of dismiss them...on my phone, I always look at my reminders...I’m like always looking because it’s so like immediate and it’s a small screen as well” (Participant 2, Female, Age 18).

Therefore, it was decided that both (optional) text and email reminders were sent to participants to remind them about engagement with SleepWise and sleep related activities (e.g., goal setting, sleep logs) (see Appendix Q for an example). Participants in later interviews liked this feature, for example, one participant thought that reminders were useful as they could help users stay committed to behaviour change “...reminders are good I think because it feels like they [users] have a commitment” (Participant 16, Female, Age 13).

Goal Setting

Participants liked the purpose of setting goals, as they felt that goal setting would motivate and remind them to engage with the intervention and thus attempt behaviour change, as demonstrated from the focus group extract below:

“P10: I like it...I always set goals but I never do them, so if you can have something that can help you...it’d be a good thing...”

P12: I think having the option to set your goals makes me want to change... because you have to physically put your goals in, because then that makes you stick to it, because [sometimes] you can just say it in your head and forget it”

(Focus Group: P10, Male, Age 14; P12, Female, Age 15)

In addition, participants felt that it would be useful if they were able to monitor their goals and any associated improvements in sleep or health via SleepWise: “Maybe an option to say what’s improved...to say what’s improved so they [users] realise that these steps they’ve taken actually do work...” (Participant 6, Female, Age 16). While participants liked the idea of setting goals, they felt that the concept of setting small and realistic goals should be emphasised throughout SleepWise:

“ [Should] make the aim less to do [with] these things [goals]...it’s like, the achievement is the small steps... you don’t have to do like all of it, it’s just small, doing things every now and then, even if it’s not everything....it’s still an improvement... you’ve got to walk before you can run”

(Participant 11, Male, Age 14).

It was therefore decided that small and achievable goals, using the acronym S.M.A.R.T (Specific, Measurable, Attainable, and Reasonable, Timely) (Doran, 1981; Les MacLeod, 2012) was included in SleepWise (as a tip when setting goals) (see Appendix R for the before and after modification process). A profile dashboard was also imbedded within SleepWise to allow participants to monitor their goals (see Appendix S). Additionally, as part of monitoring set goals, participants were asked, at the beginning of each weekly session, whether they had met, part met, or did not meet their goal/s (from the previous week) (see Appendix T), and were given the chance to renew their goal/s (or remain with the same one) later in each session. Participants in later interviews liked these changes, as, for example, the ‘part met’ option of the goal review provided participants a middle-ground for tracking their progress:

“I think this [goal review] is good because you can reassure - I think to remind yourself what your goals are and what you did in the week to meet your goals or not meet your goals... instead of just yes or no there is a middle option because it’s not [always] just yes or no”

(Participant 14, Female, Age 17).

Discussion

Study 2 provided insight into users’ experience and engagement with the prototype version of SleepWise and its recommended behaviour change techniques. Findings revealed that, overall, participants found SleepWise interactive and informative, however, modifications regarding its

content, aesthetics, and implementation of behaviour change techniques (e.g., goal setting) were needed. Findings also helped identify potential barriers (e.g., unrealistic food/drink recommendations) and facilitators (e.g., goal reviews) to engagement with SleepWise. Five key findings were identified as providing valuable insight to the adolescence sleep literature.

Firstly, in regards to the eating/drinking information provided in SleepWise, participants found information on night-time snacking important for changing unhealthy sleep behaviours, as they felt that they were not always taught this information at school or college. This finding is consistent with previous research, indicating that evening snacking is an unpredictable habit and among key struggles that adolescents face when attempting to improve sleep behaviours (Paterson et al., 2017). As might be expected, research shows that sleep deprived adolescents indicate higher intake of calories from foods with a high glycaemic index, with inadequate sleep also increasing vulnerability to over-eating, which may be due to having more opportunities for eating when awake (e.g., night-time snacking) (Beebe et al., 2013; Weiss et al., 2010). Further, participant feedback showed that adolescents found some of the snack and drink suggestions on SleepWise unrealistic for their age group, and recommended that more feasible options (e.g., decaffeinated options) should be included, as it was deemed that not all young people will be familiar with the alternatives given on SleepWise, or have access to such options. This finding is in line with research suggesting that multiple psycho-social and environmental factors influence adolescent's food choices (Story et al., 2002), such as preference, time demands, convenience, and cost (Bissonnette & Contento, 2011; Neumark-Sztainer et al., 1999). As indicated by the intervention's guiding principles in Chapter 2, methods to help adolescents regulate evening eating patterns was a key behaviour which SleepWise addressed. Thus, including realistic food/drink recommendations for adolescents could help towards aligning SleepWise's behavioural techniques with adolescents' values and concerns, which could, in turn, improve engagement and acceptability, and maximise the potential for improved sleep quality.

Second, while participant feedback indicated that SleepWise provided useful sleep education for improving and supporting adolescents' sleep knowledge and behaviours, participants felt that sleep education is often ineffective within their place of education, which suggests that sufficient information regarding why sleep is important or how to improve sleep behaviours is often absent from school and college settings. In line with these findings, research shows that schools and the wider society do not prioritise adolescent sleep (Gruber et al., 2014; Perkinson-Gloor et al., 2013), and that education alone is not effective for improving sleep behaviour or mental health (Blake et al., 2019; Blunden & Rigney, 2015). As indicated in Chapter 1, sleep education programmes that are informed by the principles of cognitive behavioural therapy, which include components such as stimulus control, relaxation training, and addressing unhelpful beliefs and attitudes about sleep,

are more successful at changing actual sleep behaviour than solely educational programmes (Blake et al., 2019; Edinger & Means, 2005). While SleepWise includes information about the importance of sleep and methods to help overcome sleep problems, and helps facilitate sleep behaviour change (e.g., relaxation techniques), results from this chapter also suggest that adolescents value sleep information and sleep aiding methods that are time-efficient and easily accessible, which could indicate their willingness to partake in sleep behaviour change.

Third, during the optimisation of SleepWise in this study, it was important to consider for times where practical limitations hindered the ability for user feedback to be implemented (i.e., when a change was difficult to implement). For example, some changes to the intervention were costly (e.g., purchasing computer programme or web-design expertise). However, developmental barriers, such as the ones mentioned here, are common when creating digital interventions, as outsourcing design and development experts often requires additional costs that may be unaffordable, especially for early stage researchers (Biagianni et al., 2017). Typically, one solution to this barrier is to develop close relations with programmers and use flexible in-house software, which make modifications to interventions less costly and time-consuming (Schueller et al., 2013; Yardley et al., 2015a). Although software expertise was not purchased for the optimisation process, outsourcing an affordable digital hosting platform, and gaining support from friends who were familiar with web-development, helped overcome this barrier. In addition, collecting feedback via both think-aloud and focus group interviews provided insight into participants' personal experiences with the intervention, as well as insight into participants' shared experiences and likes and dislikes of the intervention. Both methods allowed for a flexible and adaptable approach to data collection, while ensuring rigor and commitment to answering the study's research questions.

Fourth, and as mentioned briefly earlier, feedback about developing SleepWise into a mobile phone app was a prominent finding from this study. Developing SleepWise into an app was not feasible within the scope of this PhD, for the cost-related reasons mentioned above. However, participants showed a strong preference for a mobile-friendly sleep intervention, and while they were not encouraged to engage with SleepWise on their mobile phones, they found mobile-friendly features, such as SleepWise reminders and the sleep diary, important for engagement with SleepWise, but only when their use was made flexible and optional. These findings are in line with Werner-Seidler et al.'s (2017) findings, who gained user feedback about a mobile phone sleep app for adolescents, and found that adolescents were attracted to elements of flexibility of use. However, unlike the findings in this chapter, adolescents in Werner-Seidler et al.'s (2017) study found consistent reminders about sleep/wake patterns irritating. SleepWise reminders were made

as an optional feature of the intervention, whereby participants were given the option to opt out if they wished, which, for example, highlights the autonomy promoting elements of SleepWise.

Lastly, the software upgrade meant that some app-like features were available to users, which could help towards personalising SleepWise for users (Blake et al., 2019). For example, participants' specific sleep issues (e.g., difficulty switching off) might be realised through completing regular sleep diaries, which could help guide usage on SleepWise (e.g., engagement with relaxation techniques). However, incorporating electronic devices into adolescent sleep interventions warrants careful consideration, as, conversely, exposure to media and digital use has shown to negatively affect adolescents' sleep (Hale & Guan 2015). Thus, providing individualised phone cut-off times (Bartel et al., 2018), and reducing colour and brightness of screens during evenings and at night (Czeisler et al., 1989), can overcome this barrier and help adolescents self-regulate their sleep behaviours (Blake et al., 2019). Tips for reducing exposure to digital media and associated risks was provided as 'sleep tips' in session 3 of SleepWise (see Figure 3.6).

Figure 3.6

Exposure to Media Before Sleep (Session 3)

The screenshot shows the SleepWise website interface. At the top left is the 'SleepWise' logo. At the top right are navigation links: 'HOME', 'ABOUT US', 'CONTACT US', 'MY PROFILE', and 'LOGOUT'. The main content area features a tip about digital device use before sleep. The tip is presented as a list of points with orange arrowheads. To the right of the text is an illustration of a person in a blue shirt sitting at a desk, using a laptop and a smartphone. Below the tip is a 'Click here' link. At the bottom of the content area are two orange buttons: 'BACK' on the left and 'NEXT' on the right.

SleepWise HOME ABOUT US CONTACT US MY PROFILE LOGOUT

- ▶ Research shows that being on your phone, game console, or laptop/tablet 2-3 hours before sleep can lower your sleep quality
- ▶ The light from your device makes your brain think it's not time to sleep because it's still day light – even when it's not!
- ▶ Overtime this can lead to poor sleep, feeling low and difficulty waking up

Tip: It's a good idea to dim your phone's blue light so you can sleep better at night. Eventually, you might decide to spend less time on your phone all together!

[Click here](#) to find out how digital devices lower sleep quality and tips to cut down on screen time

BACK NEXT

Note. From SleepWise.org.uk © 2020 SleepWise

Brief Outline of the Optimised Version of SleepWise

Based on the findings from this study, an optimised version of SleepWise was created. This optimised intervention consisted of four weekly sessions, available over 5-weeks. Each session was tunnelled (i.e., participants had to work through a set number of pages), whilst additional 'click-through' options were provided for more information, such as vignettes and sleep information. All

sessions included nine to 11 (main/compulsory) pages, with additional optional pages. Session 1 of SleepWise provided information about the importance of sleep in young people, and how eating behaviours impact sleep. Session 2 provided information about physical activity and sleep, and sessions 3 and 4 provided information about sleep and everyday habits (e.g., screen use, sleep environment etc) (see Table 3.3 for a summary breakdown of each week, or Appendix K for full illustrative details. See Appendix U for instructions about how to access SleepWise).

Table 3.3

Weekly Session Outline

Session	Content Outline
Session 1	<ul style="list-style-type: none"> • Importance of Sleep • Sleep and Young People • Sleep and Eating • A Challenge • Stop or Swap • Goal Setting • Track Sleep
Session 2	<ul style="list-style-type: none"> • Congratulations: End of Session 1 • Goal Review • Physical Activity and Sleep • Being Physically Active • A Challenge • Goal Setting
Session 3	<ul style="list-style-type: none"> • Congratulations: End of Session 2 • Goal Review • Sleep and Habits: Digital World • Sleep and Habits: Where You Sleep • Sleep and Habits: Mental Health • Goal Setting
Session 4	<ul style="list-style-type: none"> • Congratulations: End of Session 3 • Goal Review • Sleep and Habits: Balance • Sleep and Habits: Weekends • Sleep and Habits: Sleep Routine • Sleep and Habits: Write • Sleep and Habits: Mindfulness • Sleep and Habits: Friends and Family • Goal Setting • Congratulations: End of Session 4

In addition, participants were encouraged to set weekly goals via SleepWise and log their sleep daily via the sleep diary on SleepWise (Appendix O). The sleep diary was compatible with mobile phones; however, participants were not encouraged to use their mobile phones. Participants had the chance to review their goals from the previous week at the start every weekly session, and

had the opportunity to set new goals or continue with the same goal later in each session. Participants could also print their goals if they wished. Besides goal setting and the sleep diary, other interactive behavioural change aiding tools included a sleep routine chart (for planning night-time sleep routine), audio instructions for mindfulness activities, weekly games and quizzes, and access to external videos and other sources of information about sleep. Further, participants had the option to save their progress (see Appendix V) and come back to SleepWise at a later point. Participants also had the option to revisit their goals, sleep logs, and saved pages via their profile dashboard on SleepWise. Main menu components of SleepWise (on home page) included details about SleepWise, such as SleepWise's contact details (SleepWise email address), and an 'About Us' page (for example, see Figure 2.5). It was this optimised version of SleepWise that was evaluated and tested in a feasibility trial and process evaluation in study 3 (Chapter 4).

Conclusion

The intervention optimisation process of this PhD provided useful insight into user experience and engagement with SleepWise. Findings from this chapter identified potential barriers and facilitators to sleep behaviour change and subsequent modifications ensured that SleepWise was as feasible and acceptable as possible, with the overall aim of increasing its feasibility and acceptability prior to evaluation in study 3. Based on the iterative feedback and modification process in this chapter, an optimised version of SleepWise was developed. The next study in this PhD undertook the testing and evaluation of SleepWise by conducting a feasibility trial with an embedded process evaluation (Chapter 4).

Chapter 4: SleepWise Feasibility Trial and Evaluation (Study 3)

In the previous chapter (Chapter 3), study 2 of this PhD was presented, which explored participants' experiences with a prototype digital (website) sleep intervention called SleepWise. As part of study 2, think-aloud and focus group interviews with target users were undertaken, whereby participant feedback informed modifications made to SleepWise. This led to creating an optimised version of SleepWise, to ensure that it was as acceptable and feasible as possible, prior to evaluation. This chapter presents study 3 of this PhD, whereby two (2-arm) randomised controlled feasibility trials, with an embedded process evaluation, were carried out to investigate the feasibility of SleepWise as a digital sleep intervention aimed at adolescents.

Feasibility is defined as an overarching concept for studies that investigate whether a future trial, testing the effectiveness of an intervention, should be undertaken (Eldridge et al., 2016). Feasibility trials receive minor consideration in the literature, and even smaller consideration in scientific research training (Blatch-Jones et al., 2018; Thabane et al., 2010). However, best practice guidance (e.g., Medical Research Council (MRC), National Institution for Health Research (NIHR), and Consolidated Standard of Reporting Trials (CONSORT)), state that feasibility trials must be conducted before proceeding to a main trial (Arain et al., 2010; Craig et al., 2013; Eldridge et al., 2016). Feasibility trials help test the acceptability of study procedures, estimate the likely rates of recruitment and retention of participants, determine a required sample size for a main trial, and ensure a cost and time effective method for testing the intervention prior to a main trial (Cocks & Torgerson, 2013; Eldridge et al., 2016). Feasibility trials are recommended for new sleep interventions, as this helps reduce research waste and time (Blake et al., 2019; Blatch-Jones et al., 2018; Cassoff et al., 2013; Eldridge et al., 2016).

The NIHR's research evaluation centre (National Institute for Health Research's Evaluation, Trials and Studies Coordinating Centre (NIHR NETSCC)) differentiates between pilot and feasibility studies, and this was taken into consideration when planning the feasibility trial in this PhD (NIHR NETSCC, 2020). According to the NIHR NETSCC definition, a pilot study is defined as "a version of the main study that is run in miniature to test whether the components of the main study can all work together" (Arain et al., 2010, p.5), whereas a feasibility study determines whether it is feasible to conduct the main study. In a feasibility study, no hypotheses are tested, and the primary outcome is not evaluated (i.e., effectiveness of the intervention on the primary outcome is not tested) (NIHR NETSCC, 2020). As well, feasibility trials help to estimate important parameters required to design the main study, such as: standard deviation of the primary outcome measure (which is needed to estimate a sample size for a main study), the willingness of participants to be randomised, follow-up rates, appropriateness of outcome measures, response rates to questionnaires, and adherence and

compliance rates to the intervention (Arain et al., 2010). As part of this PhD, a feasibility trial was undertaken to understand the acceptability and feasibility of recruitment (e.g., uptake, attrition), study procedures (e.g., appropriateness of outcome measures, randomisation, incentivisation), and trial outcomes (e.g., exploratory effect size). While primary and secondary outcome measures (discussed later in this chapter) were not analysed in the feasibility trial, their appropriateness was explored and will be discussed later in this chapter. An exploratory effect size analysis for the primary outcome (sleep quality) was also undertaken to provide vital information to estimate a sample size for a future main study. Lastly, a process evaluation was carried out to investigate intervention usage and perceptions of user experience with the intervention and study procedures.

Below, the methodology of the feasibility trial is discussed first, followed by the trial findings. Findings will be discussed in relation to recruitment (attrition (dropout rate) and completion), across three different time points (start of study, 5-weeks, and at 3 and 6 months follow-up). Results from the process evaluation will be presented next, in relation to quantitative usage analysis of SleepWise, followed by qualitative (follow-up) feedback about participants' experiences with SleepWise and the study procedures. Lastly, a revised logic model, exploratory effect size analysis, and recommendations about a future sample size from each trial, will be discussed before presenting conclusions.

Methods

Ethical approval for this study was received from the University of Winchester's ethics committee (RKEEC190204) (Appendix W). Ethical approval gained in this study was separate to that gained in Study 2, as study 3 responded to the findings in study 2 i.e., study 3 aimed to test the optimised version of the intervention. Thus, each study required its own individual ethical approval.

Feasibility Trials Undertaken

Two separate feasibility trials were undertaken instead of one trial. This was due to originally incentivising participation (in the first trial), but understanding that incentivisation may have motivated participants to highly engage with the intervention, in order to finish the intervention and receive their incentive. As this may have caused bias towards higher levels of engagement with the intervention, a second trial was undertaken that did not incentivise participants upon completion of the intervention. Undertaking two feasibility trials helped investigate the feasibility of incentivisation and the associated outcomes (e.g., usage with the intervention). The procedure for each trial (as described below) remained identical. However, in the first trial (trial 1), participants who took part in the intervention group were emailed a £20 Amazon e-voucher once they had

completed the intervention and answered the 5-week follow-up questionnaires. Participants in trial 2, who took part in the intervention group, did not receive an incentive upon completion.

In regard to the use of incentives, the effectiveness and maintenance of behaviour change when using incentives, especially when targeted at more challenging and complex behaviours, is not well-understood, and their feasibility (e.g., practicality, usefulness) even lesser so (Ball et al., 2019; Cahill & Perera, 2011; Mantzari et al., 2012; Marteau et al., 2013; Paul-Ebhohimhen & Avenell, 2008). Incentives need careful consideration in research, by considering 'if' and 'when' incentives may be effective and appropriate (Vlaev et al., 2019). The use of incentives in promoting health behaviours is relatively recent (Oliver et al., 2009), and can take several forms, such as giving participants money or shopping vouchers (Vlaev et al., 2019). Incentives are thought to provide an immediate reward for behaviours that take place and can lead to long-term health benefits (Domjan, 2003; Marteau et al., 2009). There is evidence to suggest that 'indexed' and 'escalating' incentives (e.g., a set and increasing value of incentives awarded for each completed task) could be more effective than non-set and escalating incentives in promoting health behaviour change and medication adherence (Higgins et al., 2004; Pope & Harvey-Berino, 2013). There is also evidence suggesting that more guaranteed incentives are more effective than those that are 'lottery-based' (e.g., prize draw), and incentives that are awarded shortly after achieving the required behaviour/task might be more effective than those provided at a later time (e.g., weeks or months later) (Ball et al., 2019; O'Donoghue & Rabin, 2000), which may be explained by individual's inclinations to be more motivated by instant than delayed gratification (O'Donoghue & Rabin, 2000). Further, research suggests that, for optimal improved outcomes, incentives should be used alongside other evidence-based behaviour change techniques, such as goal setting, to facilitate increased intrinsic motivation that is maintained after incentives have ended (Hunter et al., 2013; Marteau et al., 2009).

There may be an expectation that incentives could be more attractive and effective for individuals from more disadvantaged socioeconomic status backgrounds (Anderson et al., 2001). However, there is concern around the coercive effect of using incentives, and the inequity of rewarding individuals for performing tasks that are already in their favour (Grant, 2002; Marteau et al., 2009). For example, research suggests that incentive-based health promotion interventions may be more suitable or attractive to those from more deprived backgrounds (Aveyard & Bauld, 2011; Cookson & Popay, 2008; Giles et al., 2014). In this feasibility trial, the use of incentives was explored across two separate trials, and will be discussed in more depth later in this chapter.

Sample Size

The target sample size for the feasibility study was 100 adolescents (50 participants per trial) aged between 13-19 years. A sample size of 100 was deemed appropriate as this allowed for a 40-50% dropout or loss to follow-up, which is common in internet-based research, resulting in an overall sample of at least 50 participants (Bennett & Glasgow, 2009). It was intended that 25 participants be randomised to an intervention group (receiving the SleepWise intervention) and 25 to a control, who received 'normal' sleep education as per usual i.e., sleep-related content that was already being taught at school/college. The control group was essentially the equivalent of receiving 'treatment as usual' in a clinical setting, which is commonly used within adolescent sleep intervention research (e.g., Bonnar et al., 2015).

Participant Criteria

The eligibility criteria included having access to a computer/laptop with internet (due to the digital nature of the intervention) and being aged between 13-19 years (participant demographics are presented later in this chapter).

Recruitment

Four secondary schools and two colleges showed interest in participating. However, one school dropped out without reason, which resulted in the total of three secondary schools and two colleges taking part. Most participants who showed interest were from secondary schools, as one had an already existing relationship with the university, and included psychology as a GCSE option. Trial 1 recruitment took place from November 2018 – May 2019 (study running in the summer term), with a rolling start time. Trial 2 recruitment took place from May 2019 – December 2019 (study running in the autumn term), also with a rolling start time.

Adolescents aged 13-19 years were recruited by emailing organisations (e.g. secondary schools, colleges) asking them about their interest in partaking in the study (see Appendix X for an email template). If an organisation agreed to take part, the researcher met with an allocated member of staff (study facilitator) to discuss the study procedures, and consequently sent the facilitator a study poster (Appendix Y) for advertising the study. Some facilitators suggested that an assembly about the study, or a psychology related talk, would be useful for engaging pupils to participate, which happened for sites who inquired, and as a token of appreciation for sites that agreed to take part in the study. Facilitators were not required to view the intervention, however could do so if they wished (in which case the researcher would grant them access by emailing them a link to the intervention).

Consent and information sheets (Appendix Z) were collected by interested participants from the study facilitator, or emailed to interested participants by the researcher. The latter was most common for college students, as they often responded to poster adverts, which included an email address to get in touch with the researcher. As parental consent was not required for college students, since they were aged 16 years and over, those who agreed to take part emailed their consent form to the researcher. Parental consent was sought for participants below the age of 16, as per the British Psychological Society's (BPS) ethical guidelines (BPS, 2017). Participants who collected consent forms from facilitators were instructed to return their forms within 1-2 weeks. The researcher then collected consent forms from each site. The researcher's personal email address was not used for contact with participants, instead, the researcher operated from a SleepWise email address (info@sleepwise.org.uk) for contacting participants. Only the researcher had access to email correspondence with participants and staff, and undertook a Criminal Record Background check prior to starting recruitment.

Procedure

Participants who agreed to take part provided consent (i.e., via email or physical copy) and demographic information (Appendix H), and were randomly allocated to the intervention or control group using an online randomisation generator (Randomisation.com). Those allocated to the control group continued to receive education as per usual (e.g., at school/college), and were not asked to do anything differently. However, they were given the opportunity to use the intervention at the end of the study. Participants in the intervention group were emailed a link (email addresses were provided on consent forms) to the intervention and were asked to work through it for 4-5 weeks. Both groups were asked to complete baseline measures (detailed later in this chapter), via the Qualtrics survey software, accessed by a link in an email sent by the researcher. Only those allocated to the intervention group had access to the intervention. Participants were not screened for any sleep, mental, or physical health conditions, as SleepWise was intended for use in a general population of adolescents, and not in an exclusive clinical or sub-clinical group.

Participants in the intervention group were sent weekly emails that included the web-link to each weekly SleepWise session. Access to SleepWise was provided by the researcher each week, and participants could not view the content of each weekly session earlier than the scheduled 1-week window. Participants in the intervention group were encouraged to set weekly goals, and asked to complete a daily sleep diary log as part of the study, which was embedded within SleepWise (Appendix O). While the sleep diary was compatible with mobile phones (as per participant feedback in study 2), participants were not encouraged to use their mobile phones as part of the study. At the start of each weekly session (excluding session 1), participants reviewed goals from the previous

week by answering a question about whether they had met, part met, or not met their goals. Later in each session, participants were given the option to set a new goal or continue with the same goal. The researcher could not access the content of participants' goals or sleep logs. Information about the date, time, frequency of participants' weekly goals, sleep logs, and pages visited was automatically tracked by the SleepWise website. Participants were sent weekly email and text reminders to remind them about completing their goals and sleep logs. However, participants had the option to opt out of these reminders if they wished (by ticking an electronic box when prompted) (Appendix Q). All email reminders were sent by the researcher via the SleepWise email address, and text reminders were sent using a research specific sim-card that the researcher purchased specifically for contact with participants.

After 4-5 weeks, participants in both groups were asked to complete the same measures as those completed at baseline (described below), as well as questions regarding the intervention's acceptability for those in the intervention group. Participants in the intervention group in trial 1 were sent (via email) a £20 Amazon voucher once post study (5-week) questionnaires were completed. This incentive was only given to participants in the intervention group who completed each session of the intervention and the post study follow-up questionnaires in trial 1.

At 3 and 6 months, participants in both groups (across both trials) were emailed and asked to complete follow-up measures (the same as the baseline measures). Follow-up text and email reminders were sent to participants if they had not responded to post-study (5-weeks, 3 and 6 months) questionnaires. No incentives were given in either trial for completing the 3 and 6 month questionnaires, as the sleep intervention was complete by this stage.

Measures

The reliability of each measure was evaluated by calculating Cronbach's alpha using the SPSS software (Version 26). A reliability score below .70 suggested that the items within the scale components indicated poor internal consistency, where the items correlated poorly with other items, the items may have been measuring different constructs (Rattray & Jones, 2007).

The Pittsburgh Sleep Quality Index Short Form (PSQI-SF)

The PSQI-SF (Famodu et al., 2018) was used to measure sleep quality among participants (Appendix AA). The PSQI-SF is a shortened version of the PSQI 19-item self-rating questionnaire and includes 13-items differentiating between "good" and "poor" sleepers. The PSQI is a well-validated self-rated questionnaire that has been used widely in the adolescent population, to assess subjective sleep quality and disturbances, and the impact of poor sleep on functioning (Devine et al., 2005; Lund et al., 2010; Megdal & Schernhammer, 2007). The PSQI demonstrates strong reliability and

validity and moderate structural validity among adolescents and young adults (Biddle et al., 2015; de la Vega et al., 2015). The PSQI-SF is measured along five dimensions: sleep latency, sleep duration, sleep efficiency, sleep disturbances, and daytime dysfunction. Scores across the five components were summed on a Likert scale ranging between 0 (very good) to 3 (very bad), using the PSQI-SF scoring system (Famodu et al., 2018). A total score greater than “4” was indicative of poor sleep quality (Famodu et al., 2018). Cronbach’s alpha for the five components of the PSQI-SF was .73 pre-intervention and .52 at post-intervention in trial 1, and .81 and .79 respectively in trial 2.

The International Physical Activity Questionnaire (IPAQ)

The IPAQ (Craig et al., 2003; IPAQ, 2002) was used to measure physical activity levels among adolescents. Three categories of the IPAQ were assessed, using six questions, including walking, moderate and vigorous activity, assessed in days, hours, and minutes (Appendix BB). While it is commonly advised that the order or wording of the IPAQ is not altered (IPAQ, 2002), job related physical activity and transportation physical activity were excluded from the IPAQ questionnaire, as these questions were not relevant to the everyday lives of adolescent users (e.g., on how many days did you do vigorous physical activities like heavy lifting, digging, heavy construction, or climbing upstairs as part of your work). Metabolic equivalents (MET) were calculated across the three categories and summed to give a total MET score. One metabolic equivalent (MET) is defined as the amount of oxygen consumed while sitting at rest and is equal to 3.5 ml O₂ per kg body weight x min (Forde, 2020). Higher MET scores indicated higher levels of physical activity.

The IPAQ has been successfully implemented in adolescent population research (Garaulet et al., 2011; Haerens et al., 2007). Cronbach’s alpha for total MET scores across the three categories was .50 pre-intervention and .55 post-intervention in trial 1 and .39 and .47 respectively in trial 2. While physical activity outcomes were not analysed in the feasibility trial, participant feedback (discussed later) indicated that this scale was difficult to interpret, which may explain low alpha scores across both trials. Low alpha scores may also be due to modifying the IPAQ scale, by removing certain unsuitable items from the questionnaire. It is not uncommon for physical activity scales to be unsuitable and/or unfeasible for adolescent users (e.g., see systematic review by Chinapaw et al., 2010), thus their use requires careful consideration.

Eating Behaviour/s

Eating behaviour was assessed across five self-report questions composed by the researcher (Appendix CC). Two questions used a Visual Analogue Scale to assess adolescent’s confidence (0 = not at all confident, 100 = strongly confident) and intention (0= do not intend, 100= strongly intend) to resist unhealthy snacks. Two further questions assessed the frequency of snacks per week and per

day, ranging from “none” to “5 or more”. A final question assessed the frequency of sugary caffeinated/energy type drinks consumed per day, ranging from “none” to “5 or more drinks per day”. Intention and confidence to eat healthier are among important factors that influence adolescent’s healthy eating behaviours (Chan et al., 2014,2016; Gronhoj et al., 2012), and food frequency questionnaires are commonly used in research assessing adolescents’ eating behaviours, and have shown good validation and reliability across European adolescents (Garaulet et al., 2011).

The Depression Anxiety Stress Scales (DASS) 21

The DASS-21 (Lovibond & Lovibond, 1995) was used to measure depression and anxiety among adolescents. This scale has three components (depression, anxiety, and stress) and each item comprises of a statement and four short response options, ranging from 0 (did not apply to me at all) to 3 (applied to me very much) (Appendix DD). To yield equivalent scores to the full DASS-42, the total score of each component was multiplied by 2 and ranged from 0 to 42. This scale has been shown to have excellent reliability and good internal consistency among adolescent users (Silva et al., 2016). Cronbach’s alpha for the 21 items of DASS was .94 pre-intervention and .95 post-intervention in trial 1 and .93 and .94 respectively in trial 2.

Acceptability E-Scale

Acceptability of the intervention was assessed using the 6-item Acceptability E-Scale (Tariman et al., 2011) (Appendix EE). This scale was used to indicate on a 5-point Likert scale (1= negative evaluation, 5=positive evaluation) the extent to which users deemed the intervention to be acceptable. Scores on each subscale were summed for a total acceptability score. This measure was slightly adapted (replacing “computer programme” with “this website” and removing one item that was not relevant to this study (asked how helpful the programme was for describing symptoms and quality of life)). Cronbach’s alpha for the five items of this scale was .76 in trial 1 and .66 in trial 2.

Actigraph

To investigate the feasibility of objectively collecting sleep data via actigraphy, 10 participants in the intervention group were chosen at random to wear actigraph (wristband) devices. Only 10 participants in each trial were asked to wear actigraph devices, as only 10 devices were available per trial. Actigraphy is a popular method to measure sleep-wake patterns through body movement (Littner et al., 2003), which records data from accelerometers several times per seconds. Actigraphy is widely used in adolescent populations to assess sleep-wake patterns in participant’s normal environment over extended periods of time (Sadeh, 2011; Weiss et al., 2010).

In this study, GENEActiv actigraph devices, designed to monitor physical activity and sleep activity, were used to investigate the feasibility of objectively measuring participant’s sleep quality.

Participants were instructed to collect and drop off their devices from their school/college reception. A handout with instructions (Appendix FF) about how to wear and care for the actigraph device was emailed (and a physical copy provided upon collection) to the selected participants. The device was advised to be worn around the wrist (like a watch) for 24-hours a day (where possible) for the duration of 5-weeks. Participants with actigraph devices were sent email and text reminders (Appendix GG) asking them to return their device to their school/college reception upon intervention completion. The feasibility of using these devices, from a user (e.g., comfort) and researcher (e.g., data download, analysis process) perspective, is discussed later in this chapter.

Sleep Diary

Participants in the intervention group were asked to log their sleep daily, on a computerised version of a sleep diary, accessed via SleepWise. Sleep diaries are a cost-effective, clinically acceptable, and subjective method to gather sleep data, which are commonly used in sleep related research (Lawrence & Muza, 2018). Participants answered nine short questions regarding their bed-time, wake time, how easily they fell asleep (easily, after some time, with difficulty), how many times they woke during the night (and for how many minutes), total sleep hours, and how they felt upon waking (refreshed, somewhat refreshed, tired) (Appendix O). Participants were provided space to write other factors that may have affected their sleep (e.g., monthly cycle for females etc).

Process Evaluation

Alongside the feasibility trials, a separate process evaluation was undertaken in order to assess adolescents' engagement and experience with SleepWise and that of the trial procedures. The process evaluation consisted of both quantitative and qualitative data collection and analysis as follows:

The quantitative component evaluated participants' usage of SleepWise. Participants' engagement with each weekly session (time and pages viewed) and the number of goals and sleep logs completed across the 5-weeks was examined using SleepWise's automatic data tracker. Participant's individual usage data was then downloaded into an excel document by the researcher, and the researcher cleaned the data (e.g., deleting empty rows), and charted and anonymised each participant's usage data from each trial in a separate excel document (for an example, see Appendix HH). The data was then converted into a SPSS file, for creating tables and charts. This helped compare the differences and similarities in usage patterns between participants across the two (incentivised vs non-incentivised) trials. Once usage data was downloaded from SleepWise, the website's track history was deleted. The same procedure was carried out for participants' sleep and health outcomes, downloaded from the Qualtrics survey software, and converted into separate SPSS

files for each trial. While this data was not analysed as part of the feasibility trial, sleep quality outcomes were used to undertake an exploratory effect size analysis to estimate a future sample size for a main study (discussed later in this chapter).

The qualitative component of the process evaluation explored participants' experiences with SleepWise, via qualitative follow-up interviews. Participants from both trials across both the intervention and control groups were contacted at 5-8 weeks post intervention via phone-call interviews. Additionally, staff members who helped facilitate the study (facilitators) (e.g., point of contact, advertising study details, distribution, and collection of consent forms) were interviewed to gain insight into their experience of assisting with the study. Interview guides for each interview type (e.g., intervention user, control group, facilitator) can be found in Appendix II. A £20 Amazon voucher was emailed to each participant on completion of interviews. This was not part of the incentivisation evaluation of the intervention, as the intervention usage would have ended by this stage.

The qualitative interviews aimed to gain an in-depth understanding about participant's engagement and experience with SleepWise, the potential barriers and challenges to engagement, and the acceptability of trial procedures (e.g., questionnaire measures, using Actigraph devices etc). All interviews were audio recorded and lasted for approximately 20-30 minutes, depending on how much information the participant provided. Interviews stopped until saturation was reached (i.e., no new themes were derived from the latest interview transcripts) (Green & Thorogood, 2018). The recordings were transcribed verbatim and an inductive thematic analysis was conducted, using Braun and Clarke's (2006) six phases to thematic analysis. Transcripts were read and re-read to become familiarised with the data. Subsequently, line-by-line analysis of the transcripts was carried out, whereby interviews were coded, and a coding manual created. Themes were then created from codes that shared similar components of the data, which will be discussed later in this chapter.

Results

The data from the feasibility trials and process evaluation were analysed separately and brought together in order to determine the acceptability and feasibility of recruitment (e.g., uptake, attrition), study procedures (e.g., randomisation, incentivisation), and trial outcomes (e.g., exploratory effect size). The process evaluation investigated intervention usage and perceptions of user experience with the intervention, as well as participants' experience with the study procedures. In this section, each trial will be discussed in turn regarding attrition and completion. Findings from each trial will then be brought together when discussing the process evaluation (i.e., intervention usage and qualitative feedback).

Participant demographics, attrition, and completion will be discussed first. After these findings, quantitative results regarding usage of the intervention will be discussed, followed by the qualitative feedback regarding user experience. Thereafter, the feasibility of the study measures (questionnaires and actigraphy), as well as the feasibility of undertaking trial procedures within an educational setting (from a facilitator perspective), will be discussed. Lastly, exploratory estimated effect sizes and a recommended future sample size from each trial will be discussed.

Participant Demographics, Attrition and Completion

Table 4.1 shows participant demographics in each trial and Figures 4.1 and 4.2 show the recruitment, attrition, and completion process in trial 1 and trial 2. Participants were not asked to provide reasons as to why they dropped out after consenting to taking part. While some participants across both trials dropped out (over the course of each trial), the expected figures for recruitment were approximately met and dropout rates were low across both trials (see Figures 4.1 and 4.2). This is promising, as these findings may suggest that retaining participants could be feasible within digital sleep interventions targeted at adolescents (discussed later in this chapter).

Table 4.1

Participant Demographics in Each Trial

Trials		Trial 1 (N=39)		Trial 2 (N=35)	
Age	M (SD) Median (Range)	14.74 (0.44)	15.0 (1)	14.71 (1.07)	14.0 (3)
Gender	<i>n</i> , (% of group)				
	Male	11 (28.2 %)		6 (17.1 %)	
	Female	26 (66.7 %)		29 (82.9 %)	
	Non-Binary	1 (2.6%)		-	
	Transgender Male	1 (2.6%)		-	
Ethnicity	<i>n</i> , (% of group)				
	White	34 (87.2 %)		32 (91.4 %)	
	Chinese/ South East Asian		-		
	Black African		-		
	Indian	2 (5.1 %)		2 (5.7 %)	
	Black Caribbean		-		
	Pakistani		-		
	Bangladeshi		-		
	Other - Black British	1 (2.6 %)		-	
	Other – Mixed Heritage	2 (5.1 %)		-	
	Other – Native American	-		1 (2.9 %)	
School/College	Year <i>n</i> , (% of group)				
	Secondary School: Year 10	39 (100 %)		29 (82.9 %)	
	College: 1 st Year College			2 (5.7 %)	
	College: 2 nd Year College			4 (11.4 %)	

Note. Data are presented as means and (standard deviations), unless otherwise stated. *N*= total number of participants; *n*= total sample number.

Figure 4.1

Recruitment, Attrition, and Completion Process in Trial 1

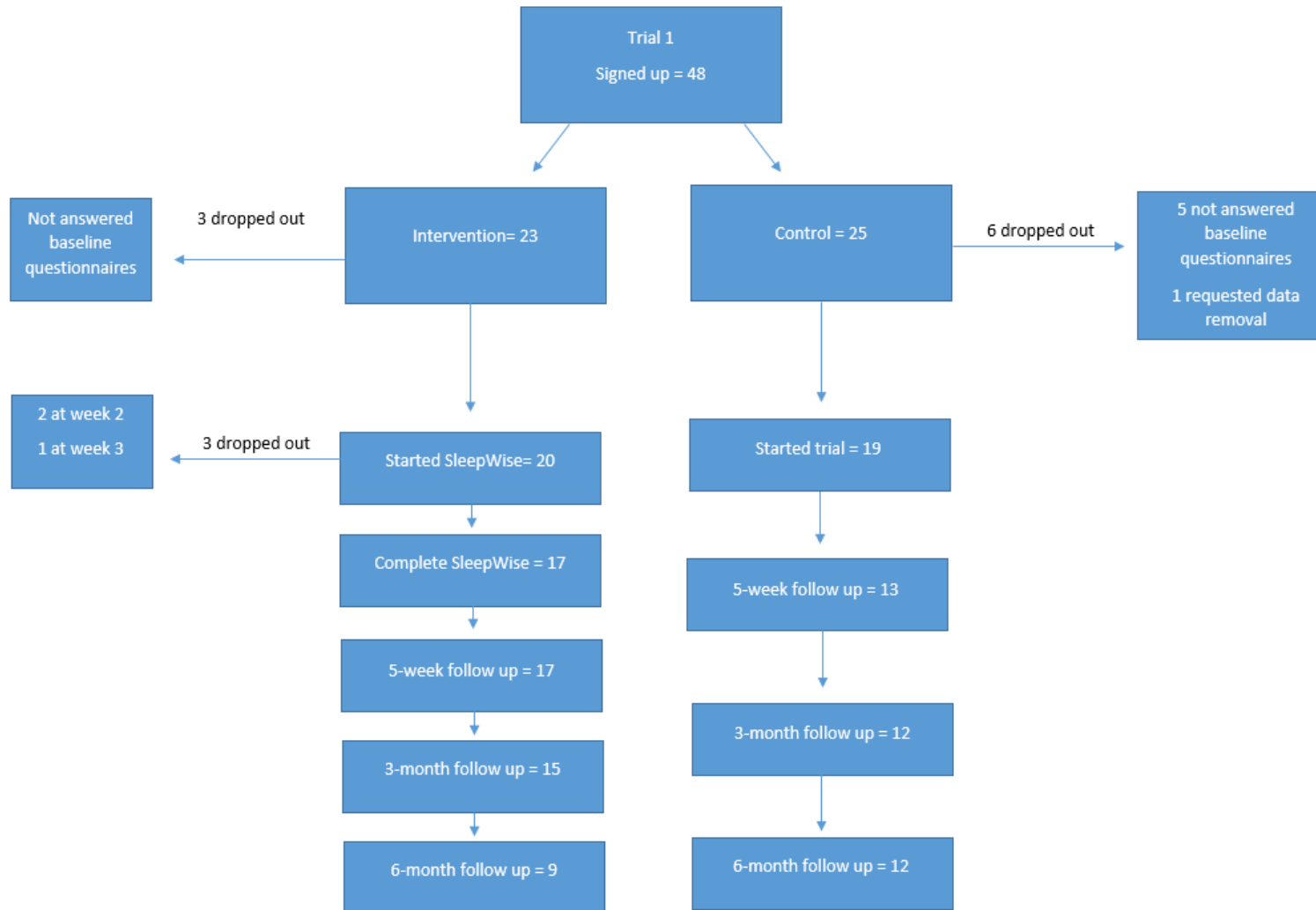
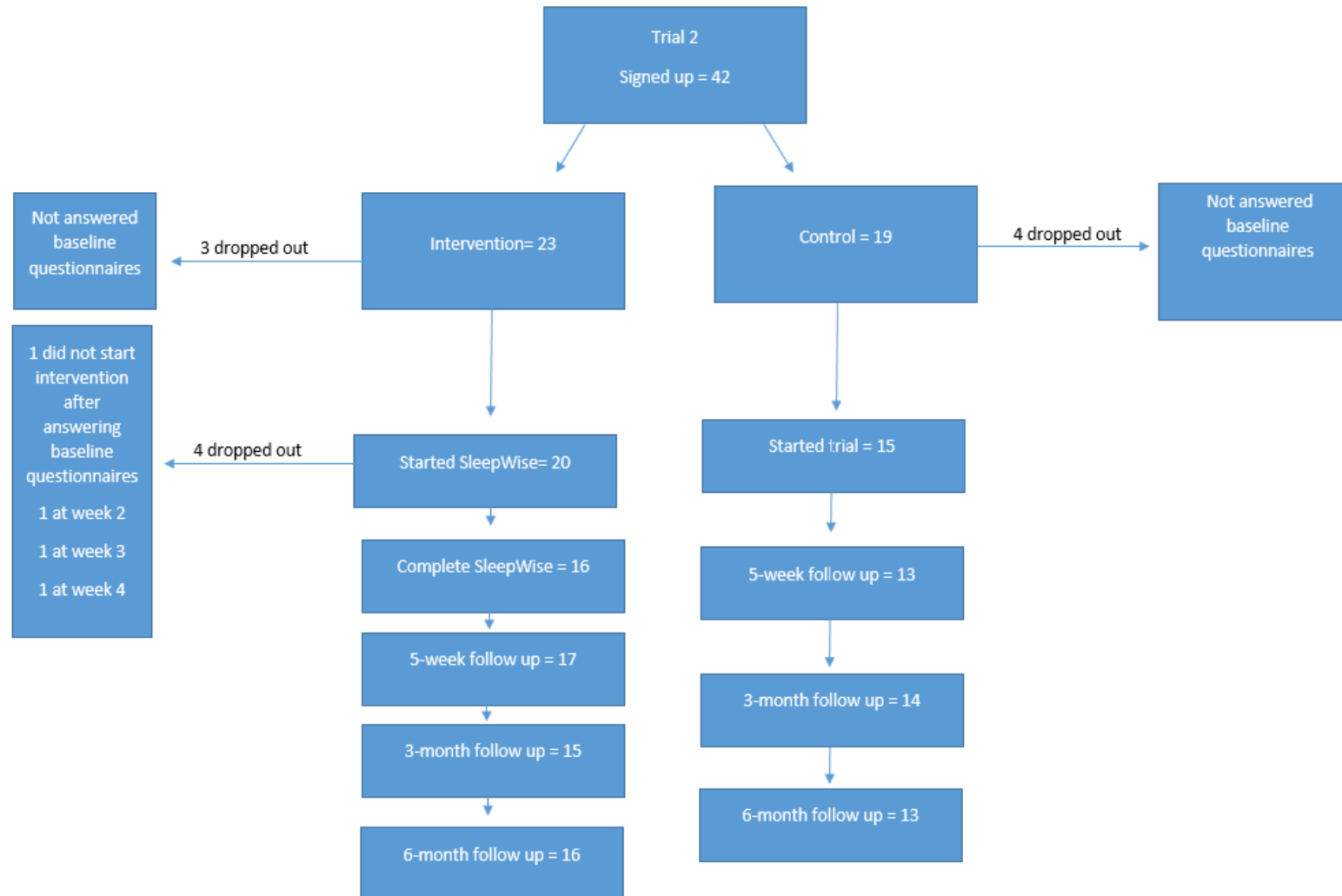


Figure 4.2

Recruitment, Attrition, and Completion Process in Trial 2



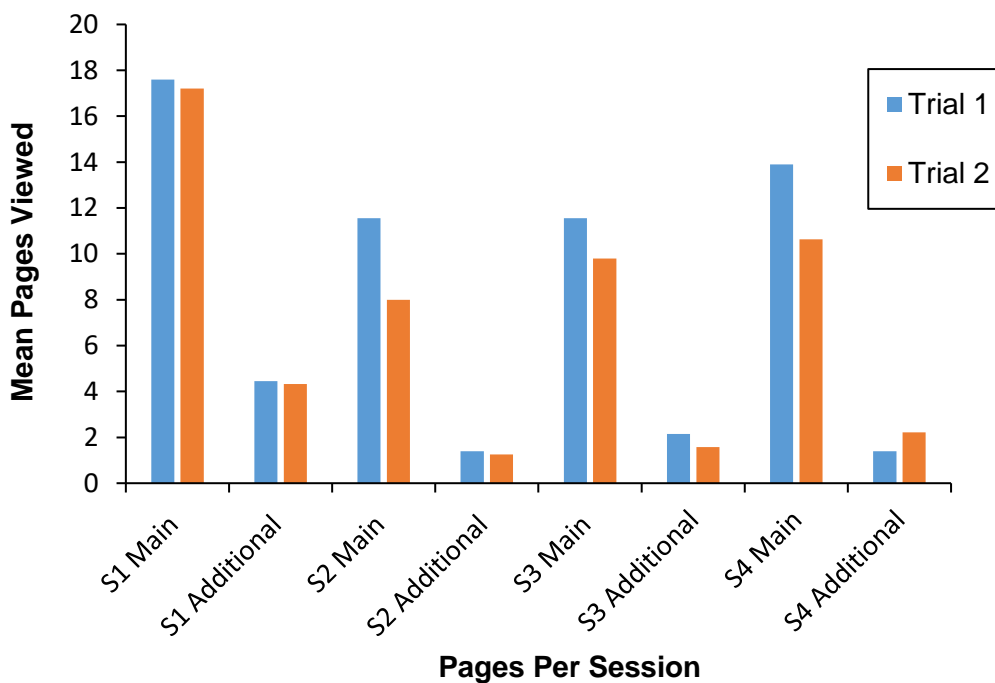
Quantitative SleepWise Usage Data from Both Trials

Number of Pages Viewed

Participants in both trials showed near-similar usage patterns, with those in trial 1 showing a higher number of main pages (compulsory website pages) viewed across all sessions (Figure 4.3). Participants in both trials viewed more pages in the first session (eating and sleep) than any other session on SleepWise. Participants in both trials also explored the additional (optional) pages of the first session more than those in any other session (Figure 4.3), suggesting higher levels of interest for session 1.

Figure 4.3

Pages Viewed Per Session in Each Trial



Age band data showed that older participants, represented by college-level education, also viewed more main and additional pages on the first session ($M = 20.17$ ($SD = 6.24$); $M = 6.50$ ($SD = 5.51$), respectively), when compared to any other session. Older participants also showed a higher mean number of main and additional pages viewed for the fourth session ($M = 13.33$ ($SD = 7.47$); $M = 3.83$ ($SD = 5.19$), respectively), when compared to younger participants, suggesting that both sessions 1 and 4 may have been more liked and relevant to older adolescents.

Frequency of Sleep Logs, Goals, and Goal Reviews

Participants in both trials completed a similar number of sleep logs and goals across the 4-5-week period (Figure 4.4). However, when reviewing goals across the 4-5-week period, participants in trial 2 'met' their goals more frequently (Figure 4.5) than those in trial 1 (Figure 4.6). Participants in trial 1 mainly 'part met' their goals. This may, tentatively, suggest that participants in trial 2 were slightly more successful in achieving their goals than those in trial 1.

Age band data suggests that older participants completed a similar total mean of sleep logs and set goals ($M = 9.68$ ($SD = 10.93$); $M = 2.5$ ($SD = 1.87$), respectively) when compared to younger participants.. Overall, like participants in trial 1, older participants also 'part met' their goals more frequently across the intervention period (session 2 = 50% part met goal; session 3 = 33% part met goal; session 4 = 16.7% part met goal)

Figure 4.4

Mean Sleep Logs and Goal in Each Trial

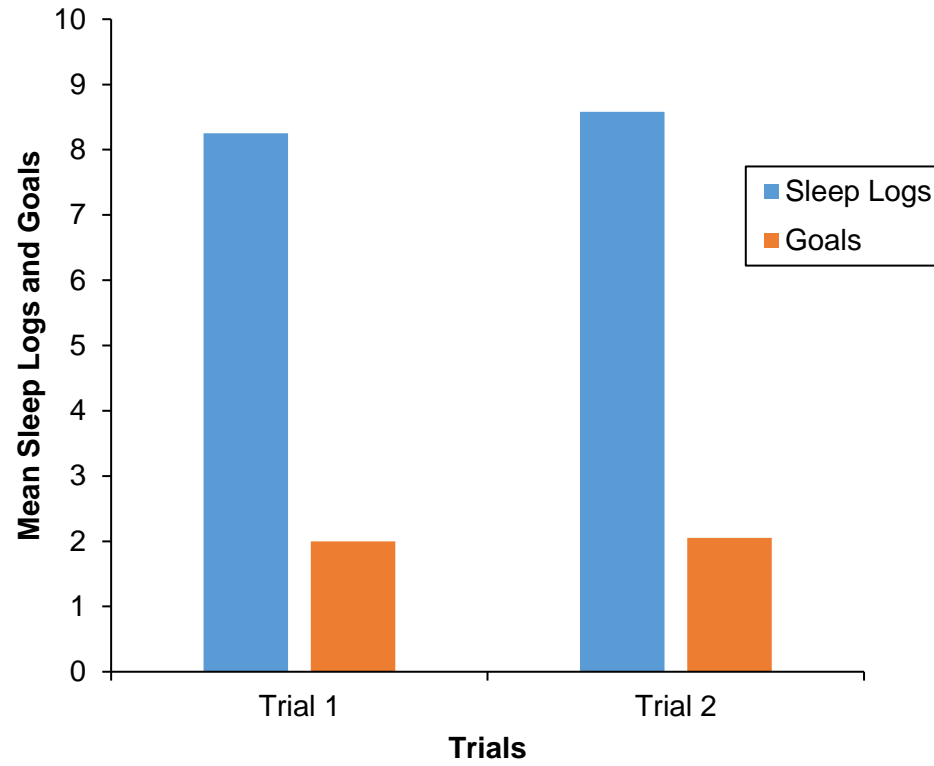


Figure 4.5

Goal Review Trial 2

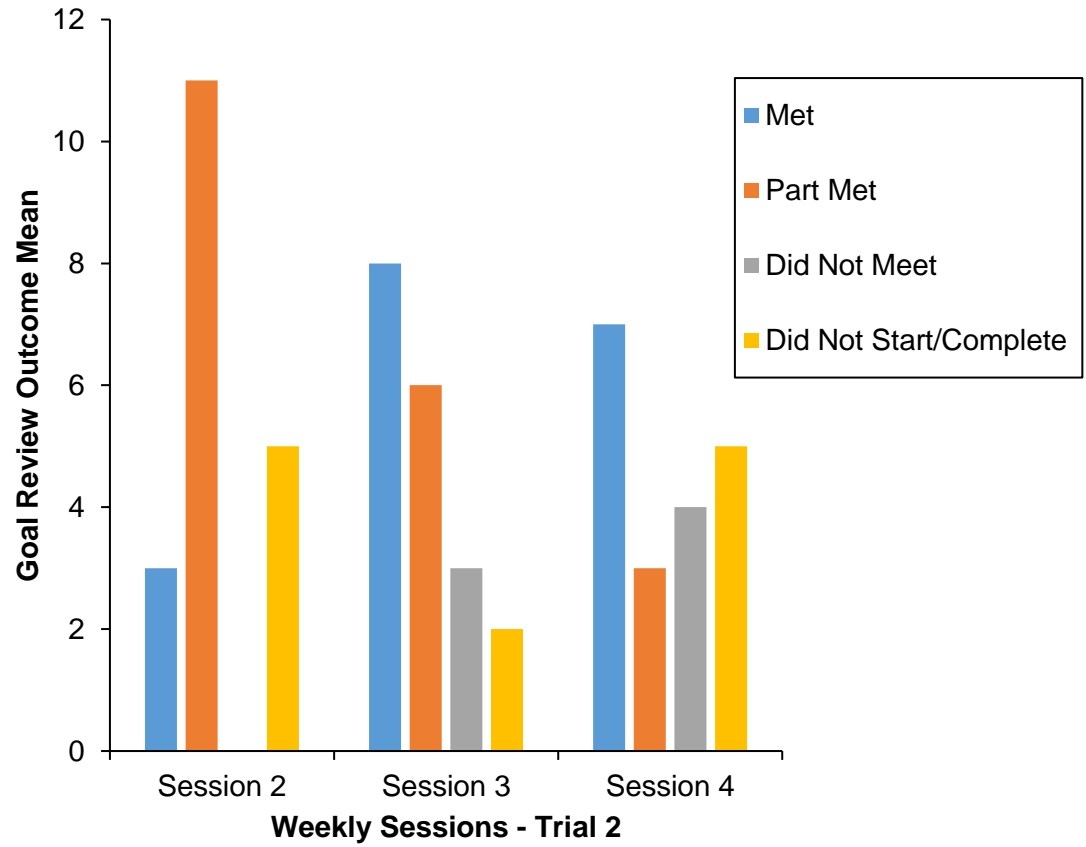
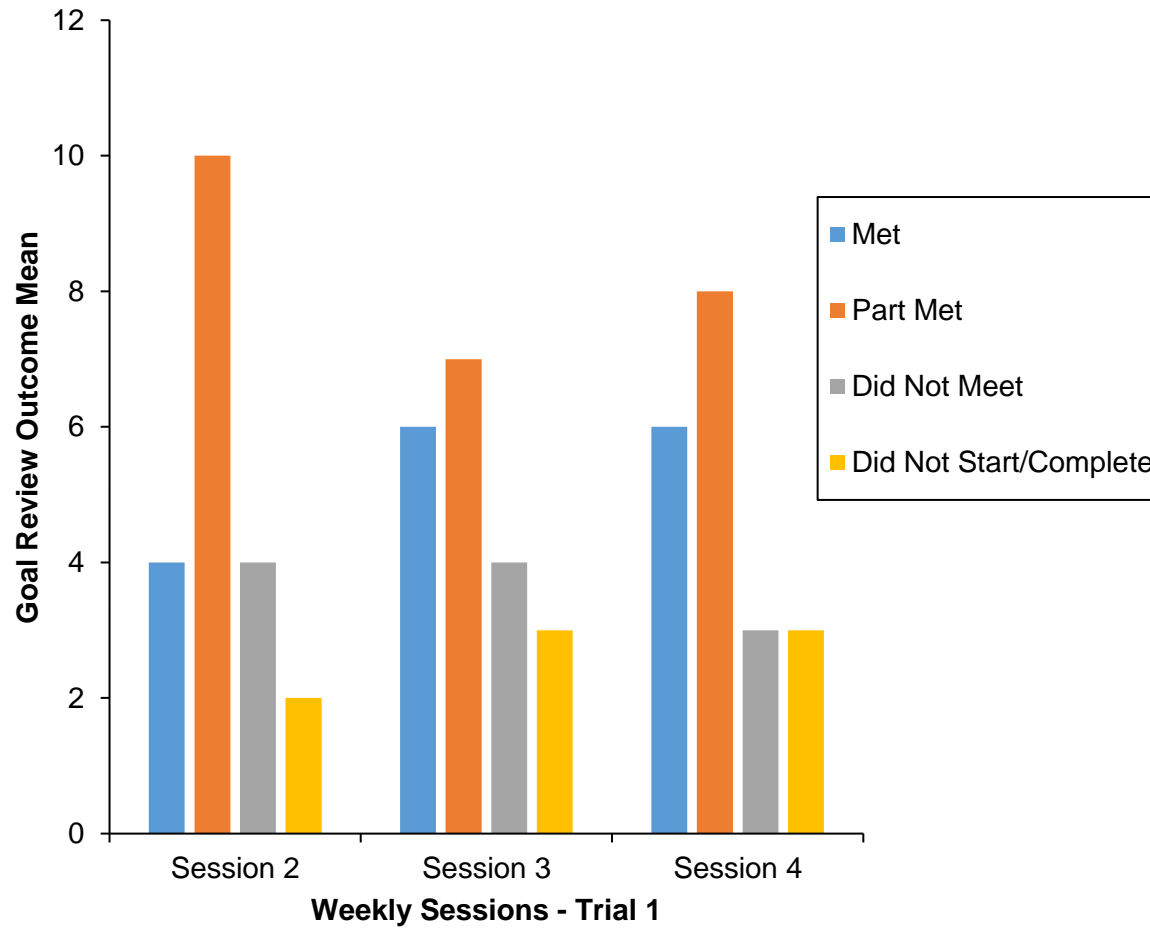


Figure 4.6

Goal Reviews Trial 1



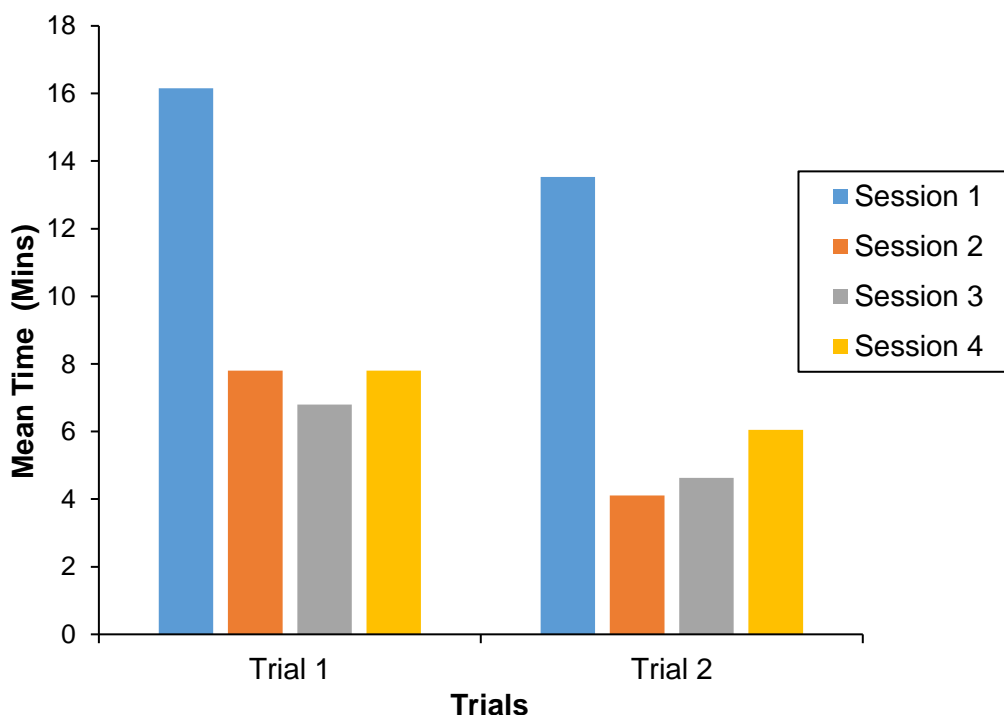
Time Spent on Each Weekly Session

Participants in both trials spent more time on the first session (sleep and eating) of SleepWise when compared to later sessions (i.e., sessions 2, 3, and 4). Participants in trial 1 spent more time on each session of the intervention than those in trial 2 (Figure 4.7). This further supports earlier findings about participants indicating more engagement and interest in the first session of SleepWise. These findings also suggest that participants in trial 1 were slightly more engaged with the intervention than those in trial 2.

Usage data across age band suggests that older participants (i.e., college students) spent longer on sessions 1 and 4, as indicated by total mean time (session 1 M = 19.83 (SD = 4.36); session 4 M = 10.83 (SD = 14.16)) when compared to any other SleepWise session (i.e., sessions 2 and 3). This may suggest that older adolescents found sessions 1 and 4 of particular interest. This may also tentatively suggest that older adolescents were attracted to the behaviour change tools (e.g., goal setting) and information provided in session 1 (e.g., encouraging less snacking before sleep) and session 4 (e.g., reducing arousal before sleep). These findings may be expected, as older adolescents (e.g., college students) are often required to manage multiple priorities such as employment, college work, and relationships, which may compete with opportunities to implement healthier sleep behaviours (Paterson et al., 2017). Thus, these findings may (tentatively) indicate that older adolescents may require these management skills more, and therefore benefit from tools that help them relax and/or manage their sleep behaviours.

Figure 4.7

Mean Session Time in each Trial



Overall, findings from the quantitative usage data analysis suggest that participants in both trials showed similar levels of engagement across all SleepWise sessions but that session 1 was highly engaged with by all participants across both trials, when compared to other sessions. Those in the incentivised trial (trial 1) showed slightly higher usage across all sessions, when compared to those in the non-incentivised trial (trial 2). However, those in the non-incentivised trial (trial 2) 'met' their goals more frequently, when compared to those in the incentivised trial (trial 1). These findings could tentatively suggest that incentivisation may have improved engagement with SleepWise, in terms of participant's usage of the intervention. However, it does not seem to have encouraged further behaviour change (e.g., achieving set goals) among these adolescents. The use of incentives and their implication will be discussed in more depth in Chapter 5.

Qualitative Feedback

As discussed earlier in the methodology section of this chapter, the process evaluation (follow-up) interviews helped investigate the acceptability and feasibility of the SleepWise website and that of the trial procedures (e.g., appropriateness of questionnaire measures etc). Participants were contacted 5-8 weeks post intervention. In total, 19 participants ($M_{age}= 14.79$ $SD=0.97$ $Range= 3$) were interviewed as part of the follow-up interviews (see Table 4.2 for demographics). Fifteen participants were from the intervention group, and four participants were from the control group. Additionally, two staff members, who helped facilitate the study (e.g., point of contact, distribution and collection of consent forms, advertising study details), provided verbal consent to partake in follow-up interviews, in order to help gain insight into their experience of assisting with the trial. Findings regarding participant (adolescent) feedback will be presented first, before presenting findings from facilitators.

Table 4.2

Follow-up Participant Demographics

Demographics (N=21)	Intervention (n=15)	Control (n=4)	Facilitator (n=2)
Gender <i>n</i> , (% of group)			
Male	4 (26.7%)	-	1 (50%)
Female	11 (73.3%)	4 (100%)	1 (50%)
Ethnicity <i>n</i> , (% of group)			
White	13 (86.7%)	4 (100%)	2 (100%)
Indian	2 (13.3)	-	-

Note. Data are presented as means and (standard deviations), unless otherwise stated. *N*= total number of participants; *n*= total sample number

Seven main themes were identified after undertaking a thematic analysis of participant (adolescent) feedback, which included: Leading Busy Lifestyles, Study Reminders, SleepWise Format (sub-themes: content, completion time, interactive elements), Logging Sleep, Setting Goals, Changes in Behaviour (sub-themes: eating behaviour and sleep, sleep-related behaviour change, awareness and maintenance of behaviour, additional tools for behaviour change, parental/familial involvement), and Recommendation of SleepWise to Others. Participant number, gender, age group (young vs old, as determined by education level), and study group (intervention vs control), are provided after each quote for informative purposes.

Leading Busy Lifestyles

Participants often reported that school or college was an enjoyable experience, as they liked learning about topics that interested them: “[I] enjoy certain aspects, like some of the options I’ve chosen and I’m interested in my lessons” (Participant 17, Female, Young, Control). Socialising with friends was also deemed an enjoyable experience: “...ability to see everyone and make plans after

school and on the weekend – with everyone being together makes it easier” (Participant 3, Female, Young, Intervention). However, most participants felt that they were frequently tired, busy, or overworked, which often led to staying up late at night: “There is a lot of work because we are doing our GCSE’s now and so it’s busy and because we’ve got a lot of homework we have to stay up really late” (Participant 8, Male, Young, Intervention). Participants explained that a high workload coupled with leading busy lifestyles was often a stressful experience, as they found it difficult to manage academic workload with extra-curricular activities: “It can be stressful because it’s a big workload sometimes – especially balancing school work with extra-curricular clubs and outside of school clubs as well” (Participant 18, Female, Young, Control). This was more prominent among older (i.e., college education) participants, as some were also managing employment with academic workload: “Yeah I have two other jobs, apart from college, so it’s a bit hectic” (Participant 7, Female, Old, Intervention).

For most participants, leading a busy lifestyle meant that they could not engage as much as they wanted with SleepWise: “I just got really busy – I just went on there to do the necessities and do what I needed to do and then get on with my homework” (Participant 7, Female, Old, Intervention). A busy lifestyle also meant that participants did not always complete every SleepWise related task, such as logging their sleep on a daily basis: “...sometimes I didn’t have time [to log sleep] because I was rushing and getting ready for school” (Participant 16, Female, Young, Intervention). Nevertheless, some participants had considered the required time commitment associated with partaking in the study and were prepared to make time for SleepWise related activities: “I knew that it would take time away from studying, but I was prepared to do that because I thought it was a very interesting concept” (Participant 1, Female, Young, Intervention).

A smaller number of participants also felt that, apart from being busy, parental control over digital devices meant that they could not spend more time on SleepWise:

“My phone – it cuts off at 10 o’clock, or on 9 o’clock, because my mum and dad don’t like me to be on my phone past 9 o’clock so they have an app on it which cuts it off past 9...” (Participant 10, Male, Young, Intervention).

Study Reminders

Most participants reported that receiving text and email reminders was helpful for reminding them about engaging with SleepWise related tasks, with some suggesting that reminders motivated them to remain engaged with SleepWise: “I think with the text and email [reminders], it was like I haven’t done this yet- I need to log my week 4 or whatever...I think having the texts and the reminders motivated me mostly” (Participant 12, Female, Young, Intervention).

Participants often preferred text reminders over email, as they felt that text messages were more easily accessible and instant: “[I] had my phone on me all the time erm I don’t get emails on my phone I get them on my laptop so it’s just much easier” (Participant 16, Female, Young, Intervention). However, some participants opted out of reminders by accident, and mentioned that they had not realised that they had ticked the electronic opt-out box on SleepWise: “I think it might have been clear and I might have accidentally opted out” (Participant 11, Female, Young, Intervention).

SleepWise Format

Content

Participants generally enjoyed engaging with SleepWise and found the content interesting and user-friendly: “I thought the website was relatively easy to follow which was helpful - I think the format was pretty good in general, like having the text there and diagrams and the examples were very useful as well” (Participant 1, Female, Young, Intervention). Delivery of information was also liked by participants: “It was quite good – summarised it quite nicely – it didn’t put it in complicated terms that no one would understand” (Participant 7, Female, Old, Intervention). Optional choices provided in each session were also deemed useful by participants, as they provided participants an opportunity to explore their topics of interest: “It [optional click-through button] just gives you more of a choice and like interesting to see what you’re actually interested in so you don’t have to read what you’re not, just what you are” (Participant 11, Female, Young, Intervention).

Completion Time

Participants felt that the time it took to complete each weekly session was acceptable and time-efficient: “...liked how short it was - like I was expecting a lot more stuff I had to do - but I quite liked, you could finish one week’s worth of stuff in like five minutes” (Participant 4, Male, Young, Intervention). Participants also found that the 4-5 week intervention period suited their busy lifestyle and enjoyed receiving small fragments of information in each weekly session: “I think it was good to be spaced out...I think that works – just a little bit at a time” (Participant 11, Female, Young, Intervention).

Interactive Elements

Participants enjoyed the interactive elements of SleepWise. For example, participants felt that the quiz and game playing components of SleepWise added a fun element to their experience, and allowed them to revise learnt material: “I liked playing the quiz and the game... I think sometimes it’s a bit – well not boring – but just to read information – I think if you are quizzed on it, it gets it into your head a bit more” (Participant 12, Female, Young, Intervention). However,

participants suggested that it would be more useful if the quiz and the games were incorporated within each session, rather than made optional at the end of each weekly session, as this would help users stay engaged and recall information better: “So just like if the quiz was in the middle, about the information that I’d just learnt, then I think I’d probably remember more of it than [if] it was kind of like optional at the end” (Participant 5, Female, Young, Intervention).

Logging Sleep

Overall, participants enjoyed logging their sleep via the sleep diary, as it made them aware of their sleep patterns and/or behaviours: “[I] liked tracking the sleep, I thought it was quite interesting just to see the data basically, and I hadn’t really looked at much [of my] sleeping pattern in that much detail before” (Participant 2, Male, Old, Intervention). However, some participants felt that the sleep diary questions could be improved by being shortened, especially when compared to already existing methods of logging sleep (e.g., phone application (app) sleep diaries):

“Because on my phone, I have a sleep logging app anyway, every time I woke up I would put ‘add sleep log’ and then I would adjust the slide to when I fell asleep or when I woke up – that [sleep app] wasn’t as in depth as the [sleep diary] form, but it felt like it could have been a bit quicker to fill out my sleep log [on SleepWise]” (Participant 4, Male, Young, Intervention).

Most participants also felt that the sleep diary would be best implemented on a mobile phone app, as this would make it more accessible:

“I think it’d be a lot better to fill out the sleep log on an app rather than a laptop or website because I don’t really go on my laptop until after school and by then I probably forgotten what time I fell asleep or woke up” (Participant 4, Male, Young, Intervention).

Some participants suggested that the format of the sleep diary could be improved by allowing participants to back-log their diary entries, instead of logging their sleep on a daily basis. Although this would defeat the purpose of a daily sleep log, participants mentioned that logging multiple (sleep) data at once would be useful, because they did not use their laptops daily, and thus were not able to log their sleep on a daily basis: “I think the only thing was not being able to do [enter] multiple data at once in terms of logging sleep, because, sometimes, I’d go on my laptop, but I wouldn’t always get my laptop out every day” (Participant 2, Male, Old, Intervention).

However, as indicated by participant feedback earlier, the development of the sleep diary into an app may help overcome the above limitation, as an app would be more instant and accessible when compared to logging sleep via a laptop or computer.

Setting Goals

Most participants liked the idea of setting goals, as setting individual goals felt like a personalised feature of SleepWise: “I liked being able to set the goals cos it gave you – we were able to set them – they were like unique to each person instead of like being a generic goal that we all have to follow” (Participant 5, Female, Young, Intervention). Participants felt that setting goals helped them reflect on their behaviours, or the information learnt, throughout the week: “The goal setting I quite liked because it meant I had something to think about for the rest of the week, instead of just taking in the information” (Participant 5, Female, Young, Intervention). Participants also liked having access to each session on a weekly basis, as this allowed them adequate time to work on their weekly goals:

“[I] think that [four weeks] was better because it meant that you could focus on one goal each week instead of like everything at once because I don’t think I would’ve taken in much as I did if it was all at once” (Participant 5, Female, Young, Intervention).

Further, participants liked reviewing their goals, and found this feature a useful tool for reflecting on their weekly progress towards achieving their set goals:

“...it helped me reflect...like what I should remember to do like sometimes you know you forget to do stuff and by the end of the week you get to review your goal it’s like yeah I was meant to do that, and if it didn’t work out I could replace it with another like goal, like a healthy ambition” (Participant 3, Female, Young, Intervention).

Participants felt that the goal setting tool could be improved in several ways. Firstly, when reviewing weekly goals, some participants felt that the intervention should ask them whether they had (or had not) set a weekly goal, as this would check whether a goal was set in the first place: “Like a simple programming thing of checking whether I *actually* created a goal before asking me whether I met it or not” (Participant 4, Male, Young, Intervention). Second, participants felt that goal setting could be improved by enabling each goal to be reviewed independently, instead of all together: “I think for some weeks... I set more than one goal and I think if I could say if I had part met that goal, and if I fully met another one, [not] just overall” (Participant 12, Female, Young, Intervention). Third, participants suggested that having personalised goal suggestions could help them think about alternative goals to set: “...maybe specific to each goal you set it would tell you the alternative” (Participant 11, Female, Young, Intervention). Lastly, participants suggested that the goal setting and goal review could be developed into a mobile phone app, to help keep them notified about their weekly goals and reviews: “...told me to set a goal and later on when I logged back in asking me

whether did it or not so erm I thought if you do make an mobile app you could do a notification thing” (Participant 4, Male, Young, Intervention).

A small number of participants did not find setting goals a useful tool for changing sleep behaviour, as they felt that they had pre-existing methods for setting goals, and thus were not motivated to engage with this tool on SleepWise:

“I made mental goals – so I like – I’m not a big goal setter – I have like plans, if I don’t need them, then I have mental plan – at the start of this I was like I’m going to try and get like cut off – and not be on my phone for at least an hour before it [bed]” (Participant 10, Male, Young, Intervention).

Changes in Behaviour

Eating Behaviour and Sleep

Most participants found the first session of SleepWise the most interesting session regarding sleep, mainly due to its novelty: “I just liked looking through how food affects your sleep ‘cos I hadn’t heard that before so I just thought it was interesting to read up [on it]” (Participant 7, Female, Old, Intervention).

Whilst changes in behaviour varied across participants, most participants felt that session 1 was the most useful session for helping them adopt healthier sleep related behaviours, especially in regards to their eating habits: “...when I had supper I tried not to snack after that and get into my bedtime routine...I felt good that I wasn’t just sitting around eating stuff” (Participant 12, Female, Young, Intervention).

Changes to evening eating habits were mainly motivated by becoming aware of the disruptive effects of late night snacking on sleep: “It [SleepWise] said that if you carry on snacking unhealthy [foods] it can cause disruption in your sleep and chemical imbalances in your body so I just thought that’s not very good” (Participant 7, Female, Old, Intervention).

Other Sleep-Related Behaviour Change

Alongside changes to eating behaviour, participants also reported that they attempted to make other sleep-related behavioural changes in subsequent weeks, such as reducing media use before bed: “...trying to put the phone down before I go to bed because blue light is really bad for your brain” (Participant 3, Female, Young, Intervention), or keeping to a consistent bedtime routine: “I tried to keep my bedtime consistent the entire time and that helped keep the time I woke up quite consistent so I usually got the same amount of sleep every night” (Participant 11, Female, Young, Intervention). These attempts at behaviour change could be explained by participants’ sense

of relatedness to a certain session, which may have been more relevant to meeting their individual sleep needs:

“ I think it [session 3] was just, because it’s more, relatable on my part, erm because I do go on my kindle or watch television before I actually go to sleep, and so I think that’s maybe why I spent [more] time on that [session 3]” (Participant 2, Male, Old, Intervention).

Lower levels of engagement with SleepWise were mainly due to participants who did not deem information relevant to their needs and felt that certain information was already learnt at school or during their childhood:

“[I] already understood the impact of technology on sleep, and [of] sleep on my general wellbeing, because that’s generally recognised from school, from a young age, and so that again may be the reason for the short period of time spent on there” (Participant 11, Female, Young, Intervention).

Ultimately, this may suggest that these participants did not attempt to change their sleep behaviour, as certain information may have been deemed as irrelevant to their needs.

Awareness and Maintenance of Behaviour

Participants felt that becoming aware of sleep information via SleepWise helped them become aware of their own poor sleep behaviours:

“...reading that [sleep routine] information made me realise that I don’t really have a good routine when I go to sleep or when I wake up – yeah I think you realise that information, doing that like was quite useful for me” (Participant 12, Female, Young, Intervention).

It seemed that becoming aware of good sleep practices may have motivated participants to maintain behaviour change over time: “I found it [information] mostly useful about the sleep plan...obviously helped, because I just stuck to that afterwards” (Participant 9, Female, Young, Intervention). Behaviour maintenance may have also been explained by noticing improvements in sleep and/or health, such as feeling refreshed upon waking: “I actually felt a lot better – especially being off my phone, I felt more refreshed in the morning” (Participant 13, Female, Young, Intervention), as well as noticing improvements in night-time sleep: “I don’t actually wake up in the night anymore – I can actually sleep through, which is good” (Participant 7, Female, Old, Intervention). These improvements in health and/or sleep outcomes appeared to make the changed behaviour ‘worthwhile’, which may have motivated continuation of the behaviour: “After the first week I started to see a good improvement... Mainly getting to sleep quicker and not waking up so much... I thought maybe it could be worth doing” (Participant 8, Male, Young, Intervention).

Additional Tools for Behaviour Change

Similar to the goal setting tool on SleepWise, participants who did not engage with other behaviour change tools (e.g., sleep routine chart), felt that they were already aware of the steps needed to change their behaviour and did not need to engage with such (behaviour change) tools:

“I didn’t use the sleep plan or print it out...but I would think about what time I would go to sleep and what time I would wake up each day. And then with the sleep environment I would try and work more at my desk rather than at my bed” (Participant 9, Female, Young, Intervention).

Some participants felt that they had similar tools (e.g., on their mobile phones) to those that were made available on SleepWise, which may have discouraged them from engaging with certain behaviour change tools on SleepWise:

“I set up this thing on my phone...it’s like sets you an alarm to tell you when to go to bed I think within half an hour you’d get like eight hours of sleep or something...So that was kind of similar to the sleep chart” (Participant 12, Female, Young, Intervention).

Parental/Familial Involvement

Some participants found that their family were already taking part in good sleep practices:

“We have a rule in our house where we are not allowed on our phone half an hour before bed and erm I think it [SleepWise] said something, it was more than that on the website, and that was really interesting and I talked to my mum about that actually” (Participant 16, Female, Young, Intervention).

This often led to the family changing behaviour collectively: “We made sure we weren’t on our phones – because you know, sometimes we were on our phones a bit later but we definitely stopped it, especially on school nights” (Participant 16, Female, Young, Intervention).

Recommendation of SleepWise to Others

Most participants felt that they would recommend SleepWise to other young people, as the information and behaviour change tools on SleepWise were deemed useful for becoming aware of new sleep and health information: “Yeah definitely because a lot of it is information that isn’t given, we’re not necessarily given it anywhere else and I think it’s really important information” (Participant 16, Female, Young, Intervention). However, some participants felt that some young people (e.g., those not experiencing sleep difficulties) may not be motivated to engage with SleepWise, as they may skip certain sessions:

“I think maybe some people wouldn’t use it as much- I think it would really help some people... Because I think some people skip through the information and stuff or forget to log in and stuff but for others it could be quite useful” (P12, Female, Young, Intervention).

Similar to earlier suggestions, participants suggested that a possible solution to improve adolescents’ engagement with SleepWise would be to develop SleepWise into a mobile phone app: “Well I guess if there was an app, so it was on the home screen, reminding them to do it [engage]” (Participant 12, Female, Young, Intervention).

Feasibility of Study Measures

Measures

Most participants mentioned that questions regarding the physical activity measure were confusing to understand:

“I found it [physical activity questionnaire] quite confusing...because I do like tennis on Monday but I do like single but I also do double, but I think the example for the less vigorous one was double tennis... So I wasn’t really sure what category to put that in” (Participant 12, Female, Young, Intervention).

Alongside confusion regarding how to classify different types of sports, some participants also mentioned that they took part in multiple sports, which added to their confusion: “It was more that it was like if you do different types of exercise, some of them kind of mix between those, so I was like do I add this to this or keep them separate?” (Participant 14, Female, Young, Control).

Most control participants felt that answering the questionnaire measures helped them become more aware of their own sleep and health patterns, and some even felt that they had noticed sleep improvements after taking part in the study:

“When I did the first questionnaire I was seeing how, when I was filling in all the answers, I thought I could really be doing more... So I started doing that – and when I did the second questionnaire, I felt a bit better – with sleep and things” (Participant 14, Female, Young, Control).

Control participants also found that the process of being allocated to the control group was an easy and acceptable experience, as answering the study questionnaires was not time consuming: “It’s quite nice how it’s not something you have to always be thinking about, it’s there and you know you have to do it but you do it when it comes around and it’s not always there” (Participant 14, Female, Young, Control).

All participants felt that answering follow-up questionnaires was an acceptable request from the researcher and a useful way to track maintained behaviour change:

“I think that’s quite a good idea because I think it will remind me around that time of the things that I’d learnt from the study and help me be able to carry on doing those things...’cos it [questionnaire] doesn’t take very long” (Participant 5, Female, Young, Intervention).

Actigraph as a Tool for Objectively Measuring Sleep

Participants felt that the actigraph instruction handout was useful and that their overall experience with the actigraph wristband was acceptable: “They [instructions] were very clear, they were very useful... It [actigraph] was very easy – I didn’t really have any problems with it – it was easy to use” (Participant 16, Female, Young, Intervention).

Participants often felt that wearing the actigraph wristband was fun, as peers found the wristband interesting and asked questions about it: “Because my friends would always ask what it was about and I made loads of jokes about I’m being checked/tracked by the police, you know and they all found it funny” (Participant 1, Female, Young, Intervention).

Some participants reported that, at times, the actigraph wristband felt uncomfortable: “...it became uncomfortable trying to fall asleep with it on” (Participant 1, Female, Young, Intervention), but mentioned that they forgot about or got used to wearing it after a short period: “...after a couple of days I got used to it...you kind of forget it’s there after a couple of days” (Participant 1, Female, Young, Intervention).

Most participants felt worried about damaging the actigraph wristband: “...when I was showering, I was really worried that it would break even though it said it was water resistant...so I had to take it off for things like that” (Participant 1, Female, Young, Intervention). Participants were also not permitted to wear the actigraph wristband during physical exercise at school or sport clubs: “...in PE and things like that it was kind of annoying because erm we’re not really supposed to wear anything on our wrists” (Participant 16, Female, Young, Intervention). Some participants mentioned that not being allowed to wear the actigraph wristband at school or sport club was an off-putting experience, as they were asked to cover the wristband with a sweatband (this was the case at only one school):

“...my school, if you’re going to wear a watch or anything you have to put a sweatband over it... I think that would discourage a lot of people from wearing them during PE, they don’t want to put a weird sweat on this thing they were wearing...which is unfortunate, that’s exercise that it wouldn’t track”(Participant 9, Female, Young, Intervention).

Nevertheless, some participants mentioned that wearing the actigraph wristband during school physical activity was not an issue, as it was only for a short period of time: "...the teachers were fine with it, especially because it was only for a few weeks" (Participant 16, Female, Young, Intervention).

Actigraph Data Analysis

As mentioned earlier, the feasibility of collecting and analysing actigraph data was evaluated as part of the feasibility trial. The actigraph supplier provided instructions (Appendix JJ) for setting up, operating, and analysing data from the actigraph devices. The overall cost associated with purchasing 18 actigraph devices (plus two temporary on-loan devices) and charging cradles was £2,750. Software installation was simple, as instructions were easy to follow and the software was automatically downloaded. In terms of charging the devices, each device had to be charged in a charging cradle for exactly 3 hours until a LED light on the device flashed green. Each cradle could hold up to four devices at one time. The LED light flashed red while the device was charging and green once it had finished charging and was ready for use. However, when charging, the actigraph devices did not fit securely in to the cradle and thus became disconnected and required adjusting. This made the charging process longer than 3 hours, as devices required constant monitoring and re-adjusting. The actigraph devices were required to be charged every 2 months and could not be charged for longer than the required 3 hour period.

In terms of setting up the devices for use, three recording options were available. The first included starting the device on a 'button press', which meant that participants were required to press a button on the device to begin recording. The second option included 'immediate recording', which started immediately after the device was removed from the charging cradle. The last option included 'at a future time', which meant that the device started recording at a selected future time. For the purposes of the feasibility trial, the on 'button press' option was chosen, whereby participants were asked (as per the instructions provided in the actigraph handout) to press the actigraph button upon wearing the device. Each time a device was (re)connected to the charging cradle, it would stop recording, require reconfiguration, and data on each device was erased. Therefore, each device was only placed back in the charging cradle once data collection had ended.

In terms of data extraction, devices were put in to the charging cradle and the data was downloaded via the software provided by the supplier. It took approximately 20 minutes to download the data, which were subsequently converted to .csv files (opened in Excel) upon completion. An automatic visual summary output including sleep metrics was produced for each user's physical activity and sleep activity data (Appendix KK). The sleep metrics data collected by the

actigraph device included sleep time, sleep duration, total sleep time, sleep efficiency, as well as daily activity levels. Further data was also collected by the actigraph device, which were not required in the study, such as body temperature and light exposure (Appendix KK). Data were kept in a password protected file on the researcher's personal computer, and deleted automatically from each device when the device was put back in to the charging cradle.

As part of data analysis, an updated user-manual had to be requested, as the supplier provided an out-of-date manual, which meant that data could not be downloaded in the first instant. Once an up-to-date manual was received, and the data downloaded, data cleaning was undertaken for a total of 20 devices (10 per trial). Open R analysis, using the R statistical computing programme software (Version 4.0.5) and Activinsights R Markdown, was used to analyse the actigraphy data (see Appendix LL for a full breakdown of results). In total, 17 datasets were suitable for analysis, as one participant had not collected their actigraph wristband when assigned, and two had not started their devices as advised. Summary data produced by R indicated that, overall, adolescents' total mean score for sleep efficacy was 72.2%, indicating that, over the course of the intervention, adolescents maintained high sleep efficacy scores. These results could be indicative of SleepWise's efficacy on adolescent's sleep efficacy scores and thus warrants further research in a future main trial. However, these results should be interpreted with caution, as baseline (sleep efficacy) scores were high (see Appendix LL), data was not representative of all intervention participants (as not all participants in the intervention groups were tested with actigraphy devices), results included missing sleep data - due to participant not wearing their device for the entirety of the allocated period and thus increasing the likelihood of inaccurate data - and not all 20 participants were included in the analysis, due to unavailable data.

Overall, adopting more innovative approaches to collecting and analysing sleep data, such as sleep sensor technology (via mobile phone apps for example), could be more time and resource efficient, as such innovative methods could help collect further important sleep data (e.g., stage of sleep) and help personalise the intervention to each user (Blake et al., 2019). The use of actigraphy and other methods to objectively collect sleep data among adolescents is discussed further in Chapter 5.

Feasibility of Trial Procedures within Education Settings: Facilitator Feedback

As mentioned earlier, one facilitator from each site helped conduct each trial. The trial was conducted across secondary schools and colleges, and facilitators were recognised staff members from each site. Facilitators liaised information about the study with head teachers, teachers, and helped advertise the study to students/pupils. Findings from facilitator interviews is discussed in

relation to the following themes: Workload, Benefit to Young People, Recruitment, Incentives, Socioeconomic Status, and Timing and Logistics.

Workload

Prior to partaking in the study, facilitators were concerned about an increase in their workload as a result of taking part: “We had some initial reservations around confidentiality and how much work load it would incur but actually it has worked out incredibly well” (Wellbeing Officer, Male). Both facilitators felt that the trial procedures were easy to follow and did not increase their workload:

“It’s been easy. I think it has helped - because you have managed to pop in and pick up consent forms, so there was very little for me to do apart from to set it up in the first place... I think from a teacher’s point of view, a busy teacher’s point of view, the ease of it, so it wasn’t a hassle for me at all” (Secondary School Teacher, Female).

Facilitators felt that, once they had started the study, their reservations regarding the accumulation of additional workload lowered: “...certainly the initial fears I had of it being extra workload were relieved very quickly” (Wellbeing Officer, Male).

Benefit to Young People

Facilitators felt that the study benefited participants in various ways, such as empowering participants and raising awareness about their mental health: “We’re always trying to find ways in school of empowering young people and actually getting them to think about the wider life, and erm you know, mental health issues” (Wellbeing Officer, Male). This was something that facilitators felt that SleepWise offered, as young people were encouraged to think about their sleep and were guided in taking responsibility for their own health behaviours:

“I think this just gave another opportunity where they could be involved in something where they could really think about their processes of sleep and what they went through ...you know it’s given them a lot more resilience and gives them a lot more sort of facts and figures about that area...gives them a little bit of responsibility” (Wellbeing Officer, Male).

One facilitator felt that having a pre-existing relationship with the university was an added benefit for participating in research, as this allowed pupils to learn about applying research skills in practice:

“We’ve done it in the past...helped out at various universities with either masters, PhDs...really useful for the kids to see it [research] working, and we’ve had it in the past kids actually take part in experiments in the classroom...the idea of the differences between the laboratory setting and field

experiments ... that's why I agreed to do it because I think it's really useful for the kids" (Secondary School Teacher, Female).

The facilitator that is mentioned above felt that teaching psychology as part of their curriculum often meant that the school were enthusiastic to partake in psychology related research: "There is only one other school in XXXXXX that does psychology, and that's probably why we are happy and why my head of the school is happy for us to take part" (Secondary School Teacher, Female). This was also evident from the perspective of participants, as participants from this site expressed that they were interested in partaking in the study, due to being interested in psychology, and wanting to help the advancement of research:

"I just liked the sound of it because I've always wanted to be a part of a [study]— because we're doing psychology I thought it'd be cool to see what it's like and also I'm not very good at sleeping that well and I thought it might help me a little bit" (Participant 8, Male, Young, Intervention) / "I thought it would be interesting, especially to help you guys [researcher] and for me to understand like how what I do affects my sleeping pattern as well" (Participant 18, Female, Young, Control).

Recruitment

Facilitators acknowledged that it is not always feasible to recruit participants from educational settings: "I know it's very very difficult to find schools who would actually participate in these things" (Secondary School Teacher, Female). This was mainly due to the process of gaining ethical consent from parents, and head teachers feeling wary of this ethical step in research:

"There is a lot of problems with sort of getting consent and things like that, with being in a secondary school...I think lots of heads will go oh no we don't want to touch that with a bargepole, because of that ethical side of things" (Secondary School Teacher, Female).

Incentives

Facilitators felt that providing participants an incentive for partaking was an important aspect to participation, as many participants were interested in the incentive aspect of the research: "I think that, to be honest, a lot of young people were doing it because of the freebie of the voucher..." (Wellbeing Officer, Male). This was prominent during the advertisement of the study: "When I did the assembly, one person put their hand up and said "what shop is the voucher for?"" (Wellbeing Officer, Male). Facilitators felt that this meant that those who were not randomised to the intervention group often felt disappointed: "When they found out that wasn't necessarily available it was sort of the ones that were going to be picked, I think erm I don't know maybe they were disappointed with that, some of them wanted to be picked" (Wellbeing Officer, Male).

Socioeconomic Status (SES)

Facilitators felt that students from lower SES backgrounds could have been overlooked when recruiting, as an online intervention like SleepWise requires access to digital resources and the internet:

“One big problem is, we do, and it sounds strange at a school like XXXXX from a very wealthy area, we do have kids who don’t have access to computers... as great as having a website and going on a course is, you are missing a chunk of children who perhaps would benefit from it more than others” (Secondary School Teacher, Female).

Timing and Logistics

Timing of both trials (trial 1 in the summer term and trial 2 in the autumn term) was deemed important for successful completion and uptake of research, as facilitators felt that stress levels and workload for participants differed across term time:

“Timing was important, so for example we did mainly year 10s and that’s fine because they weren’t kind of [in a] stressful situation at the time, however erm had we pushed it with the year 11s, they were obviously going through with their GCSEs at the time” (Secondary School Teacher, Female).

It was suggested that the summer term could be a suitable period for conducting a study with school pupils:

“Summer term of year 10 is probably a good time, the only other time for younger kids would’ve been the same in sort of year 7 and 8, erm but for year 11s from now on [autumn term] it’s stress, and actually so it is for the year 10s who’ve just started their GCSEs” (Secondary School Teacher, Female).

However, facilitators felt that, regardless of timing and preparation, logistical and practical issues will always be present when conducting research within educational settings: “sometimes you can’t come in, for example, they went on work experience and [could not] collect the forms, so within an school environment you’ve always got logistical issue I’m afraid” (Secondary School Teacher, Female). Nevertheless, both facilitators agreed that a digital intervention such as SleepWise could be feasible and useful for implementation across educational settings:

“I think the benefits we’ve found from it and the way it engaged our young people in something different something new, something a little bit more exciting, erm with the rewards vouchers as well, was a nice bonus, and I think the process has been great, very positive” (Wellbeing Officer, Male).

Facilitators suggested that, if findings showed positive user feedback, adolescents may be more likely to engage with a user-friendly and person-based intervention, as they believed that young people may be less likely to engage with sleep and health advice that is given by adults:

“They [adolescents] don’t listen to adults, about something like that [sleep and health], they will only listen to their peers, erm so if our kids did agree with you and think it really worked, then you know they would be [the] market you’d want to ship out to other schools” (Secondary School Teacher, Female).

Revised Logic Model

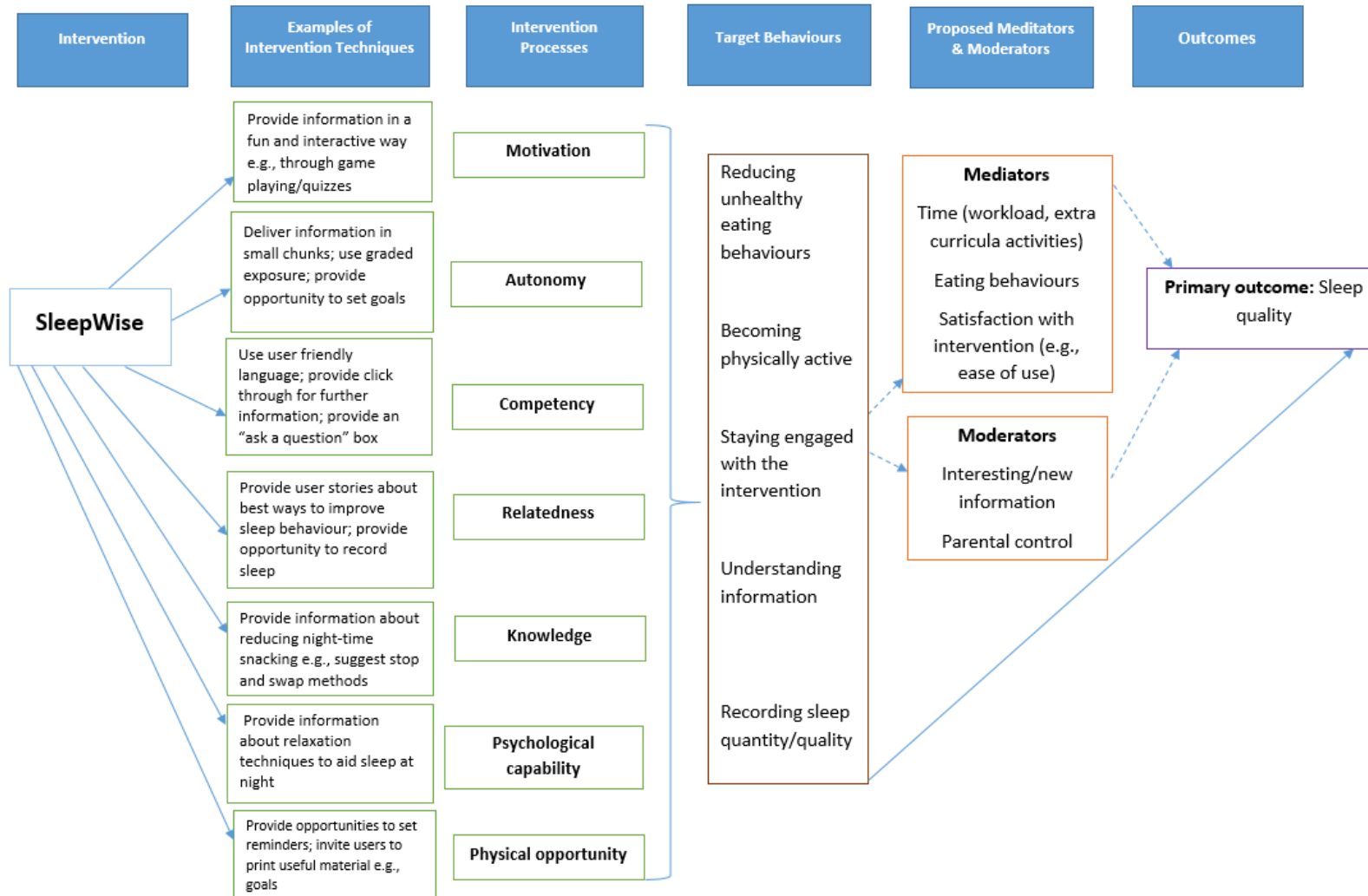
The revised logic model is the final version of the logic which would be taken forward to a future main trial. The purpose of the logic model (as discussed in Chapter 2) was to understand and model the hypothesised mechanisms of action of the intervention (i.e., how it was thought to work/change behaviour). The proposed mediators enabled the model to synthesis a set of important factors that could mediate the effects of the intervention on sleep quality, which helped identify the intervention’s mechanisms of change. The proposed mediators were revised based on the qualitative findings from this study, as feedback indicated that participants felt that the availability of time was an important factor to engaging with SleepWise, which was mainly due to participants leading busy lifestyles. Thus, this new finding was incorporated into the logic model (Figure 4.8), with a new mediator named Time. Additionally, qualitative findings indicated that new/interesting information and parental control over digital devices contributed toward high or low engagement with the intervention. The intervention may thus work differently across different participants and situations; therefore, these new factors were added as potential moderators in the intervention’s logic model (Figure 4.8). In a future trial, the newly added mediators and moderators of the logic model can help understand the mechanisms needed to help improve the likelihood of intervention success (i.e., improved sleep quality). This could mean that the intervention’s functions could be improved by, for example, the inclusion of relevant and interesting information (e.g., incorporating age-specific modules). Parental worry and control over child’s usage of the internet could also be addressed by providing evidence-based benefits of using digital technology, as well as tips on managing worries regarding child’s internet usage, to parents and guardians, which will be discussed in more detail in Chapter 5.

Based on the findings from this chapter, it can be concluded that the theories which underpinned the intervention are appropriate to be taken forward in to designing the final version of the intervention (i.e., in a main trial). The Self –Determination Theory (SDT; Deci & Ryan, 2012) proved useful for highlighting potential determinants of behaviour change among adolescents. The

SDT's focus on autonomy, competency, and relatedness helped support adolescents' autonomy (e.g., choosing own schedule for reminders), competency (e.g., goal setting), and perceived relatedness (e.g., use of autonomy-supportive language). In addition, applying the Behaviour Change Wheel and Behaviour Change Taxonomy (Version 1) (Michie et al., 2011; 2013; 2015) helped the standardisation of the intervention, which mitigates confusion when using different research terminology for the same intervention techniques, or when different techniques are referred to when using the same terminology (Michie et al., 2015).

Figure 4.8

Revised Logic Model



Exploratory Effect Size from Each Trial

An exploratory effect size, using Cohen's d , was calculated for the mean changes in sleep quality (PSQI-SF) for intervention completers by subtracting participants' follow-up sleep quality mean from their baseline sleep quality mean (mean difference) in the two study groups by using the SPSS software (Version 26). Cohen's d is deemed more suitable for determining the effect of an intervention in contrast to r , which is more appropriate for evaluating correlations between variables (McGrath & Meyer, 2006). While feasibility trials do not test the effectiveness of interventions (Eldridge et al., 2016), an exploratory effect size analysis was undertaken to help determine a required sample for a future trial, and explore initial indicators of SleepWise on participants' sleep quality outcomes. An exploratory effect size was undertaken for each trial, to investigate whether incentivisation had any initial impacts on effect size analysis. Effect sizes were interpreted using the following criteria: $< .30$ small effect size; $.30$ to $.80$ medium effect size; $> .80$ large effect size (Cohen, 1992).

Prior to calculating Cohen's d , intervention sleep quality mean scores in both of the intervention groups (trial 1 and 2) were screened for excessive skewness (>3) and kurtosis (>8) (Horowitz et al., 2007). Upon inspection, excessive skewness or kurtosis was not detected for trial 1 (skewness = 0.78, kurtosis = 0.61) or for trial 2 (skewness = 2.45, kurtosis = 7.83).

Trial 1

Based on the 5-week post intervention follow-up sleep quality data from 17 participants, the intervention group improved sleep quality by an average (PSQI-SF) mean of 1.35 (SD = 2.12). Participants in the control group ($n = 13$) improved sleep quality by an average mean of 0.23 (SD = 1.83). A medium effect size was found based on participants' mean change in sleep quality between the two study groups, Cohen's $d = 0.57$. This medium effect size suggests that participants who used the intervention may have improved more than participants who did not use the intervention (control group). Thus, it can be concluded that the intervention did work for the intervention participants and is therefore feasible to be taken forward to a definitive main trial.

Trial 2

Based on the 5-week post intervention follow-up sleep quality (PSQI summed score) data from 17 participants, the intervention group improved sleep quality by an average (PSQI) mean of 0.94 (SD = 1.44). Participants in the control group ($n = 13$) showed reduced sleep quality by an average mean of -0.31 (SD = 1.44). A large effect size was found based on participants' mean change in sleep quality between the two study groups, Cohen's $d = 0.87$. This large effect size suggests that participants who did use the intervention improved more than participants who did not use the

intervention (control group), as those in the control group worsened over time in sleep quality. Therefore, as with trial 1, it can be concluded that the intervention did work for the intervention participants and is thus feasible to be taken forward to a definitive main trial. An in-depth discussion about incentivisation of each trial is offered in Chapter 5.

Acceptability of Intervention and Future Sample Size from Each Trial

Mean acceptability scores from both trials indicated that participants found the intervention highly acceptable across both trials (trial 1 $M = 21.00$ $SD = 2.74$; trial 2 $M = 20.82$ $SD = 2.48$). This finding is in line with the positive feedback received in the follow-up interviews and further supports the intervention's feasibility to be taken forward to a future main trial.

Based on the effect size finding from each trial (trial 1 $d = 0.57$; trial 2 $d = 0.87$), a power calculation using G*Power 3.1 was conducted, to detect a two-tail between groups comparison of sleep quality scores, with a predicted alpha value of 0.05 and statistical power of 0.95. To meaningfully detect a statistical difference between the two groups' sleep quality scores using the effect size in trial 1 ($d = 0.57$), approximately 162 (81 in each group) adolescents would need to be recruited for a main trial. Based on the effect size from trial 2 ($d = 0.87$), 72 adolescents would need to be recruited (36 in each group).

Conclusion

Overall, results from the quantitative usage data analysis showed that, while there were similarities in usage between the two trials, participants in trial 1 showed slightly higher engagement across all four sessions than those in trial 2, with the first session (eating and sleep) being the most highly used session across both trials (as indicated by time spent on each session and pages viewed). This may suggest that participants were more interested in and engaged with the content and behaviour change tools presented in session 1, as they may have found session 1 novel, and most relevant to their needs and interests (e.g., tips on cutting down snacking before bed, introduction to goal setting). Age band data indicated that older adolescents engaged highly with sessions 1 and 4, which could suggest that content in both session 1 (e.g., tips for improving eating behaviours before sleep) and 4 (e.g., relaxation tips) were most relevant to their needs, when compared to other SleepWise sessions.

Qualitative findings indicated that participants enjoyed the novelty of session 1 (e.g., impact of sugary snacks before sleep) and behaviour change tools (e.g., introduction to goal setting), which could explain participant's high usage of session 1. Qualitative feedback also showed that participants in both (intervention and control) groups felt that SleepWise, or partaking in the study, had improved their sleep behaviour and/or awareness. However, leading a busy lifestyle (lack of

time), and already being aware of sleep related topics (presented in SleepWise) were common barriers to engagement. Low engagement, for a small number of participants, was also explained by lack of access to digital devices (due to parental control).

As shown from qualitative feedback from study facilitators, providing incentives was deemed as an important component to successful recruitment. Nevertheless, the number of participants recruited and retained across the two trials were similar and met the required uptake total, which could be due to one site having an already existing relationship with the university, and including a psychology module as part of their curriculum (and thus more interested in taking part in psychology research).

Encouragingly, exploratory findings indicated that SleepWise could feasibly be taken forward in to a definitive main trial, with pending improvements needed to enhance engagement with SleepWise. A larger effect size was found in trial 2; thus, incentivising participants may not be an important part of engagement and improved sleep quality. However, it may be an important part to recruiting participants and may produce higher engagement with the intervention. A definitive main trial is needed to confirm this conclusion. Findings and implications from this study will be discussed in more depth in the final (discussion and conclusion) chapter of this thesis (Chapter 5).

Chapter 5: Discussion and Conclusion

The first chapter of this thesis discussed the importance of sleep as part of healthy development during adolescence, as duration and quality of sleep can impact adolescents' physical and mental health, by affecting biological and psychological changes during puberty (Dahl & Lewin, 2002; Redeker et al., 2004). Existing research presented in Chapter 1 showed that there is growing concern around poor and insufficient sleep among adolescents, which has led to sleep increasingly becoming an important public health problem (Office of Disease Prevention and Health Promotion 2011; Owens & Adolescent Sleep Working Group, 2014).

Five key research barriers and recommendations for future research were proposed in Chapter 1. Firstly, interventions targeting sleep among adolescents are often limited by being non-interactive, costly, include short follow-ups, and lack a strong theoretical foundation (Moran, & Everhart, 2012; Yoong et al., 2016). Second, significant challenges remain in maximising the impact of interventions on adolescents' health outcomes, for example, adolescent users often report interventions as being mundane and time consuming (Blake et al., 2019; Cassoff et al., 2014). Third, digital platforms should be combined with a more personalised and systematic methodological approach to treating sleep problems among adolescents. Fourth, the evaluation of the scalability of interventions, such as including a wide age-range of adolescents (early, mid and late adolescents), inclusion of facilitators (e.g., school teachers), implementation across different settings (such as education settings), and the application of both objective and subjective measures of sleep, should be investigated in adolescent sleep intervention research (Blake et al., 2019). Lastly, the feasibility of such interventions should be evaluated before proceeding to a main trial, to reduce research waste and time (Blake et al., 2019; Blatch-Jones et al., 2018; Cassoff et al., 2013; Eldridge et al., 2016).

The main aim of this PhD was to address these key barriers in sleep interventions aimed at adolescents, by designing, developing, and evaluating the feasibility of implementing a digital sleep intervention using the Person-Based Approach (PBA) to intervention development (Yardley et al., 2015a). In line with the steps of the PBA, a systematic scoping review was carried out to investigate interventions that addressed adolescent sleep. This review (Chapter 1) identified successful intervention components and facilitators and barriers to behaviour change among users, and later informed the PBA intervention design in Chapter 2.

Chapter 2 discussed the first study of this PhD, which involved undertaking the design process of a digital (web-based) sleep intervention called SleepWise. In this first study, the development of guiding principles, a causal model, and a logic model was undertaken. The guiding principles of the intervention outlined intervention objectives that addressed important behavioural

needs and challenges, as identified from the scoping review, and helped identify the necessary intervention features to address them. The causal model then brought together barriers and facilitators to intervention engagement (as identified from the scoping review) and the necessary intervention components, using theory and framework. The Behaviour Change Wheel (Michie et al., 2011), Behaviour Change Technique Taxonomy (version 1) (Michie et al., 2011, 2013) and the Self-Determination Theory (SDT) (Deci & Ryan, 2012), were drawn upon to systematically identify determinants of behaviour and describe the intervention's active ingredients (i.e., components). Lastly, a logic model drew together findings into a testable model that specified how the intervention components were hypothesised to impact subsequent intervention components, and the mechanisms (of change) which affected participants' sleep quality. At the end of study 1, a prototype theory and evidence-based version of SleepWise was created on a digital platform, in preparation for optimisation in study 2.

Chapter 3 discussed the second study in this PhD. In study 2, think-aloud interviews were undertaken with target users to provide insight into user experience and engagement with SleepWise. Interviews indicated the likely implementation of SleepWise, and identified features that influenced participant engagement. Participant feedback indicated that SleepWise was liked by users. However, important modifications to enhance engagement and acceptability (e.g., easy navigation) were required. An iterative approach was undertaken to making modifications to SleepWise, which included moving back and forth between data collection, analysis (identifying potential modifications), modifying the intervention, and thereafter collecting further participant feedback. Modifications were informed by user feedback, and ensured that the optimised version of SleepWise was as feasible and acceptable as possible, and essentially more likely to change sleep behaviour, prior to the feasibility trial in study 3. By the end of study 2, an optimised version of SleepWise was developed.

Chapter 4 discussed the final and third study in this PhD. Study 3 consisted of two 2-arm (intervention vs control) trials to investigate the feasibility of SleepWise. The difference between the two trials was the incentivisation process (as discussed in Chapter 4). The aim of both trials was to investigate the acceptability and feasibility of recruitment (e.g., uptake, attrition), study procedures (e.g., randomisation, incentivisation) and trial outcomes (e.g., exploratory effect size). A process evaluation was carried out to investigate intervention usage and perceptions of user experience with SleepWise and that of the study procedures. As part of the process evaluation, facilitators who helped conduct the study were also interviewed to gain insight into the feasibility of trialling and implementing a digital sleep intervention in an educational setting (e.g., secondary schools).

Results from study 3 showed that, overall, SleepWise and the study procedures were deemed feasible and acceptable by users and facilitators. Quantitative usage data showed that participants in trial 1 (incentivised trial) showed slightly higher levels of engagement across all (four) SleepWise sessions when compared to those in trial 2 (non-incentivised trial), with the first session (eating and sleep) being the most highly engaged with session across both trials. This may suggest that participants were more interested in and engaged with the content and behaviour change tools presented in session 1, as they may have found session 1 most relevant to their needs and interests. Further, older adolescents were highly engaged with sessions 1 and 4, which could suggest that, besides session 1, session 4 (e.g., relaxation tips) included relevant information and techniques to address participant's age-specific needs (discussed later in this chapter).

Qualitative findings from the process evaluation indicated that, participants felt overworked at school and/or college, which may have contributed to lower levels of engagement with SleepWise. However, they enjoyed the learning and socialising aspect of school and college. Further, participants often felt that academic workload and leading busy lifestyles (e.g., extracurricular activities) limited their engagement with SleepWise. Other factors that limited engagement with SleepWise included having pre-existing knowledge about a certain sleep related topic (and thus skipping sessions or pages within a session), and, for a small number of participants, parental control over digital devices (e.g., mobile phone, laptop).

The eating and sleep session (session 1) was reported as the most useful and liked session for improving sleep awareness and behaviour change among participants. Subsequent sessions (2, 3 and 4) varied in frequency of usage. Behaviour change tools, such as setting weekly goals and recording sleep in a daily sleep diary, were deemed useful for tracking sleep and encouraging behaviour change. Participants often engaged with SleepWise on a family computer, or personal/family laptop, most commonly after school hours. Whilst advice given in the study did not encourage participants to engage with SleepWise on their mobile phones, some participants did so, as they deemed their phones more accessible than any other digital device (e.g., laptop).

Completion time for each weekly session, study questionnaires, and study procedures were deemed acceptable and easy to understand by users, however, some participants experienced difficulty with understanding the physical activity questionnaire. Future recommendations from the participants for improving SleepWise included adding more interactive elements throughout SleepWise, reviewing the clarity of questionnaires and intervention tools (e.g., goal setting), and developing SleepWise in to a mobile application (app).

In terms of assisting with the study, staff members who helped facilitate study procedures felt that, given participant acceptability, a digital intervention supporting adolescent health and sleep would be a useful and needed programme within educational settings. Facilitators deemed the study as an easy and useful project for school participation, and felt that partaking in the study did not add to their already high workload. While not the case in this study, facilitators felt that it is important to consider that secondary schools may be a difficult setting for conducting research, as head teachers are often wary of ethical issues that accompany research (e.g., gaining parental consent), and that teachers are extremely limited in time, and curriculums often full with little room to integrate new content. Facilitators also felt that a digital intervention may risk neglecting participants from lower socioeconomic status (SES) backgrounds, as access to digital devices may be scarce in this demographic. Furthermore, facilitators felt that incentivising participation was an important part of motivating adolescents to partake in research, and that some participants felt disappointed when not incentivised, or when allocated to the control group.

Having provided a summary of the key parts of this thesis, this final chapter will address the implications and contribution of this PhD to current literature. The application of the PBA and its strengths to developing SleepWise will be discussed first. Thereafter, the digital nature of SleepWise and its relevance to adolescents will be discussed. Subsequently, engagement with SleepWise, maintained goals and behaviours, the recruitment and incentivisation process, and the strengths and limitations of this PhD, will be discussed before final conclusions are offered.

Person Based Approach (PBA) to Developing SleepWise

This PhD thesis is the first to apply the PBA to developing and evaluating a digital sleep intervention aimed at adolescents. The adoption of the PBA provided many positive aspects to the intervention development process. Firstly, the PBA provided ‘step-by-step’ guidance to intervention development, ensuring that theory, evidence, and user feedback was applied to the development of SleepWise. This helped to overcome the shortcomings of previous sleep interventions targeted at adolescents, including the application of a strong theoretical foundation, addressing user needs and social context (person-based), and the inclusion of interesting and relevant information (Blake et al., 2019; Cassoff, et al., 2014; Gruber, 2017; Moran, & Everhart, 2012; Yoong et al., 2016). Second, as a result of the application of evidence-based behaviour change techniques (e.g., self-monitoring, goal setting) during intervention development, along with the application of theory (e.g., SDT), it can now be understood how the different components of SleepWise work together, or independently, to affect participant’s sleep quality, and provide shared language among researchers (Dennison et al., 2013; Martin et al., 2013; Michie et al., 2014). This makes SleepWise a novel, and evidence-based, digital sleep intervention for adolescents.

Third, adolescent feedback was at the centre of intervention development, which was key to the PBA methodology, as this ensured that SleepWise was aligned with participants' priorities and helped make SleepWise as acceptable and feasible as possible (McDonagh & Bateman, 2012; Yardley et al., 2015a). Research indicates that adolescents are not always active or equal contributors to the development, evaluation, or implementation of interventions aimed at their age group (Marjeed-Ariss et al., 2015). This is problematic, as equal involvement of adolescents is an important recommendation made by the public involvement body (INVOLVE), who are funded by the UK National Institute for Health Research (Gray, 2020). INVOLVE guidelines suggest that involvement, engagement, and participation are regularly associated to one another, and while they are distinct roles, they complement one another (Marjeed-Ariss et al., 2015). Lastly, the methodology undertaken in this PhD thesis could be an example to future researchers about how to actively involve adolescents in research, while incorporating theory and evidence, when developing digital health interventions. Adolescent feedback could help better understand barriers (or facilitators) to implementing behaviour change in real life, and help improve interventions' acceptability and feasibility.

Digital Nature of SleepWise Deemed Acceptable by Adolescents

As discussed in Chapter 1, digital interventions are a useful method to involve and encourage adolescents in behaviour change, as they are easily accessible, cost-effective, can reach numerous individuals, and require limited human resources (Cummins et al., 2004; Gradisar & Richardson, 2015; Kohl et al., 2013; Spek et al., 2006). However, despite this, sleep interventions targeted at adolescents rarely utilise digital platforms for delivery (Blake et al., 2019). As expected, a common recommendation for future sleep interventions is to use digital platforms with a more personalised and systematic methodological approach to treating sleep problems among adolescents (Blake et al., 2019; Blatch-Jones et al., 2018; Cassoff et al., 2013; Eldridge et al., 2016).

SleepWise provides exactly such a platform, as it applied a systematic methodology (PBA) to developing a digital web-based intervention, while putting user feedback at the centre of the development process. For example, qualitative feedback from users in study 2 indicated that participants liked the interactive contents of SleepWise (e.g., quizzes), and suggested further modifications to help optimise the intervention, in order to make it as acceptable and feasible as possible. Developing digital sleep interventions may also appeal to adolescents' preference to receive internet-based treatment, and complement their view of the internet as a trustworthy source of health information (Blake et al., 2019; Cassoff et al., 2014; de Bruin et al., 2015; Gradisar & Richardson, 2015).

While the digital nature of SleepWise ensured that the common limitations of sleep interventions targeted at adolescents, such as non-digital, non-interactive and time-consuming content, were addressed (Moran & Everhart, 2012; Yoong et al., 2016), participant feedback in study 3 indicated that three key modifications were required to further improve engagement with SleepWise. Firstly, participants suggested that SleepWise would be more enjoyable if the same interactive content - such as quizzes and games – were included throughout each session, instead of made optional at the end of each weekly session. Second, participants felt that the sleep diary would be more accessible if it was made available via a mobile phone app. Lastly, when setting goals, participants suggested that they should be asked whether they had set a new weekly goal in the last week, before being asked if they had met their goal. This would mean that the intervention checks whether a goal was set in the first place, and allow participants who had not set a new weekly goal to continue with a previously set goal. Addressing these modifications is vital to improved engagement and experience with SleepWise, especially as adolescents often report sleep interventions as uninteresting and time-consuming (Moran, & Everhart, 2012; Yoong et al., 2016).

A common suggestion from participants in study 2 (optimisation) and 3 (feasibility and evaluation) was regarding the development of SleepWise in to a mobile phone app, as participants believed that this could improve accessibility and engagement. For example, participants in study 3 reported that they preferred accessing their sleep diary via an app, as this would provide instant accessibility, instead of logging on to a computer, then on to SleepWise, and then recording their sleep via their SleepWise sleep diary. Developing SleepWise in to an app could have several benefits to adolescent users and researchers. For example, a SleepWise app could incorporate tools to help monitor sleep objectively (e.g., sensor in mobile), as opposed to wearing a wearable (actigraph) device. While participants deemed actigraph wristbands acceptable for collecting objective sleep data (study 3), an app-based SleepWise sensor could allow a more personalised approach to adolescent sleep interventions, as interventions could be customised to the specific sleep problems faced by users (Blake et al., 2019). For example, users' specific sleep problems (e.g., difficulty falling asleep) could be identified via the sensor, and the section of the intervention relevant to that problem could be suggested thereafter via the app (e.g., managing pre-sleep arousal) (Blake et al., 2019). Such innovative methods could provide all day and night data on users' sleep/wake activities, which could help users become aware of their sleep behaviours when awake and asleep.

Mobile phone apps are also widely accepted by adolescents, as they can help reflect users' specific needs and allow adaptive, responsive, confidential, and targeted communication (Majeed-Ariss et al., 2015). With the addition of personalised feedback, innovative methods could replace activity monitors and sleep logs (Blake et al., 2019), and may even decrease clinical time, and

increase availability to treatment for adolescents with clinical sleep problems (Blake et al., 2019; Espie, 2009). User interaction and adherence to intervention components could also be improved by using more innovative technology, as well as potential reductions in dropout rates, and improved efficacy, acceptability, and cost-effectiveness (Blake et al., 2019; Luik et al., 2018).

However, while the use of innovative technology in improving adolescent sleep may be beneficial for the mentioned reasons, its use requires careful consideration to ensure that it does not impede adolescent sleep (Blake et al., 2019). Evidence-based methods to help overcome this barrier include encouraging phone-cut off times of 1-hour prior to sleep and reducing screen colour temperature and brightness (Bartel et al., 2018; Czeisler et al., 1989). Additionally, encouraging techniques to decrease pre-sleep arousal through activities such as mindfulness (Bei et al., 2013; Carney & Water, 2006), could help improve adolescents' sleep, especially for those who use technology to avoid feelings of anxiousness and/or negative thoughts before sleep (Eggermont & Van den Bulck, 2006; Hiller et al., 2014).

From a health service perspective, research from the UK National Health Services (NHS) supports the development of health apps, as they believe that mobile technologies offer appropriate platforms for medical and public health practice (NHS England, 2013; Majeed-Ariss et al., 2015). Developing SleepWise into an app could provide a novel and user-friendly approach to intervention delivery among adolescents and address the Institute of Medical Science's urgent need for credible evidence-based health apps (Misra, et al., 2013). Thus far, only one (pilot) study has investigated the feasibility and acceptability of a cognitive behaviour therapy (for insomnia) (CBT-I) app targeted at adolescents (Werner-Seidler et al., 2019). Preliminary findings from Werner-Seidler et al.'s (2019) study indicate that their sleep app is acceptable and feasible among adolescents. Exploratory effect size analysis showed improvements in insomnia, anxiety, and depression over time. Effect size findings for sleep quality showed similar findings to SleepWise, as a medium effect size (-0.46) was found for participants using Werner-Seidler et al.'s (2019) sleep app. While these findings are encouraging, Werner-Seidler et al.'s (2019) study, and previous research evaluating web-based CBT-I interventions (e.g., de Bruin et al., 2014, 2015, 2018), are often aimed at a clinical population of adolescents, who differ to a non-clinical population, as they are more likely to experience higher levels of depression, anxiety, irritability, anger, conduct problems, inattention, and drug and alcohol use (Kaneita et al., 2006; Liu et al., 2000; Morrison et al., 1992; O'Brien & Mindell, 2005; Roberts et al., 2008; Tynjälä et al., 1993). Thus, a sleep app like SleepWise, which would be aimed at the general population of adolescents (i.e., inclusion of both clinical and non-clinical adolescents), could be a practical, cost and time effective method to overcome sleep problems among all adolescents, regardless of clinical status.

Engagement with SleepWise: Reasons for High vs Low Engagement

High Engagement

Efficiency, Relevance, and Novelty

Overall, engagement (i.e., weekly session usage) with SleepWise was high across both trials, with the first session being the most engaged with session. Session 4 also indicated high engagement levels among older participants. Participant feedback in study 3 indicated that the time-efficient nature of SleepWise (i.e., bite-sized information) made it easier to stay engaged with the intervention. For example, participants liked logging on to SleepWise at regular but short intervals (one session per week), as this ensured that they had the opportunity to work through each weekly session at their own pace. As mentioned, a key finding from study 3 was participants' high usage of and positive experience with the eating and sleep session (session 1). Participants reported that session 1's content was novel and interesting, as they were not aware of how or why eating patterns in the evening could impact their sleep, and felt that this type of sleep information is not often taught at school or college. While the novelty of this session may have been a contributing factor to high engagement, participants reported that snacking in the evening was a common habit for them, and follow-up feedback indicated that some participants attempted to reduce snacking behaviour (or swap to healthier options) before sleep. Participants felt that, after attempting to change sleep related behaviours, such as those mentioned here, they noticed improvements in their sleep (e.g., undisturbed sleep). Similar to the findings from this thesis, Paterson et al. (2017) found that unpredictable habits, particularly eating foods high in carbohydrates and sugar before sleep, were reported as common barriers to implementing healthy sleep behaviours among adolescents. Thus, while adolescents may be willing to change sleep behaviours, and are aware of poor sleep habits, their own attempts at doing so may often be unsuccessful (Paterson et al., 2017), and thus providing them with the tools and information to do so may help improve the likelihood of implementing sleep behaviour change in practice.

Given that adolescents enjoyed the time-efficient nature of SleepWise, an implication from this PhD could be to use novel and time-efficient methods to encourage and engage adolescents with sleep behaviour change. One method to do this could be through using short interactive app-based communications. For example, sleep promoting messaging (e.g., sleep education) could mimic technology used by adolescents on popular social media platforms, such as Instagram (72% adolescent usage) and Snapchat (69% adolescent usage) (Dienlin & Johannes, 2020). With adolescents strongly favouring the development of SleepWise into an app, a precursor could be to utilise social media platforms for instant sleep related messaging and encourage engagement with sleep interventions. It is not surprising that some health professionals have already attempted to use

social media platforms to communicate public health messages (Yurieff, 2020), with organisation such as WHO joining platforms such as 'TikTok' to provide reliable public health information (Brown, 2020). The accessibility and instant nature of apps, coupled with novel and relevant sleep information, could prove efficacious for engaging adolescents with sleep behaviour change, as this could be an innovative approach to encouraging engagement with sleep interventions.

Age band data revealed that session 4 was also highly used among older adolescents. Session 4 included content about the benefits of and methods for reducing arousal before sleep. It might be expected that older adolescents would engage highly with session 4, as findings from follow-up interviews showed that they often struggle to manage the added pressures of employment, with academic workload, and extra-curricular activities. Session 4's content may have thus been more relevant to older adolescents' needs, as methods to relax before sleep (e.g., mindfulness techniques) were provided. This is in-line with findings from Paterson et al. (2017), who found that adolescents often struggle to 'switch-off' at night (due to pressures of studies and employment), which contributes to difficulty falling asleep. Indeed, research indicates that effective coping strategies may be vital for managing and improved sleep among older participants (Matthews et al., 2016). Evidence from Miller and Rollnick (2002) also suggests that resolving ambivalence and barriers to behaviour change could help towards effective behaviour change among adolescents.

Together, an important conclusion from these findings is that older and younger adolescents may require different intervention tools and/or sleep information to help them improve sleep behaviours, which suggests that personalising interventions to meet age-specific requirements could help improve engagement with sleep interventions. These findings may be expected, as adolescence is a wide-ranging developmental period, ranging from early, middle, and late adolescence, which could make the personalisation process of interventions a difficult task. Some researchers believe that 'middle adolescence' (ages 14-17), is a key period to target, as it marks the early stages of puberty, encompasses the rapid physical developments of puberty, and comes before the stage of being regarded as an 'adult' within society (Yeager et al., 2017). While middle adolescence may refer to those aged 14-17 (and older to those aged 18-21), it is important to acknowledge that chronological age is a proxy for developmental processes that take place during adolescence, and that puberty can start at different ages across individuals, which can vary across ethnicity and socioeconomic status (Yeager et al., 2017). With this in mind, an implication of these findings is that intervention developers could incorporate age-specific sleep sessions within their interventions, whereby users are given the option to view age-specific targeted sessions, which could, in turn, help encourage and improve engagement with interventions and behaviour change.

Lastly, acceptability findings from study 3 indicated that participants across both trials found the intervention highly acceptable, in terms of ease of use, understandability, enjoyment, usefulness, completion time, and overall satisfaction. While participants reported that additional modifications were needed to further improve SleepWise's acceptability and feasibility, the combination of interesting, relevant, and novel content, as well as easy-to-implement behaviour change techniques, and the time-efficient nature of the SleepWise, could explain high engagement with the different parts of SleepWise. Additional modifications to SleepWise, as per participant follow-up feedback, could help further improve SleepWise' acceptability levels, which could improve its likely effectiveness in a future main trial.

Low Engagement

Leading a Busy Lifestyle

Participant feedback from follow-up interviews in study 3 indicated that adolescents often felt fatigued as a result of leading a busy lifestyle, which was commonly reported as a barrier to engagement with SleepWise. For example, high academic workload was commonly reported as a barrier to engagement with SleepWise, and often led to later sleeping times among adolescents. Both usage findings and qualitative feedback from adolescents also suggested that older adolescents felt that the added pressure of managing employment with academic workload was an additional factor to feeling busy and tired, which may have contributed towards lower levels of engagement with SleepWise. While most participants reported that the time-efficient nature of SleepWise helped overcome time barriers, these findings are in line with previous research, indicating that adolescents often lead busy lifestyles, and time constraints are common barriers to improving health behaviours among adolescents, including sleep behaviours (Balasubramanian, 2017; Couriel 2003; Nelson et al., 2009; Paterson et al., 2017).

In terms of adolescent fatigue, there may be additional underlying factors to consider, which could help explain lower levels of engagement with SleepWise. As might be expected, fatigue is a common complaint among otherwise healthy adolescents (ter Wolbeek et al., 2011), with sleep characteristics predicting levels of fatigue in adolescents (ter Wolbeek et al., 2006). Societal demands such as early school start times further exacerbate the patterns of late sleep and fatigue, as adolescents are required to wake early but inclined to sleep later at night, with a majority of adolescents reporting fatigue between 8-10AM during the working week (Gibson et al., 2006). This pattern can be detrimental to adolescents' already delayed sleep patterns, as adolescence is characterised by a slower build-up of the homeostatic drive, resulting in adolescents feeling tired later in the evening and therefore sleeping later at night (Cassoff et al., 2013; Hagenauer et al., 2009). Further, on weekends, when wake up times are not restricted by school hours, adolescents

often sleep longer during the morning (Cassoff et al., 2013). Delayed sleep schedule on weekends is often interpreted as a manifestation of fatigue, which is related to sleep restriction accumulated throughout the working week (Giannotti et al., 2002). The problem arises when weekends draw to an end and the working week starts again (Cassoff et al., 2013), as it becomes impossible to maintain the delayed wake up schedule, and the accumulation of sleep debt continues (Carskadon, 2011). Together, these findings suggest that adolescents remain in a vicious cycle of delayed sleep and early wake up times, both of which contribute to experiencing continued fatigue.

A practical solution to adolescent fatigue could be encouraging the notion of later school times. Starting schools later in the morning, often with relatively small delays of up to half an hour (Wheaton et al., 2016), has indicated several improvements, including: lower levels of daytime sleepiness and fatigue complaints, lower levels of vehicle accidents and depressed mood, improved sleep duration (by 25-77 minutes), and higher levels of motivation, school attendance, and academic achievement (American Academy of Paediatrics, 2014; Boergers et al., 2014; Dexter et al., 2003; Minges & Redeker, 2016; O'Malley & O'Malley, 2008; Owens et al., 2010; Wheaton et al., 2016). However, the impact of early school times are not yet well understood (Kelley et al., 2015), which may be due to a common belief that adolescents are often tired and irritable because they choose to go to sleep late at night, and experience difficulty waking early because they are lazy (Kelley et al., 2015). Society's misconception about adolescents being inherently 'lazy' was challenged by the findings in the third study of this PhD, which indicated that adolescents engaged with SleepWise and attempted to change their sleep behaviours. For example, usage findings indicated that participants engaged with goal setting activities and sleep diary logs, and qualitative feedback from users suggested that participants felt the benefits of changing sleep behaviours, such as uninterrupted sleep. Overall, early school times may make it difficult to implement regular rise times in practice, as adolescents are required to wake early but inclined to sleep later at night (Gibson et al., 2006). Thus, adolescents may be willing to change sleep behaviours, but societal pressures, such as early schools times, may hinder their attempts.

Besides being a contributing factor to adolescent fatigue, early school times may also be a challenge for sleep interventions, as an important component of sleep advice includes the maintenance of regular rise time (Blake et al., 2019). Some studies in the scoping review in Chapter 1 showed that their interventions attempted to explore regular sleep wake patterns that reflected adolescent's circadian preferences (e.g. Paavonen et al., 2016), while others used bright light exposure to assist wake up (e.g., Bonnar et al., 2015). However, intervention methods that include components such as bright light exposure to assist rise time could risk imposing chronic circadian misalignment (Blake et al., 2019), as rising at early hours of the morning is not aligned with

adolescent's circadian rhythm. Nevertheless, delaying school times may help align adolescent's sleep patterns with their circadian rhythm. Delayed school times may also be more impactful than attempting to individually treat adolescent sleep problems (Blake et al., 2019). While there are many benefits to implementing later school times (e.g., improved sleep duration, alignment of sleep with circadian rhythm, reduced daytime sleepiness, increased grades and attendance; Dunster et al., 2018), the practicalities involved in doing so may burden the school system (Cassoff et al., 2013). Thus, a practical implication is the suggestion that future research could carry out follow-up interviews with participants, school teachers, head teachers, parents, and policy makers, in order to better understand the feasibility of implementing later schools times in practice. If starting school later in the morning is successfully implemented in the future, it could, as research indicates, improve adolescents' sleep and health outcomes.

While some participants reported that lower levels of engagement were due to fatigue and/or leading a busy lifestyle, some also reported that they were already aware of some of the methods for improving sleep, and thus skipped and/or did not engage with certain SleepWise sessions. Although this may have been the case, some participants may have lacked the motivation to engage with SleepWise, as they may have not been in the 'action stage' of change, and thus lacked intention to change sleep behaviour (Prochaska & DiClemente, 1983). One method that may help improve motivation and intention to engage with SleepWise and/or behaviour change could be to enable ease of access to SleepWise (e.g., via an app), or provide optional sessions so that participants engage with parts of the intervention that are most relevant to their needs. This may, in turn, move these individuals into later stages of change, such as the determination stage, where change talk could be reinforced and potential barriers to behaviour change identified and overcome (Bartel et al., 2018).

Lastly, as leading a busy lifestyle (lack of time) was a key contributor to low engagement, the time-efficient nature of the intervention could be improved for future implementation. While feedback from users indicated that participants generally found the intervention to be time-efficient (as mentioned earlier), many reported that developing the intervention into a mobile phone app could improve its accessibility and acceptability, which could make it more time-efficient. This could be achieved, for example, via the methods mentioned earlier in this chapter, such as the use of short interactive app-based communications.

Lack of Access to Technology

Difficulties over access to technology was a concern shared by study facilitators in study 3, as they felt that participants from lower SES backgrounds were more likely to have less access to technology. This is an important factor to consider when developing and evaluating digital

interventions for adolescents, as research shows that young people from high SES backgrounds are more likely to be frequent and long-term users of technology, than those from low SES backgrounds (Jackson et al., 2008; Koivusilta et al., 2007). While government intervention has attempted to commit to all young people having access to digital technology and internet access at home (e.g., for school and college work) (Department for Education, 2011), in practice, inequalities are still apparent and are greater in the UK when compared to any other European country (Livingstone et al., 2014). This is indicated by data from the Department of Education, which shows that government intervention has accounted for only 2.8% of increases in access to technology and the internet (Department for Education, 2011), and that a staggering 12% of adolescents (700,000) have no internet access at home from a computer or tablet device, while a further 60,000 have no internet access at all (Office for National Statistics, 2019).

An implication from the above findings is the need for intervention developers to better understand how SES impacts the management of young people's health and development, as access to technology is embedded in a sociocultural context and can impact health outcomes among young people (Collins & Karsenti, 2013; Harris et al., 2017). A practical solution to this problem could be for future researchers to explore how to improve government schemes that ensure adolescents from low SES backgrounds are equipped with technological devices and internet access (e.g., ensure distribution of study findings to local policy makers), which could help improve inequalities and bring about policies to equalise and improve school and home access to digital technology (Harris et al., 2017). While SES data was not collected as part of the feasibility trial in this PhD, and thus a conclusion cannot be reached regarding how SES may have impacted technology access in study 3, a future trial could address this by collecting participant SES data. One way to directly ensure that participants have access to technology is to provide participants with digital devices. While this may be a costly approach, it could help reduce the digital disparity between participants.

Parental Control

Participant feedback from study 3 showed that parental control over digital devices was a contributing factor to lower levels of engagement with SleepWise, but only for a small number of participants. Although instigating parental control over digital devices was true for only a small number of participants, participants in studies 2 and 3 reported that they use mobile phones regularly for multiple purposes (e.g., social interaction), and that mobile phone technology is generally more acceptable and accessible among young people. However, adolescents often struggle to 'switch off' at night due to media use, which consequently leads to difficulty sleeping (Paterson et al., 2017). Thus, it may be expected that parental control is a common practice among many parents who worry about their child's use of digital devices (e.g., spending too long on one activity, staring at

the screen etc) (Livingstone et al., 2015). Research by Helsper et al. (2013) found that parents in 25 European countries, including the UK, favour restrictive approaches to limiting their child's online activity. While lower SES households may have less access to digital technology, families from low income, and less educated backgrounds, have been shown to implement more restrictive parental mediation strategies, especially among younger adolescents (e.g., 11-13), and report being more worried about their child's use of digital media (Livingstone et al., 2015).

Important recommendations from Helsper et al.'s (2013) study indicate that more support for parents, especially those with lower levels of confidence and experience with digital media, is needed to communicate and acknowledge the benefits of internet use. Feedback from parents in Helsper et al.'s (2013) study also suggest that parents would prefer such support from schools, which is not currently available (Helsper et al., 2013; Livingstone et al 2015). An implication of these findings could be for researchers to provide parents and participating schools/colleges with evidence-based benefits of using digital health interventions, as well as encouraging parents to engage with methods for helping their child's internet usage and sleep practices (Helsper et al., 2013). This could help alleviate parents' anxieties about their child's technology use, and reassure them that technology can be used safely and for educational purposes, which could, in turn, increase adolescent's engagement with sleep interventions and consequently improve sleep outcomes.

Maintained Goals and Behaviour

Study 3 findings indicated that participants felt that changed behaviours were maintained over the course of the intervention due to improved awareness of good sleep hygiene, making small and realistic goals (e.g., reducing snacking behaviours before sleep), and experiencing improvements in sleep and/or health (e.g., less disturbed sleep). This may have led to enhanced levels of intrinsic motivation to continue these behaviours (e.g., due to inherent satisfaction), as per the SDT (Deci & Ryan, 2012). Maintained behaviour could have also been due to adolescence being a marker for improved self-regulatory behaviours, which could have improved participants' motivation to maintain behaviour change (Fuhrmann et al., 2015; Taut et al., 2015).

However, adolescence is also a marker for reduced application of health related self-regulatory behaviours (Fuhrmann et al., 2015; Taut et al., 2015), which may mean that priority may be given to other areas of life (e.g., studying, socialising), instead of sleep health. This could explain older participants' tendencies to often 'part meet' their goals in trial 2, as oppose to fully 'meet', as priority may have been given to other areas of life, such as employment. This could also explain the tendency for participants in trial 1 to 'part meet' their goals, as participants who took part in trial 1 were preparing for work experience placements, which could have lowered prioritisation of sleep behaviour change. In practice, these findings may indicate that engagement in sleep behaviour

change among adolescents were maintained, but only partially (i.e., participants part met goals). This could suggest that participants intended to change behaviour (e.g., by setting goals), but their intention and motivation to carry out or maintain the behaviour may have been hindered by overriding priorities, such as employment and/or school related activities (e.g., work experience placement).

A possible implication of these findings could be to better address and improve adolescent's levels of competency in managing competing priorities in their lives. This could be done through targeting the 'competence' construct from the SDT (Deci & Ryan, 2012), during the design process of sleep interventions. For example, a causal model was undertaken in the first study of this PhD, which demonstrated how activities such as goal setting were designed to address competence and autonomy from the SDT (see Chapter 2). While the added pressure of managing employment with school/college work is a common barrier to changing health and sleep behaviours among adolescents (Balasubramanian, 2017; Couriel 2003; Nelson et al., 2009; Paterson et al., 2017), addressing adolescent's competency in managing priorities in their busy lives could help improve participant's motivation and/or competency to maintain behaviour change over time (Ryan et al., 2008).

Recruitment and Incentivisation

Findings from study 3 suggest that the use of incentives did not make a large difference in intervention usage and/or recruitment. The intended recruitment figures for study 3 (50 participants per trial) were approximately fulfilled across trial 1 (48 participants) and trial 2 (42 participants). As indicated, trial 1 (incentivised) recruited slightly more participants than trial 2 (non-incentivised). Feedback from study facilitators in study 3 indicated that offering incentives to participants was deemed as an important part of successful recruitment, though there was little evidence of this in practice. Participants in trial 1 (incentivised) indicated slightly higher engagement levels with SleepWise, when compared to those in trial 2, which might (tentatively) suggest that incentivisation may improve engagement with interventions. However, a larger effect size was found in trial 2, and participants in trial 2 'met' their goals more frequently, whereas those in trial 1 mainly 'part met' their goals, which may suggest that participants in trial 2 were slightly more successful at attempting behaviour change. While these findings are tentative, a key implication of these findings is that incentives may not impact recruitment or engagement with interventions and/or behaviour change as much as believed, as the use of incentives in research is controversial (Mduluzi et al., 2013). Some researchers argue that incentives could potentially lead to recruitment bias (e.g., low income households), while others argue that, in the absence of incentives, the sample may still be biased towards participants who are more altruistic than others (Draper et al., 2009). However, while

controversy exists over the form and level of incentives, the absence of incentives could even prove cost-effective in intervention trials (Finkelstein et al., 2019).

While incentivisation may be a reason to partake in research, adolescents may have participated in study 3 in order to contribute to the advancement of research, as indicated by participant follow-up feedback (see Chapter 5, Benefit to Young People). Participants' inclination to participate in research to advance scientific knowledge could act as an advantage to recruiting adolescents in research, as targeting this age group may increase the likelihood of feasibly achieving recruitment figures. Nevertheless, this conclusion may not be true of or generalised to all adolescents taking part in research, as research settings, topic, and participant's levels of motivation will differ among different individuals, and therefore these implications may only be applicable to this PhD. As well, high interest in participation in study 3 may be explained by one of the school's existing relationship with the university, and the inclusion of psychology as part of their school curriculum.

Strengths and Limitations

Strengths

This PhD had several strengths. Firstly, a digital intervention (SleepWise) that was novel in its approach to development was created. The voices of adolescent users were put at the centre of the development process, along with the application of theory and evidence. Second, the shortcomings of previous research were addressed in this PhD, such as the inclusion of a wide age-range of adolescents (13-18), the inclusion of study facilitators (such as teachers), trialling SleepWise across different settings (e.g., school, colleges), and evaluating the use of objective and subjective measures of sleep (Blake et al., 2019). Third, SleepWise was evaluated in the context of a feasibility trial, which helped answer key feasibility questions (e.g., acceptability, usability etc), and contributed to reducing research waste and time, which is highly valued in research (Blake et al., 2019; Blatch-Jones et al., 2018; Cassoff et al., 2013; Eldridge et al., 2016).

Fourth, feedback from both adolescents and facilitators indicated that SleepWise was deemed as a feasible, warranted, and usable intervention for helping adolescents improve their sleep and health behaviours. Feedback from adolescents from school and college settings also deemed SleepWise valuable for learning about the importance of sleep during adolescence, as they felt that this information is often absent from school/college settings. These findings indicate that SleepWise could be feasibly incorporated into educational settings, for example, during personal, social, health, and economic education (PSHE) lessons. However, schools may not be receptive to including sleep content and/or interventions into their current lesson plans, due to their already

busy schedules (Kwan et al., 2005). Challenges may also arise when incorporating new material in to lesson plans and tailoring age-specific information to adolescents (Cassoff et al., 2013). However, study 3 findings indicated that, while study facilitators worried about an increase in workload, their already high workload was not increased when facilitating the study. Thus, SleepWise could be a feasible programme to be taken forward into school and college settings, with research showing that the integration of sleep promotion programmes do not burden the school system in terms of logistical changes (such as delayed school times) (Cassoff et al., 2013).

Lastly, and regarding the qualitative methodology used in this thesis, a strong commitment was undertaken to prolonged engagement with the thesis topic, and the development of an intervention that was relevant to its users, as well as undertaking a rigorous approach to qualitative data collection and analysis (Yardley, 2000). Rigour in this sense refers to the elements of data that were collected and analysed in relation to supplying all the information required for a comprehensive qualitative analysis (Yardley, 2000). For example, this was demonstrated by carefully optimising the intervention based on user feedback, and by applying a priority criterion (i.e., MoSCow) that helped guide the optimisation process and ensured that modifications were made to help maximise behaviour change. Commitment and rigour to understanding the research topic was also displayed by triangulating participants' usage data and qualitative feedback to evaluate the feasibility of SleepWise, which helped gain a comprehensive understanding about users' perspective and experience with SleepWise.

Limitations

This PhD had four key shortcomings. Firstly, the prototype version of SleepWise was difficult to modify during the optimisation process in study 2, as there was a lack of financial support during the development of SleepWise. Financial support during the optimisation process in study 2 could have helped towards computer-programming expertise to help optimally modify SleepWise. For example, instead of purchasing a software upgrade, a programming expert could have optimally personalised the prototype version of SleepWise to users and thus improved the likelihood of behaviour change. Nevertheless, as outlined in Chapter 3, developmental barriers, such as those in study 2, are common when planning and developing digital interventions, as outsourcing design and development experts requires additional spending that may be unaffordable, especially for early stage researchers (Biagianni et al., 2017). As a wider implication, it could be beneficial for researchers to seek and develop relations with programmers and use flexible in-house software when developing digital interventions, as this could help towards a more time and cost efficient approach to optimising digital interventions (Schueller et al., 2013; Yardley et al., 2015a).

Second, it was not possible to implement the PBA at every stage of intervention development. For example, user input was not gained during the initial design process, due to time constraints and the time-intensive nature of collecting and analysing qualitative feedback (6-9 months; Yardley et al., 2015), and therefore desirable intervention components or characteristics from a user perspective may have been missed. However, the scoping review that was undertaken in Chapter 1 reviewed studies that gained user feedback with similar sleep interventions (e.g., Werner-Seidler et al., 2017), which helped gain user insight (e.g., barriers and facilitators to behaviour change) and to overcome this barrier. As mentioned earlier, the PBA is a flexible approach to intervention development, therefore, it can be applied where and when feasible/possible (Yardley et al., 2015a). Third, a control group was included in study 3, who were offered access to the intervention after the trial had ended. While adolescents in the control group continued to receive usual education (i.e., at school or college), it is generally more acceptable that trials of high standard of evidence include an active control group or psychological placebo (Blake et al., 2017b; Furukawa et al., 2014). Lastly, a cluster-randomised trial was also not possible in study 3, as some study sites dropped out without reason (see Chapter 4). Implementing a cluster-randomised trial could have mitigated participant disappointment when not allocated to the intervention group and reduced the likelihood of cross-contamination of the study groups. While ‘classes-as-usual’ are commonly used as control groups in adolescent sleep intervention research (Bonnar et al., 2015), a future trial could use an active control group (e.g., sleep education; Vollmer et al., 2014), and undertake cluster-randomisation, to help overcome these barriers.

Conclusion

This PhD was the first to design, develop, and evaluate the feasibility of trialling and implementing a digital sleep intervention aimed at adolescents using the PBA to intervention development. This PhD has laid the foundation for developing the understanding of adolescents’ perceptions of and experience with a behavioural digital sleep intervention (SleepWise). In sum, four key findings from this PhD contribute to and inform the current literature regarding adolescent sleep.

Firstly, SleepWise is a feasible and acceptable intervention, which can now be taken forward in to a main trial. Participant feedback in study 3 showed that general modifications were required to improve SleepWise’s accessibility and usability in a future trial. For the purposes of implementing the intervention in a future trial, the modifications that should be undertaken to further improve the intervention’s acceptability include the incorporation of interactive elements throughout SleepWise (e.g., quizzes, games), asking participants if a goal had been set (before asking them whether they had achieved set goals), allowing users to review goals independently (as oppose to together),

inclusion of personalised goal suggestions (based on users' previous set goals), flexibility over sleep diary entries, and the inclusion of age-specific information to address low engagement levels. Overall, participants believed that developing SleepWise in to an app would overcome accessibility and usability barriers (e.g., using SleepWise without the worry of needing access to a computer/laptop), as an app-based intervention was deemed more accessible and time-efficient when compared to a web-based intervention. The latter modification could prove especially useful for adolescents who deemed the intervention tools (e.g., goal setting) irrelevant to their needs, as they felt that they had other means to achieving the same outcome/goal, such as utilising goal setting/sleep diary apps on their mobile phones.

Second, incentivisation was deemed as an important element to recruitment by facilitators, and those in the incentivised trial showed slightly higher levels of engagement with SleepWise. However, preliminary effect size analysis showed a larger effect size for those in the non-incentivised trial, and thus incentivisation may not be as impactful as believed. Third, study facilitators deemed SleepWise a useful and needed intervention for educating and helping adolescents with sleep and health behaviours within education settings (e.g., secondary schools). Lastly, a main trial is warranted to help test the effectiveness of SleepWise. Ultimately, this PhD will help shape the future of adolescent sleep interventions, as priority to engaging adolescents in healthy sleep behaviours, and the need for more innovative sleep interventions, is warranted (Blake et al., 2019; Edinger & Means, 2005). A digital sleep intervention like SleepWise offers a pragmatic and cost-effective solution to an important health issue among adolescents.

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Appendices

Appendix A

Inclusion and Exclusion Criteria for Scoping Review

	Inclusion Criteria	Exclusion Criteria
Participants	Male and females aged between 13 and 19 years	Male and females <u>not</u> between the ages of 13-19; participants with any current and/or pre-existing physical or mental health conditions
Interventions	Must be non-pharmaceutical interventions aimed at improving sleep quality/related outcomes; conducted online and/or offline; not specific to a certain population (e.g., athletes, at-risk population/behavioural problems)	Anything other than specified in inclusion criteria
Design	Randomised control trial; quasi-experimental/pre-post	Correlational; and anything other than specified in inclusion criteria
Outcomes assessed	Must include sleep quality/related measures	Other than specified in inclusion criteria
Publication type	Peer reviewed articles/dissertations/theses/reviews	Other than specified in inclusion criteria; review articles must not be older than 5 years
Language	Any	Any

Appendix B

Excluded Studies and Reasons

Excluded (first name of author and year)	Reason
Settineri et al. (2010)	Correlational study
Wallace (2012)	Cannot gain access to dissertation
Clegg-Kraynok et al. (2011)	Use of psychostimulants
Reiter et al. (2014)	Pre-existing sleep disorder/s
Gruber, (2013) (Review)	Review not recent (i.e., not within the last 5 years)
Scott et al. (2018)	Participants too old (>19 years-old)
Wong et al. (2013)	Participants too old (>19 years-old)
Avery et al. (2014)	At risk population (for psychosis)
Trockel et al. (2011)	Participant age too old (>19 years-old)
Kloss et al. (2016)	Participant age too old (>19 years-old)
Strong et al. (2018)	Correlational study
Schnoes et al. (2009)	Includes children and pre-existing sleep disorder/s
Vardar et al. (2005)	Athlete population
Blake et al. (2017a)	At risk population
Kaur et al. (2017) (Review)	No mention of interventions for improving sleep quality
Oertel et al. (2006)	Pharmaceutical intervention for restless leg syndrome
Marx et al. (2017) (Review)	Review topic was about later school times
Rydzkowski et al. (2016) (Review)	Pre-existing sleep disorder/s
Auger et al. (2011)	Pre-existing sleep disorder/s
Paterson et al. (2017)	No mention of interventions for improving sleep quality but does include important information regarding barriers and enablers to modifying sleep behaviour in adolescents
Blake et al. (2018)	Moderators of sleep
Barber et al. (2017)	Participant age too old (>19 years-old)
Caldwell et al. (2009)	Participant age too old (>19 years-old)
Law et al. (2018)	Pre-existing sleep disorder/s
Flausino et al. (2012)	Participant age too old (>19 years-old)
Quan et al. (2013)	Pre-existing conditions/sleep disorder/s
Morris et al. (2016)	Pre-existing conditions/sleep disorder/s
Zheng et al. (2014)	Protocol article
Taylor et al. (2014)	Pre-existing conditions/sleep disorder/s
Lin et al. (2014)	Participant age too old (>19 years-old)
Richardson (2010)	Cannot gain access to thesis
Caldwell et al. (2011)	Participant age too old (>19 years-old)
Moran et al. (2012) (Review)	Participant age too old (>19 years-old)

Tan et al. (2012)	Pre-existing conditions/sleep disorder/s
Brand et al. (2009)	Participants included football athletes
Werner-Seidler et al. (2017)	Protocol paper
Cassoff et al. (2014)	Protocol paper
Lang et al. (2016b)	Intervention does not target sleep

Appendix C

SleepWise Prototype Modules and Examples

Session 1: Sleep Knowledge (and an example page)



✓ Completed

Next
Sleep Is Important

Sleep is important But why?

When you sleep your body begins on some important work, including:


- ▶ Boosting your immune system (so you're less likely to become ill)
- ▶ Recovering from daily activities
- ▶ Improving your concentration, mood and energy
- ▶ Controlling your body temperature
- ▶ Keeping your heart healthy
- ▶ Controlling your hunger, weight and your blood sugar levels

✓ Completed

Prev
Introduction

Next
Sleep and Teenagehood

Note. From SleepWise.org.uk © 2020 SleepWise



Problems and Solutions
Problems

Don't forget to click "complete" on every page before moving on

[Complete](#)

Next
Your Problems

Problems

What's stopping you?

- ▶ In your last session, you set some goals to help you sleep better
- ▶ It's now important to think about any problems that might stop you from reaching your goals
- ▶ Sometimes your problems might be out of your control, for example if you live in a noisy area or share your bedroom
- ▶ In these situations, it's important to not feel helpless and do your best to overcome these problems

Now [click here](#) to write the problems that you think might get in the way of you achieving your goals.

[Click here](#) to see other people's problems.

[Complete](#)

Prev
Introduction

Next
Introduction

Note. From SleepWise.org.uk © 2020 SleepWise



SleepWise.

Sleep Boost
Boost Your Sleep

Don't forget to click "complete" on every page before moving on

Complete

Next
Mindfulness

Body Scan

- ▶ The body scan is another form of mindfulness
- ▶ This time it's about noticing different part of your body and bringing your attention to them
- ▶ This can bring about a sense of awareness. This awareness can help calm and relax your body and mind and help you sleep better
- ▶ Try out the body scan by listening to the recording below. Once you have tried it, give it a go by yourself as part of your bedtime routine and see how you get on

[Click here](#) to listen



Complete

Prev
Mindful Breathing

Next
Be Active

Note. From SleepWise.org.uk © 2020 SleepWise



**Future
Progress**

Don't forget to click "complete" on every page before moving on

Complete

Next
Setbacks

Setbacks

- ▶ You've done a great job completing all the SleepWise levels – well done!
- ▶ Being SleepWise doesn't stop here, it's important to be prepared for any setbacks – the next few sections will give you tips to help you keep going!



Complete

Prev
Introduction

Next
Remind Yourself

Note. From SleepWise.org.uk © 2020 SleepWise

Appendix D

Complete Button for Collecting Points and Completing Module

Socialising Risky Behaviours

► Poor sleep is linked to aggressive and antisocial behaviours like substance abuse (for example taking drugs for fun, drinking too much alcohol), unintentional injuries like falls and burns and driving whilst drowsy, putting you at high risk of a car accident



Prev
Your Mind

Next
Performance



Well Done!

You have completed Level 1 and successfully gained enough points to move on to the next level



Prev
Goals

Appendix E
Ethical Approval (Study 2)



Tel: 01962 841515
Fax: 01962 842280
www.winchester.ac.uk

Winchester
Hampshire
SO22 4NR

Ms. Shokraneh Oftadeh Moghadam
Faculty of HSS
University of Winchester

21/05/2018

Dear Shokraneh,

RE: Sleep Quality and Health: an Online sleep intervention for adolescents

(RKEEC17012)

Thank you for submitting your response to feedback from members of the RKE Ethics Committee which was sent to you on the 17th April, and for addressing two further minor queries from me.

I am now writing to feedback the outcome of the RKE Ethics scrutiny process, and I am pleased to confirm that your project has received a favourable opinion from the Committee. The Committee found the proposal to be strong overall, and the changes you have now made have strengthened it further.

I and the Committee wish you well in taking your project forward.

Best wishes,

A handwritten signature in black ink that reads "Samantha Scallan".

Samantha Scallan
Chair, RKE Ethics Committee

CC

Fances Hutt; ethics1; PGRAdmin

Supervisors: Debra.Gray@winchester.ac.uk; Margaret.Husted@winchester.ac.uk;

Ana.Aznar@winchester.ac.uk

HSS RKE Faculty Head of Research: Emiliano.Perra@winchester.ac.uk



Chancellor: Alan Titchmarsh MBE VMH DL
Vice-Chancellor: Professor Joy Carter BSc PhD CGeol FGS

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Appendix F

Recruitment Poster (Study 2)

**HOW WELL
DO YOU
SLEEP?**

**If you are between the ages of 13-19 years
then I want to hear from you!**

**My name is Shok and I am a researcher
looking at sleep in young people. I am
making a website to help young people
sleep better, but I need YOUR help!**

**All you need to do is give me feedback
about my website and you will be given a
£10 Amazon voucher for helping!**

**If you are interested then email:
info@sleepwise.org.uk**

THANK YOU!



UNIVERSITY OF
WINCHESTER

Appendix G

Participant Information Sheet and Consent Form (Study 2)

Hello!

I am a researcher at the **University of Winchester**. My research is about young people and how well they sleep. I am making an online website to help young people sleep better, but I need **YOUR** help!

Before you carry on reading, please answer the question below:

- ❖ Are you aged between 13 and 19 years?

- ❖ If you said **YES** then I would like to invite you to take part in my project. You will need to give your consent by **signing the consent form at the bottom**. If you are under the age of **16**, your parent/guardian will need to read the parent information sheet and sign the consent form so you can take part.

What do you need to do?

You will firstly answer some questions about yourself, like your age and gender. I will then show you the website I have made and the only thing you need to do is to tell me what you think about it. This will only take about 30-40 minutes and we will do it at a quiet place at your school/college. There are no right or wrong answers; it is just your opinion! The interview will be audio-recorded but no one but me (the researcher) will hear this recording, because I will use it to improve the website. Your answers might be used for research and teaching but all information will be kept anonymised and confidential, so no one will know who took part in the study. After we have finished, I will give you a **£10** Amazon voucher! You can stop and withdraw from the study whenever you wish, without consequence.



If you would like to take part, please write your full name here
_____ and **give consent at the bottom. Send your consent form to s.ofatadmoghadam.17@unimail.winchester.ac.uk or bring it with you when you meet me (the researcher).** If you have any questions please contact me on the above email address.

Parent/ Guardian Information Letter

Online Programme for Improving Sleep

Dear Parent/ Guardian,

I am Shokraneh Oftadeh Moghadam, a researcher at the University of Winchester. I am conducting a research project at Richard Taunton Sixth Form College along with my supervisors, Dr Debra Gray, Dr Margaret Husted and Dr Ana Aznar, all experts within the field of Psychology and very experienced in working with participants from different age groups and backgrounds. My research is interested in developing an online website to improve sleep quality within teenagers. Before you decide about your child's participation in this study, please read through this sheet giving you more information about the study. If you have any questions please do not hesitate to contact me. My contact details are provided below.

Why has your child been selected?

This research is interested in gaining feedback about an online website promoting good sleep quality amongst teenagers. The researcher will need to interview and gain feedback from teenagers so that she can improve the website. For this reason, the researcher is asking teenagers to participate in this study. Your child is in their teenage years and his/her school/college has agreed to participate in this study. The researcher has been DBS checked prior to starting this research.

Does your child have to take part?

No. Participation is voluntary and it is completely up to you and your child to decide if you want to participate.

How can you agree for your child to participate?

If you agree for your child to participate in the study, there is a consent form at the **bottom of this page** for you to sign. Your child can decide to stop taking part in the study at any point without having to give a reason. Your child will have 30 days to withdraw their data.

What if there is a problem?

There might be a minor risk of discomfort in this study. In the unlikely event that your child becomes anxious and/or upset during the interview, the researcher will stop the recording immediately and talk to the participant. If upset continues the researcher will refer the participant to the school/college's help services. If you want to, the researcher will discuss any worries with you or your child. Should you have any queries or worries please contact the researcher (Shokraneh Oftadeh Moghadam) at The University of Winchester on s.oftadehmoghadam.17@unimail.winchester.ac.uk

What does the study involve?

This study's aim is to create an online website to improve sleep quality amongst teenagers. Your child will be asked some basic demographic questions, for example age and gender. They will then take part in an interview located at their school/college, during this interview they will look at the website with only the researcher and tell them what they think of it. The researcher will also ask them some questions about their thoughts and how useful the website is. The interview will last for up to 30-60 minutes, and will be audio-recorded. After the interview, the researcher will thank your child and give them a £10 Amazon voucher for their participation.

Will your child's responses be kept confidential?

Yes. All data collected will be kept confidential. With your permission, the researcher will audio-record the interview so that she can analyse the data. These recordings will be typed up and your child's name or any other details that can identify them will be removed, to ensure confidentiality. These anonymised transcripts will be stored on a password protected file on secure University of Winchester computers. The recordings will be held in a locked cabinet in the University of Winchester which only the researcher can access. All personal data will be handled in accordance with the Data Protection Act 1998. In certain exceptional circumstances where your child or others may be at significant risk of harm, the researcher may need to report this to an appropriate authority, in accordance with the UK Data Protection Act 1998. This would usually be discussed with you first. The findings from this study will be used for research and teaching purposes, but no names will be included in the report so any quotes from the interview will remain anonymous.

Who has reviewed the study?

This study has been reviewed and received a Favourable Ethical Opinion from the University of Winchester Ethics Committee.

If you are happy for your child to participate in this study, please complete the attached consent form and return it via email to the email address below, or give it your child to bring to their interview:

s.oftadehmoghadam.17@unimail.winchester.ac.uk

Yours faithfully,

Shokraneh Oftadeh Moghadam
Department of Psychology
University of Winchester

Email: s.oftadehmoghadam.17@unimail.winchester.ac.uk

Consent Form

Online Programme for Improving Sleep

The purpose of this form is to make sure that you and/or your parent, guardian or carer have received all the information about the research project that you need, and that you want to take part. Please read the information letter that comes with this form before signing it. Also, please give the information letter to your parent or guardian so that they can read it. The important points to remember are:

- You do not have to take part in this research.
- You do not have to answer any questions that you do not want to.
- You can change your mind about taking part in the research even if you have already agreed to take part. If you do change your mind then please contact me at the contact details below.
- The data might be used for research and teaching purposes, as data collected from this phase of the study will feed into subsequent phases, however all information will be kept anonymised and confidential.
- Any information regarding acts that could lead to foreseeable harm may be reported to parents, the school, or police/medical professionals. In all cases, the researcher will talk with the participant (i.e. the minor) first about what to do. This may mean that the researcher will encourage the participant to talk to someone who could help, or agree to talk to someone on their behalf.
- If the participant (your child) does not want a concern to be raised with the parent, then the participant's confidentiality will be maintained unless there is a clear and foreseeable risk to the participant from non-disclosure.

If there is anything that you do not understand, or if you have any questions, then please ask before signing this form. Otherwise, please sign below in the spaces provided. Please note that if you are under the age of 16 then you and your parent, carer or legal guardian must sign the consent form as well.

Participant

Parent, Carer, or Guardian (if 16 years or under)

Name: _____

Name: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

You **cannot** take part in the research without a signed form.

Thank you for your time and help,

Shokraneh Oftadeh Moghadam
Department of Psychology
University of Winchester

Email: s.oftadehmoghadam.17@unimail.winchester.ac.uk

Appendix H
Demographic Questions

1. What is your gender?

Male

Female

I define myself in another way (please state)

2. How old are you?

_____ years

3. What is your ethnic background?

White.....

Chinese/ South East Asian

Black African.....

Indian

Black Caribbean.....

Pakistani

Black Other (please state).....

Bangladeshi.....

Other (please state).....

4. What school/college year are you in?

Year_____

Appendix I
Interview Guide (Study 2)

So this is a study to develop an online programme aimed at sleep and health in young people.

I'm interested in your views of the first version of this programme. All you have to do is work through the content of the programme, as you normally would if I was not here and just say your thoughts out loud.

It's also important you understand that the programme is still in development and is not ready to use, so I'm not asking you to actually follow the programme.

Is there anything you would like to ask me at the moment?

Are you happy if I start recording now?

THINK ALOUD AND RESEARCHER PROMPTS

- [only on first/home page] What are your first impressions of this page?
- What are you thinking now?
- What made you say that option?
- What do you think about [this technique, this information]?
- Can you tell me a bit more about why you think that?
- What is it you like about that?
- That's really interesting.

1. POST THINK ALOUD QUESTIONS

- Overall, what do you think about the programme?
- Can you tell me about anything you thought was particularly good about the programme?
- Can you tell me anything about the programme that you were less keen on?
- What do you think should be changed?

- Can you tell me about anything else that you think might be useful to you?
- Which parts did you find most relevant to you?
- Which aspects of the programme would you recommend to other people?
- If you were following the program, which **(behaviour change) techniques** would you try and why?
- Could you tell me about anything that would make it easier to **follow the (behaviour change) techniques** shown in the program?
- Could you tell me about anything that would make it difficult to **follow the (behaviour change) techniques** shown in the program?
- Can you tell me about any advantages of **following the (behaviour change) techniques** shown in the programme?
- Can you tell me about any disadvantages of **following the (behaviour change) techniques** shown in the programme?
- Is there anything you would like to add that we haven't covered? Or any additional issues/suggestions that you want to bring up that you haven't been asked about?

2. DEBRIEF THANKING and GOODBYE.

Appendix J

Iterative Change Table

Quote (positive/negative)	Context of Quote	Possible Change Needed (if any)	Must have Should have Could have Would like?	Decision to Implement Change or Not	Reason for Change	Date Change Made
“I think there should be more information about what the project is...you might have limited time to see the website... on the front page so people can understand, just few information, few words...” P1	The question that was asked was what your first impression of the homepage	1. Provide more information about what SleepWise is on home page	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“Erm maybe limit the (complete) pop ups to when you’re finishing the module maybe...cos there is so many modules to go through the kind of pop it does get kind of repetitive if that makes sense ” P2	The question that was asked was what do you think should be changed	2. No pop up button when clicking the complete button or limit only to one page	Should have	Yes	Repeated Consistent with Guiding Principles	December 2018 – March 2019
“I think there should be more interaction have a slide asking questions – do you think lack of sleep has	The question that was asked was what do you think about the	3. Have a question about why you have limited sleep patterns	Would like to	Yes but phrased as identifying	Repeated Consistent with Guiding Principles	December 2018 – March 2019

affected you throughout education... why have you limited your sleeping patterns” P1	information provided on sleep patterns			barriers to sleep		
“ I think when you said tips will be later on but, I think it should be [earlier], for example media and then what to avoid [at night]” P1	The question that was asked was what do you think about the page on media usage and sleep, and what needs improving	4. Provide some tips earlier on (e.g., in media use section of sleep knowledge)	Must have	Yes	Repeated Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“Maybe if there was another button just to say next level to make it clear...would there be a notification that said ok you can go to the next level now? Like an email or a text or something...That says yeah ok you can go to level two” P3	The question that was asked was what makes it hard to follow the website	5. Provide instructions about where to go when navigating to the next level, and embed email and or text reminders to log in	Must have	Yes	Repeated Consistent with Guiding Principles	December 2018 – March 2019
“Erm I think what you could do in the future is have like a student ambassador...For example be a SleepWise ambassador in their	The question that was asked was what do you think about the “Meet the Team” page	6. Suggest having school/college SleepWise ambassadors	Would like to	No	Did not seem necessary to behaviour change and was a time consuming process	December 2018 – March 2019

schools... speak about how important sleep is" P1						
" I think it should start up by making small goals and then building up for example saying I'll try and sleep 8 hours a day and then make my habit but in order to do that you need small steps first..." P1	The question that was asked was what do you think about questions the habit making questions	7. Emphasise the idea of making realistic/small/achievable goals	Must have	Yes	Repeated Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
"instead of clicking edit they can just click the box and it starts typing immediately" P2	The question that was asked was what do you think about the setting goals page	8. Remove edit button for goal setting activities	Should have	Yes	Repeated Consistent with Guiding Principles	December 2018 – March 2019
"Personally with me and my laptop I have reminders in the corner there just kind of dismiss them... Because I'll be like doing something but like on my phone I always look at my reminder if that makes sense...It's really weird I don't know why I don't look at mine on the laptop but on my phone I'm like always looking because	The question that was asked was what do you think could be improved, and what do you think about receive reminders about receiving reminders	9. Send reminders to participant's phone	Would like to	Yes	Repeated Consistent with Guiding Principles and with Guiding Principles	December 2018 – March 2019

it's so like immediate and it's a small screen as well" P2						
"Do you have graphs in this so you can measure, you can put in how much you're sleeping? ... And measure and track where your days are dipping so what happened on that day so you can find out" P2	The question that was asked was what could be useful to you	10. Provide information on tracking sleep digitally, for example an actigraph watch	Should have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
"Maybe if there is like a few more stats and stuff...Just so it's a bit more – you know when you see a statistic that you're like wow!" P3	The question that was asked was what do you think about the body and mind section	11. Provide more information about statistics of sleep, embedded within the sleep knowledge section	Must have	Yes	Repeated Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
"Maybe you should have some more times, so you know , try and not to drink caffeine for before all the like 3 hours or whatever it is before sleep" P3	The question that was asked was what do you think about the tips on eating, drinking and sleep	12. Provide more information about when to stop eating/drinking e.g., when to stop drinking coffee before bed (though later on this is stated)	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
"Erm would there be a notification that said ok you can go to the next	The question that was asked was what might	13. Implement reminders to remind participants when to start on next	Should/Would like to have	Yes	Repeated	December 2018 – March 2019

level now?...Like an email or a text or something...That says yeah ok you can go to level two” P3	make it difficult to follow the intervention	level/finish where they left off			Uncontroversial and easy Consistent with Guiding Principles	
“I think the three sign up for free, is a little bit sort of in your face, well not really, but it can be a bit repetitive for people who just want to look at the website” P4	The question that was asked was what do you think about the Home and Sign Up Page	14. Remove and replace “Sign Up for Free” with more information about SleepWise or tips for better sleep	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“So that’s pretty good (reading) yes so that might be condensing to the end age of the group – like the graduation certificate...I think for schools, school students, that might be fine, but people who are my age or above might see it as a bit condensing ... not saying they will obviously, but I would think it’s a bit like kiddy” P4	When participant was looking through the dashboard section of SleepWise	15. Think about an alternative way of describing the graduation certificate and make it optional	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“I think this part can be part of the introduction... I don’t think it needs to be a separate thing cos you	The question that was asked was what do you think about the	16. Take out introduction for every sub-section as it does not add anything new	Must have	Yes	Repeated Uncontroversial and easy	December 2018 – March 2019

don't bring anything new into it" P4	introduction pages for every sub-section				Consistent with Guiding Principles	
<p>"Basically what you do, you tell them what made you happy or angry or sad that day, and then after they collect enough data, so, erm they get these things, like what makes you happy, you click on it and it says, partner, music, friends, exercise, good sleep that makes you happy</p> <p>...With this thing [SleepWise] it's like what made you sleep well, or what you should avoid... And then go through a system, like an algorithm, pick out the things that like too much alcohol or too much chocolate [that distract sleep" P4</p>	The question that was asked was what do you think about using a sleep diary as part of the website	17. For each day of the week have a selection of descriptive words/feelings/actions to tell participant about what made them sleep well or poor that night. Have reminders to remind participant what helped them sleep that day and what did not. This can be done through creating an algorithm to give personalised feedback based on what affects the participant's sleep	Would like to	No	Not enough time to look into creating this idea. However, participants will be asked about helpful/unhelpful behaviours to sleeping well as part of a sleep diary. They will also receive personalised feedback on goal setting.	December 2018 – March 2019
"And I guess like you can like highlight that you know on pages where like a single word is highlighted so that if you	The question that was asked was what do you think about the Mindfulness page	18. Provide a page/tab for further reading/information (This could be implemented at	Must have	Yes	Repeated Consistent with Guiding Principles	December 2018 – March 2019

press it takes you to a URL for more information about the thing” P4		the end of each weekly session)				
“[the website doesn’t] actually give the person like a template to write the [sleep] routine, I think that would be good... make the template printable because I think people would like to see it on paper” P4	Participant looking at sleep routine and diary	19. Provide a template for sleep routine instead of just examples of others’ routines	Must have	Yes	Repeated Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“think maybe having like a - on the website I don’t know but on the app I mentioned before they have a mindful breathing thing and it sort of like shows when you’re breathing there’s a shape that expands” P4	The question that was asked was what do you think about the Mindfulness page	20. Implement an inflating/deflating bubble as a visual aid to breathing	Would like to	No	Very time consuming	December 2018 – March 2019
“You don’t have vegetable curry with couscous everyday...so every single day different foods or different recommendations of foods because it’s sort of there and people will come back again and you	The question that was asked was what do you think about the meal ideas/snacks (for sleep) page	21. Provide more recipes for lasting for a duration of a week or month so participants can refer back to them	Must/Should have	No	Time consuming but participants will be provided with healthy eating ideas for sleep at the end of the appropriate weekly session	December 2018 – March 2019

can make the most use out of a function like that” P4						
“...make sure you tell them that, that they should come back a week later... Because that’s obviously very important...it might not make it clear that they should come back in a week... you tell them what to do and what not to do that would be very useful and I can see myself coming back to that” P4	The question that was asked was what were you less keen on	22. Inform participants what they are expected cover in their next weekly session	Must have	Yes	Repeated Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“If the website itself gives reminders...It’ll make it much more interactive and you’ll know you’re actually doing something, you’re not just on the website for fun, it will actually help you” P4	The question that was asked was what do you think about having reminders	23. Send users reminders, or tip of day	Must/Should have	Yes (goal and sleep log reminders)	Repeated Consistent with Guiding Principles	December 2018 – March 2019
“I would have like go on there but it might not be very clear if you don’t know, people might not realise that that’s what they do ...it’s just there	The question that was asked was what do you think about the flip motion of the next level tabs	24. Provide users clear instruction about where to go/click to access the next level	Must have	Yes	Repeated Uncontroversial and easy	December 2018 – March 2019

and then you have to go on to it to make it flip” P5					Consistent with Guiding Principles	
“I would say with that [the expand button] I wouldn’t know that would come [up] if you hadn’t shown me that [the expand button]” P5	The comment that was made was about clicking on the expand button to see the progress bar	25. Clarify expand button (progress bar) on the learning system	Must have	Yes	Repeated Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“I think the introduction page, the idea itself is good, but I feel like there could be a bit more detail about it like, instead of just saying it’s going to be about sleep, body and mind little bit, like a sentence about it” P5	The question that was asked was what do you think about the introduction pages for each sub section	26. Introduce sub-sections, without the intro pages but with few detail (using some of the examples already provided) – this is the same as number 23	Must have	Yes	Repeated Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“yeah with this – where it says feeling sluggish, erm that’s like kind of repeating what it said about being drowsy” P5	The question that was asked was what do you think about this page	27. On the active page change wording of sluggish as it feels repetitive	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“you could go on to say something about you know later we’ll find out how you can change, like you could have something	The question that was asked was what do you think about this page	28. Provide information about how to stop drinking caffeinated drinks	Would like to	Not exactly	Caffeine was mentioned as disruptive to sleep and its reduction/absence	December 2018 – March 2019

about them being able to get off caffeinated drinks to sleep better because some people do get addicted to it” P5					used as a goal setting example for better sleep hygiene	
“I would have thought you would’ve had to click next, the button, instead of the bit underneath it so my immediate reaction is to click next or back cos I would think that’s the next button instead of the bit under it” P5	The question that was asked was what do you think about the button on this page	29. Allow participants to click on the actual Next and Back buttons not under them	Must have	Yes	Repeated Consistent with Guiding Principles	December 2018 – March 2019
“It might be good to like...these pictures are pointing to what in the environment might make your sleep worse, have like a little bullet point that just saying about it” P5	The question that was asked was what do you think about having the option to click through for more information	30. Explain the pictures with bullet points on the sleep environment page	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019

<p>“With this question, I don’t remember anything about your body click shifting...I can’t remember it saying what the average one is so for that I wouldn’t really know...” P5</p>	<p>The question that was asked was what do you think about the quiz in general</p>	<p>31. Take out questions that are very specific in the quiz</p>	<p>Must have</p>	<p>Yes</p>	<p>Uncontroversial and easy</p> <p>Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>“I feel like after a while you would remember to click complete so erm it might not need to say it as often” P5</p>	<p>The comment that was made was about clicking the complete button when going on to the next page</p>	<p>32. Minimise complete button reminders</p>	<p>Must have</p>	<p>Yes</p>	<p>Repeated</p> <p>Consistent with Guiding Principles</p>	
<p>“...you could always like erm have a few examples of watches that track your sleep cos I have a Fitbit but if I didn’t I wouldn’t know what you could do...What are some good ones that you can get and also affordable ones cos as a student you won’t be able to go out and get an expensive watch” P5</p>	<p>The comment that was made was about providing solutions to sleeping better</p>	<p>33. Provide information about watches that track sleep and their affordability</p>	<p>Could have</p>	<p>Not exactly</p>	<p>Suggestions will be provided regarding tracking sleep but more so in regards to using a sleep diary. However, for the purposes of this research, some participants will be given actigraph devices to measure sleep patterns</p>	<p>December 2018 – March 2019</p>
<p>“Maybe on this page you could have more about it [Sunrise Alarm Clock]?”</p>	<p>The question that was asked was what do you</p>	<p>34. Provide more information about Sunrise Alarm Clock</p>	<p>Must have</p>	<p>Yes</p>	<p>Uncontroversial and easy</p>	<p>December 2018 – March 2019</p>

Because now I'm intrigued I want to like learn more" P5	think about the Sunrise Alarm Clock page				Consistent with Guiding Principles	
"Maybe underneath that you could put some alternatives, like get a bean bag or something comfortable cos quite often you know if you want to relax by yourself your bed is your only option" P5	The comment that was made was about how not to use your bed for other activities	35. Provide alternatives for using bed for activities e.g., using a bean bag etc	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
"maybe you could have some tips or encouragement to get out of bed, because often I wake up and I'm just like, it's cold out of the bed or something and then I just, on the weekend I don't feel any encouragement to wake up" P5	The question that was asked was asked was is there anything that you'd like to add that we haven't covered	36. Provide tips on how to get out of bed in the mornings	Would like to	Yes, in the context of the Sunrise Alarm Clock and sleep diary	Uncontroversial and easy Consistent with Guiding Principles	
"Could you put a reason why – young people might not sleep these [recommended] amounts" P6	The comment that was made was about the sleep guidelines for adolescents	37. Provide more information on why young people may find it hard to sleep	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019

<p>“Maybe just say sort of your brain more than your nervous system, it depends on the people you are looking at, if there are people that do biology then that means something to them but if it’s just regular ...if you’re talking to someone who isn’t into science then that probably doesn’t mean anything to them” P6</p>	<p>The question that was asked was what do you think about the rest and recovery page</p>	<p>38. Take out the term “nervous system” , instead reword to brain and spine</p>	<p>Must have</p>	<p>Yes</p>	<p>Uncontroversial and easy Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>“Me, I don’t have much discipline slash time I don’t know if I would [write in diary]- maybe it’s better to do it online you can just sit on your bed in the morning and type it on your phone and then that’s kind of logged...Rather than having to print it out... I think it’s a bit more convenient probably because it’s on a phone for young people they would probably stick to it</p>	<p>The question that was asked was would you stick to the sleep diary</p>	<p>39. Implement sleep diary so that it can be used on mobile phones. Ensure that the sleep diary asks short questions instead of long ones</p>	<p>Must/Should have</p>	<p>Yes</p>	<p>Repeated Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>

a bit more. So like a little form... With 2 or 3 questions” P6						
“because “click here to see your problems” is kind of - maybe click here to see what you wrote or something and identify what could be stopping instead of what stops maybe just a little bit softer” P6	The comment that was made was in relation to the solutions page	40. Use softer wording instead of “see your problems”	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“ Is there any proven statistics temperature that are right say if your room is 21 degree you sleep better... And maybe suggestions for what kind of bedding, like cotton” P6	The comment that was made was in relation to sleep hygiene advice	41. Provide information on what kind of bedding and room temperature is scientifically recommended for better sleep	Would like to	No	Time limitations did not allow this to happen however comfortable bedding and suitable room temperature will be mentioned as part of sleep hygiene advice/tips	December 2018 – March 2019
“You could kind of suggest making a nice corner in your room” P6	The comment that was made was in relation to the bedroom page	42. Suggest ways of making a corner in bedroom for other activities	Must have	Yes	Repeated Consistent with Guiding Principles	
“Does it tell you what position you need be in?”	The comment that was made was in relation to	43. Ask participant to lay down in a comfortable	Must have	Yes	Uncontroversial and easy	December 2018 – March 2019

<p>Researcher: For the body scan? No I think it goes straight into it maybe mentioning again to sit or lay down in a comfortable position” P6</p>	<p>the body scan/mindfulness page</p>	<p>position and avoid lying in bed</p>			<p>Consistent with Guiding Principles</p>	
<p>“... maybe a video because with yoga postures you know you do them but it’s kind of getting into them...” P6</p>	<p>The comment that was made was in relation to the yoga page</p>	<p>44. Implement video for yoga postures</p>	<p>Would like to</p>	<p>No</p>	<p>Users will be provided with more information (at the end of the session) about relaxing activities</p>	<p>December 2018 – March 2019</p>
<p>“Maybe an option to say what’s improved...to say what’s improved so they realise that these steps they’ve taken actually do work ... maybe how do you feel now compared to how you felt last week ...” P6</p>	<p>The comment was made in relation to the programme outline page, once participants finished one level</p>	<p>45. On the future page include a question about how you feel compared to when you started</p>	<p>Would like to</p>	<p>Not exactly</p>	<p>Instead of this question, weekly goal reviews will be implemented to help users review progress</p>	<p>December 2018 – March 2019</p>
<p>“...put a line in saying it’s ok to sleep in sometimes you know, not all the time but obviously it can’t completely contradict what you’re saying but you know just a few you</p>	<p>The question that was asked was what do you think should be change</p>	<p>46. On the future page reassure users that it is OK to lay in sometimes</p>	<p>Would like to</p>	<p>Not exactly</p>	<p>Instead of saying it is ok to lay in sometimes, users will be encouraged to maintain similar weekend and</p>	<p>December 2018 – March 2019</p>

know it's ok , if you've had a long night it's ok to sleep in a few times..." P6					weekday sleep patterns	
"...suppose for me maybe I would want to kind of do it quicker I might not you know like to wait until the next Monday you know I could forget about it you know be busy doing other things by then... if you say you know you have more time you wanted to do it daily would you have to, you know I suppose it'd be frustrating for you if you had to wait a week until you do the next if you wanted to do it more often..." P7	The comment that was made was in relation to collecting points and waiting a week until the next session	47. Provide an option for personalisation if participants did not want to complete sections on a weekly basis	Could have	Not exactly	The website needs to be released on a weekly basis to enable users to set goals and work through the different sections	December 2018 – March 2019
"...then I suppose it depends on you know you actually gain through the activities is it something that's meant to you know you're using throughout the week..." P7	The comment was made in relation to the activities completed when using the website	48. Explain why some of the interactive activities (e.g., setting goals) can be important for later stages of the website	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
"Yeah I think maybe having a couple more of those quizzes cos	The question that was asked was what do you think about having	49. Break up sleep knowledge with more quiz/games	Must have	Yes	Uncontroversial and easy	December 2018 – March 2019

questions along the way would be a good thing to help to break up the information” P7	more questions [on the quiz]				Consistent with Guiding Principles	
“...I don’t want to say make the questions harder...A couple of them you know I think are quite simple to work out...” P7	The question that was asked was what do you think about the quiz	50. Provide more complex (or more) questions for the quiz	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	
“...that’s nice that you’re able to hear other people’s opinions of it... I think that’s a good idea – you could even have more I think if you – if it felt necessary...Yeah it just makes it more personal I think...” P7	The question that was asked was what do you think about others’ stories/accounts	51. Provide more personal accounts of others’ perspectives/stories	Could have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“...I think that’s – well I mean I suppose erm I’m not sure people will know that they’re going to end up with certificates I suppose...It will come as a bit of surprise” P7	The question that was asked was what do you think about a certificate once finished	52. Ensure participants know that they can get a certificate once they’ve completed the 4 weeks period	Must have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“...the arrows sort of look like they’re supposed to be the buttons that you can click on to go to the	The question that was asked was what do you think about the programme outline page	53. Ensure buttons look clickable and participants are guided to the next level clearly (P8)	Must have	Yes	Repeated Consistent with Guiding Principles	December 2018 – March 2019

next level... It might get a bit confusing” P8						
“Maybe an image or diagram or something cos I read the first bit and I still don’t know what a body scan is” P9	The question that was asked was what do you think about the body scan page	54. Implement a diagram or picture of the body for the body scan (P9)	Would like to	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“...I mean I feel most people’s parents cook dinner... this stuff, or if you’re having curry you could change it to like have vegetables in it as well or put a salad on the side, like small changes...” P9	The comment that was made was in relation to the eating healthy page	55. Some suggestions about eating out and cooking with parent/s as most of the time food is cooked for participants by parents. Also mention about making small and achievable changes to diet	Must/Should have	Yes	Consistent with Guiding Principles	
“...I’ve never heard of any of these but if I was reading I might go and search what they are and maybe try one or two...” P9	The question that was asked was what do you think about the snacks and drink page	56. Ensure that snack and meal ideas include familiar foods and mention having smaller portions of what they already have	Must/Should have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019
“...If you put [something to show] , if you made one [goal] for yourself that was not realistic if you couldn’t change it you	The comment that was made was in relation to goal setting	57. Provide more direction on what to do if goals are not achieved	Must/Should have	Yes	Uncontroversial and easy Consistent with Guiding Principles	December 2018 – March 2019

would just give up or not even attempt it..." P9						
<p>"C: there's a lot of reading B: I think how you integrate the facts...it's about how you throw loads at once... A: that's a lot [of text]...can't you break it up into smaller ones instead? "B: I think potentially have like an expandable bit so you've got keys points and expand that into further information so it's less daunting when you load the page, if you want to see more..." (Focus Group)</p>	The question that was asked was what do you think could be a better way of getting this information across?	58. Ensure text is in and more manageable chunks and include more options for click throughs (Focus Group)	Must have	Yes	Consistent with Guiding Principles	December 2018 – March 2019
<p>"C: you wouldn't have to read as much so you wouldn't feel overwhelmed... B: and I guess for some people the human interaction will be there..."</p>	The question that was asked was what do you think it makes a difference that this information, given that it's sensitive about mental health was	59. Think about implementing videos for sensitive/longer information (e.g., mental health)	Would like to	Somewhat	Although this is consisted with Guiding Principles, it was not an easy task. Instead, participants were offered videos on	December 2018 – March 2019

<p>C: so it's not just all text, something like that. I think you should have a choice between a video and text" (Focus Group)</p>	<p>given over a video or audio</p>				<p>different topic areas at the end of each weekly session</p>	
<p>"B: ...A lot of stuff now has blue light filter modes...and I think raising the point that [blue light exists]...it's not that there is a long solution that people going to have to spend 20 minutes [on], it takes 2 minutes to set up put sunset, sunrise blue light filter mode..." (Focus Group)</p>	<p>The question that was asked was what do you think about just look at that [what affects your sleep page]?</p>	<p>60. Encourage use of blue light filter and the eventual disengagement with phones at night</p>	<p>Must have</p>	<p>Yes</p>	<p>Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>"...it's like sometimes before, could be something that people aren't necessarily interested in, so starting from smaller steps... it's like making it clear that the aim – make the aim less to do these like things, to do all these things but it's like the achievement is the small steps..." (Focus Group)</p>	<p>The question that was asked was in the context of cutting down screen time</p>	<p>61. Emphasise making small and realistic steps</p>	<p>Must have</p>	<p>Yes</p>	<p>Uncontroversial and easy Consistent with Guiding Principles</p>	

<p>“I think potentially it could be on the side though, instead of having to scroll all the way down have something on the side that will scroll you down... M: you can put that in the little tiny bit, given them a button B: yeah like a FastTrack to it [information]” (Focus Group)</p>	<p>The question that was asked was in the context of spreading out information and minimising scrolling time</p>	<p>62. Minimise scrolling by having more click through options</p>	<p>Must have</p>	<p>Yes</p>	<p>Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>“A: there needs to be something that keeps your attention the whole time C: more photos, more colour M: cos at the moment it’s just orange and black” (Focus Group)</p>	<p>The question that was asked was what do you think will grab your attention</p>	<p>63. Change up colours and pictures</p>	<p>Should have</p>	<p>Yes</p>	<p>Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>“M: you might forget to do it. Because if it’s in the morning and you’re trying to like get extra sleep in, for example you might be late for something, you don’t know how</p>	<p>The question that was asked was what do you think about a chart/calendar being combined with a sleep diary?</p>	<p>64. Ensure sleep diary is not at both night and day time. A graph format or template would be useful</p>	<p>Must have</p>	<p>Yes</p>	<p>Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>

<p>B: yeah it's like suddenly it takes 30 seconds M: just write about something that you did each day B: yeah you don't have to...Cos that [chart] kind of helps you keep track of your sleep" (Focus Group)</p>						
<p>"M: cos it's just more text to read Ok M: graphs are like something different Graph for sleep routine? M: uhmm B: like change it up a bit" (Focus Group)</p>	<p>The question that was asked was in the context of having a chart for sleep routine</p>	<p>65. Implement a sleep routine chart/graph</p>	<p>Must have</p>	<p>Yes</p>	<p>Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>"A: have a section on the website who to contact or something" (Focus Group)</p>	<p>The question that was asked was in the context of asking for help</p>	<p>66. Provide other sources of contact or suggestions of people to speak to if unsure who to speak to about mental health and wellbeing</p>	<p>Must have</p>	<p>Yes</p>	<p>Repeated Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>"M: it could add maybe something else. If someone wants to know exactly what mindfulness is what apps can help them?" (Focus Group)</p>	<p>The question that was asked was what do you think about the mindfulness page</p>	<p>67. Mention about apps that might be useful for mindfulness</p>	<p>Could have</p>	<p>Not exactly</p>	<p>The use of additional digital media will not to be encouraged, thus more options regarding</p>	<p>December 2018 – March 2019</p>

					relaxation activities will be given at the end of the appropriate week	
<p>“A: you could have it in a Snap Chat style you know you have snap stories I was thinking you have Instagram accounts that are like that as well ...with like information, you could have like an account just kind of like that cos there’s (loads) of people on Instagram it’s easier to get attention on there...” (Focus Group)</p>	<p>The question that was asked was in the context of what opinions they had on the mindfulness page</p>	<p>68. Implement a social media account. This would be useful for getting information across to more users</p>	<p>Would like to</p>	<p>No</p>	<p>Social media will not to be used for this research as it would add an extra variable (e.g., social connectedness)</p>	<p>December 2018 – March 2019</p>
<p>“ A: you know you can get google maps and that – you can put sport clubs and that...put like different things into it” (Focus Group)</p>	<p>The question that was asked was what do you think about the physical activity pages</p>	<p>69. Encourage joining local sport clubs via searching for them online/on maps</p>			<p>Uncontroversial and easy</p> <p>Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>“B: the click here bit it important to not- M: obviously [with the click heres] make it clear like make a heading saying tips or something</p>	<p>The question that was asked was what do you think about the physical activity pages</p>	<p>70. Make use of click throughs to spread information and make them more noticeable</p>	<p>Must have</p>	<p>Yes</p>	<p>Uncontroversial and easy</p> <p>Consistent with Guiding Principles</p>	

<p>B: yeah just like not having all that information on the page and lay [it put] - M/C: separate B: it's like having the key information that you really want to get across then have the information that you also get across [in click throughs]" (Focus Group)</p>						
<p>"B: reflection which is good M: how close is it to the end cos if it's a reflection it should be [at the end] B: it's like showing that you're close – people are likely to continue..." (Focus Group)</p>	<p>The question that was asked was what in the context of overcoming problems to improving physical activity levels</p>	<p>71. Provide a reflection at the end/feedback box at the end of each week</p>	<p>Must have</p>	<p>Yes</p>	<p>Uncontroversial and easy Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>"M: cos then you're like encouraging young people to make their own healthy [choices] - B: cos sometimes when all you know is unhealthy food it's like the transition -</p>	<p>The question that was asked was in the context of improving healthy eating behaviours for better sleep</p>	<p>72. Ensure that healthy and unhealthy diets are clearly explained</p>	<p>Must have</p>	<p>Yes</p>	<p>Uncontroversial and easy Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>

<p>A: depends what you mean by unhealthy...” (Focus Group)</p>						
<p>“A: also things kids might eat cos I’d look at that yeah and be like that’s putting me off food, just give me a Nandos...You need to give stuff that we all know of ...B: it’s again making it clear that you don’t have to do like all of it it’s just small , doing things every now and then, even if it’s not everything, even if it’s not as [inaudible] maybe you should – it’s still an improvement...” (Focus Group)</p>	<p>The question that was asked was what do you think about the food and drink recommendations</p>	<p>73. Specify what foods/drinks specifically affect sleep and include more realistic/achievable eating options e.g., decaf PG tips instead of herbal ones</p>	<p>Must have</p>	<p>Yes</p>	<p>Uncontroversial and easy Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>
<p>“M: ...make it clear three things that also affect sleep so obviously sleep itself, physical exercise and a healthy diet... CJ: yeah cos trying to cram everything in [with the longer sections] –</p>	<p>The question that was asked was in the context of working through the different weeks and sections at your own pace</p>	<p>74. Split weekly session into modules, such as sleep/diet/physical activity</p>	<p>Must have</p>	<p>Yes</p>	<p>Consistent with Guiding Principles</p>	<p>December 2018 – March 2019</p>

B: it's less drastic [with less information]..." (Focus Group)						
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Appendix K
SleepWise Extracts

Extract of Home Page

 info@sleepwise.org.uk

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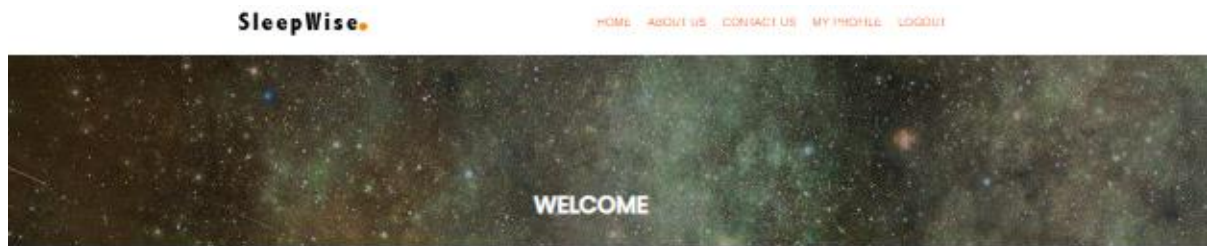
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**SleepWise for better
sleep and health**
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Session 1 Welcome Page and Session Extract



Welcome to your first SleepWise session!



This week we will look at the importance of sleep, eating habits, and how eating can affect sleep!

If you're short on time, please click [Save Page!](#) Saved pages will be in [My Profile](#) (top of page)

To log in again use the [Log In](#) link in the email you received

Your next session will be ready in 7 days!

[Click the Next button](#) to continue

[Click below](#) to see this week's outline

- Week 1 Outline
 - ▶ Importance of Sleep
 - ▶ Sleep and Young People
 - ▶ Sleep and Eating
 - ▶ A Challenge
 - ▶ Stop or Swap
 - ▶ Goal Setting
 - ▶ Track Sleep
 - ▶ End of Week 1!

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SLEEP AND YOUNG PEOPLE

▶ Young people tend to experience lots of change as they reach adulthood. These changes affect emotions, thoughts and behaviours

▶ Getting good sleep can help your mind and body develop in a healthy way

[Click here](#) to find out more about young people and sleep

[Click here](#) if you are interested about how sleep affects your health



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Week 2 Introduction Page and Session Extract

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WELCOME BACK

Welcome back!



This week we'll look at sleep and physical activity! But before doing so, we're going to review last week's goals!

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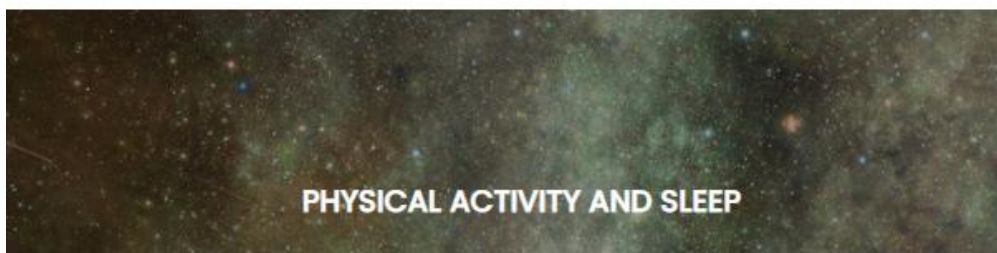
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[Click below](#) to see this week's outline

- ☰ Week 2 Outline
 - ▶ [Goal Review](#)
 - ▶ [Physical Activity and Sleep](#)
 - ▶ [Being Physically Active](#)
 - ▶ [A Challenge](#)
 - ▶ [Goal Setting](#)
 - ▶ [End of Week 2!](#)

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Did you know...

- ▶ You might find it harder to sleep at night if you haven't been very active during the day
- ▶ Staying active in the day can help you sleep better and protect against health problems like obesity and heart problems
- ▶ Being active releases the good chemicals in your brain so you're more likely to feel happier

[Click here](#) to find out more about how being active helps sleep

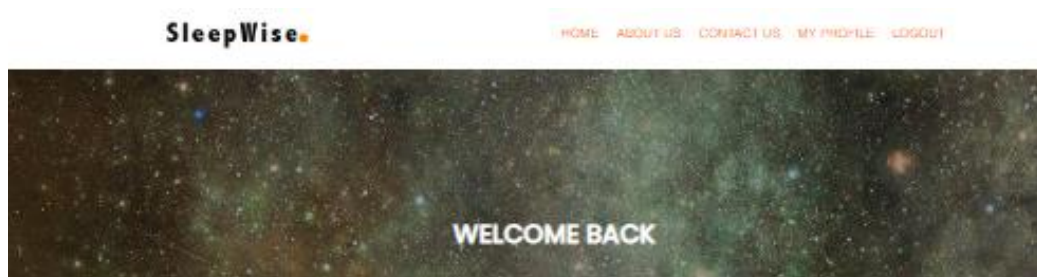


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Week 3 Introduction Page and Session Extract



Welcome Back!



This week we'll look at sleep and everyday habits! But before doing so, we're going to review last week's goals!

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To log in again use the [Log In](#) link in the email you received

Your next session will be ready in **7** days!

[Click the Next button](#) to continue

[Click below](#) to see this week's outline

- ☰ Week 3 Outline
 - ▶ [Goal Review](#)
 - ▶ [Sleep and Habits: Digital World](#)
 - ▶ [Sleep and Habits: Where You Sleep](#)
 - ▶ [Sleep and Habits: Mental Health](#)
 - ▶ [Goal Setting](#)
 - ▶ [End of Week 3!](#)

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▶ Research shows that being on your phone, game console, or laptop/tablet 2-3 hours before sleep can lower your sleep quality

▶ The light from your device makes your brain think it's not time to sleep because it's still day light – even when it's not!

▶ Overtime this can lead to poor sleep, feeling low and difficulty waking up

Tip: It's a good idea to dim your phone's blue light so you can sleep better at night. Eventually, you might decide to spend less time on your phone all together!

[Click here](#) to find out how digital devices lower sleep quality and tips to cut down on screen time

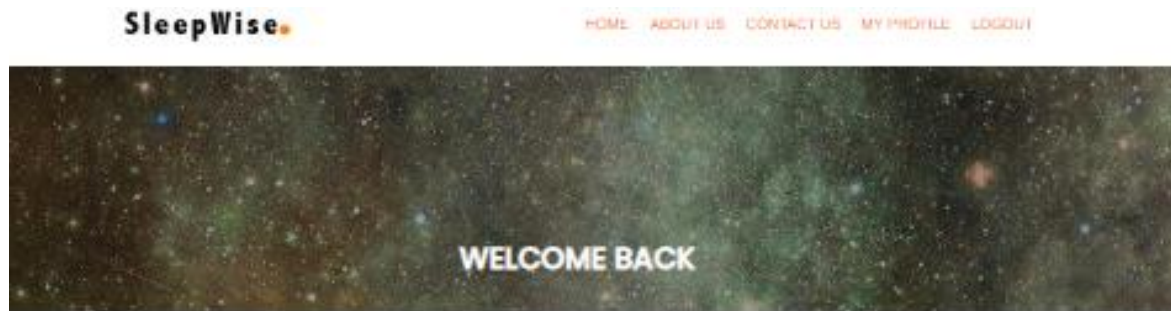


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Welcome back!



This week is your final session of SleepWise – during this session we'll continue to look at sleep and everyday habits! But before doing so, we're going to review last week's goals!

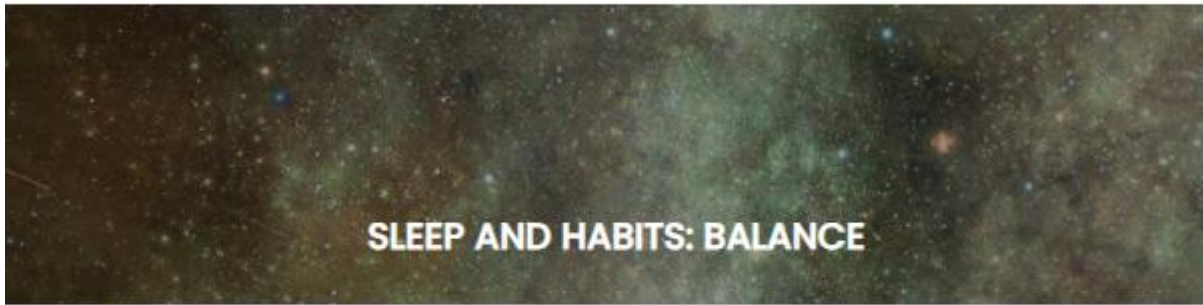
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Click [below](#) to see this week's outline

- ☐ Week 4 Outline
 - ▶ Goal Review
 - ▶ Sleep and Habits: Balance
 - ▶ Sleep and Habits: Weekends
 - ▶ Sleep and Habits: Sleep Routine
 - ▶ Sleep and Habits: Write
 - ▶ Sleep and Habits: Mindfulness
 - ▶ Sleep and Habits: Friends and Family
 - ▶ Goal Setting
 - ▶ End of Week 4!



- ▶ It's important to balance life with studying and other things, like hobbies and work
- ▶ Not having a good balance in life might lead to not sleeping well because you might feel more worried at night
- ▶ Over time, worrying can lead to waking up tired and cause mental and physical health problems in the future
- ▶ The next few pages will give you some tips about how to balance sleep with studies, hobbies and work



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Appendix L

Example of Extra Information at the End of Weekly Session

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WELL DONE!

You've completed your first SleepWise session!

- ▶ Next week we are going to look at sleep and physical activity – you will be sent a reminder when your session is ready!
- ▶ You'll be given the chance to make new goals or keep the same ones!

[Click here](#) for a quick and fun quiz about sleep and eating!

[Click here](#) to test yourself in this SleepWise game

[Click here](#) for extra useful info on this week's session!

[BACK](#) [FINISH](#)

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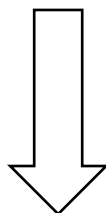
See below for some extra info about all the things you covered this week:

- ▶ If you want to find out more about foods that can help sleep click [here](#)!
- ▶ For more info on why tracking your sleep is useful click [here](#)!
- ▶ For healthy food swap ideas click [here](#)!
- ▶ Want to know more about goal setting? Click [here](#)!



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Both diet and sleep are complex, which means there's no silver bullet or single food that is guaranteed to help with sleep. However, there are some foods and drinks that may make it easier to get a great night's sleep.

Specific Foods That Can Affect Sleep

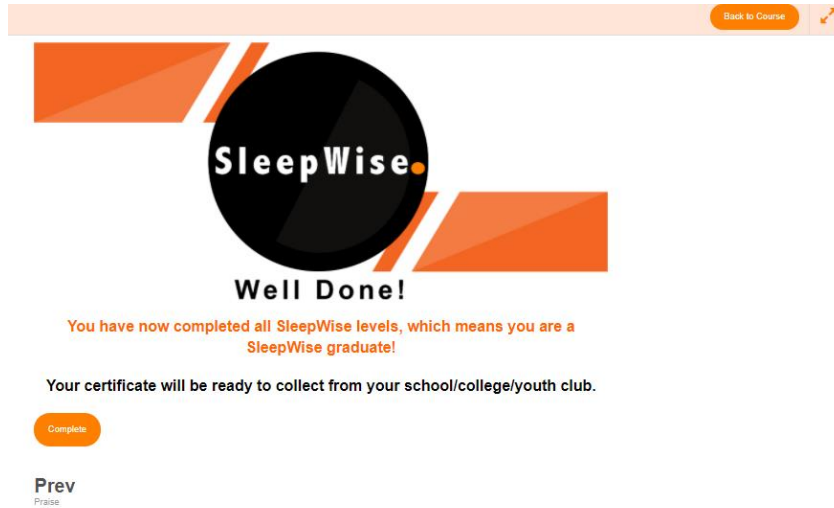
Researchers, including nutritionists and sleep experts, have conducted different types of studies to try to discover the best foods for sleep. While this research provides important clues, it's not conclusive. In general, there's a lack of direct evidence about specific foods that are good for sleep.

In addition, the range of varieties of cultivars of most foods means that their nutrient profile can be inconsistent. For example, [some varieties of red grapes](#)¹ have high levels of [melatonin](#) while others have virtually none. Climate and growing conditions may further alter the nutrients in any particular food product.

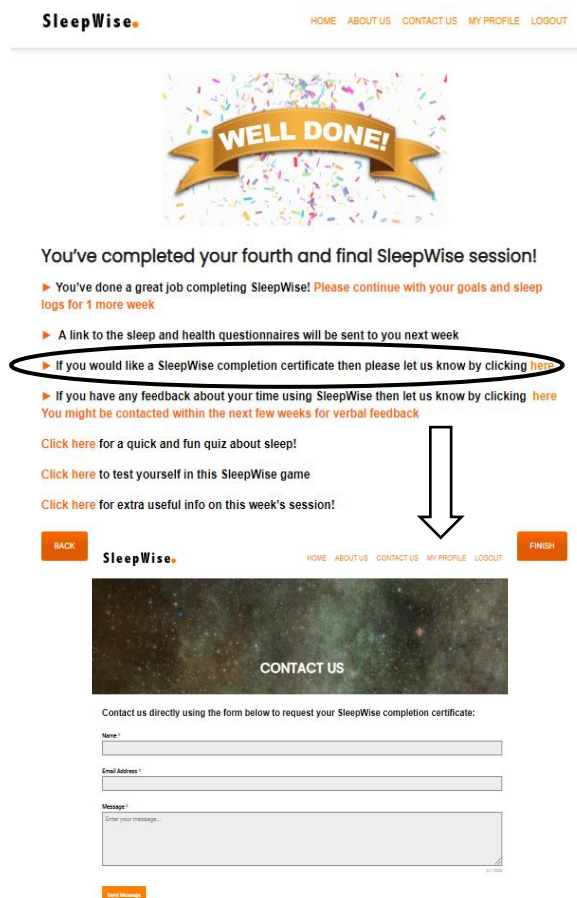
Appendix M

SleepWise Certification: Before and After

Before Modification



After Modification



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Appendix N

Goal Setting and Problem Solving

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► If you already met your goal, then think about what new goals you'd like to make this week, following these three steps:

1) **Set your goal.** You can set up to 3 goals if you like. If you want to set only 1 or 2 then you can leave the other boxes blank

2) **Decide.** How many ~~days this week you want to do your goal/s~~ and what *time* you will do them

3) **Problems?** Write anything that might get in the way of you reaching your goal/s, and a solution to help you overcome them

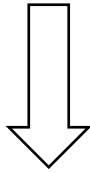
Now [click here](#) to set your goals following the above steps!

[Click here](#) to see some goal setting examples

[Click here](#) to see how other young people overcome problems to sleeping better

BACK

NEXT



(1) Goal 1

(2) On how many days?

(3) What Time?

(4) Problems (optional)

(5) Solutions (optional)

SAVE GOALS

Note. From SleepWise.org.uk © 2020 SleepWise

Appendix O

Sleep Diary

Day of Week & Date: *
E.g. Monday 27th May 19

1. I went to bed last night at: *
E.g. 7pm, 11pm etc

2. I got out of bed this morning at: *
E.g. 6am, 6.30am etc

3. Last night I fell asleep: *
Easily
After some time
With difficulty

4. How many times did you wake you last night? *
E.g. None, once, twice, 3 times, etc

5. If you did wake up last night, how many minutes were you up for?
E.g. 5 minutes, 10 minutes etc

6. Last night I slept a total of: *
E.g. 6 hours, 8 hours etc

7. Was your sleep disturbed last night? (if no, go to question 9) * Yes
No

8. My sleep was disturbed by:
E.g. List mental or physical things including noise, lights, pets, allergies, temperature of room, discomfort, being stressed etc.

Tired

10. Notes (optional)
E.g. Write any other things that may affect your sleep (e.g., hours of work shift, or monthly cycle for females)

Note. From SleepWise.org.uk © 2020 SleepWise

Appendix P
Sleep Routine Chart

SleepWise.

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- ▶ A good sleep routine will help you wind down at night and sleep better
- ▶ Sleep routines can help you sleep at regular times
- ▶ Some people find it useful to write down their sleep routine
- ▶ You can download and print your own sleep routine chart by clicking the button below

Download Here:

[Sleep Routine Chart](#)

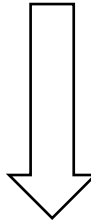
[Click here](#) to find out why sleep routines are useful for sleeping better

[Click here](#) to see how others have found sleep routines useful



BACK

NEXT



SleepWise Sleep Routine Chart

You can add as many rows as you like to your chart. It's useful to be very clear and include timings in your routine, so you can tick them off throughout the week! If you like, you can print your sleep chart and put it somewhere visible so you don't forget about it ☺

Week starting: ___/___/___

Every night before bed I need to...	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Note. From SleepWise.org.uk © 2020 SleepWise

Appendix Q
SleepWise Reminder Example

We will send you weekly reminders to help you remember your goals. If you do not wish to receive these reminders please tick the box below and click send.

I do not wish to receive reminders about my goals

Send

BACK

Note. From SleepWise.org.uk © 2020 SleepWise

Email/Text Reminder Template:

“Hi,

This is a reminder about your goals and sleep log.

Don't forget to check in with your **goals** here:

<https://sleepwise.org.uk/my-profile/?section=posts>

Logging your sleep daily helps you understand more about your sleep! To **Log your Sleep** go to <https://sleepwise.org.uk/my-profile/?section=submit-post>

If you're still working through session [insert session number], you can log in here: [insert log-in link]

If you have any questions or experience any problems please get in touch.

SleepWise Team 😊”

Appendix R

Goal Setting: Before and After

Before Modification

Goal Setting Sleep and Health Goals

- ▶ Setting yourself goals can help you stay motivated to make healthy changes. By setting yourself goals you make sure you are in charge of your health and well-being
- ▶ It's really important that you set these goals now, and put them somewhere noticeable, so you remind yourself daily and stay motivated
- ▶ Try and come up with 3 goals to help you sleep well. These can be things like putting your phone away at night or trying to be more active in the day
- ▶ Before you set your goals make sure you read the tip below

Tip: When setting your goals make sure you are very specific about when and how you will do something. For example, if you're going to switch your phone off and put it away before bed, then say **WHEN** and **HOW**. For example, switch phone off at 9pm (**WHEN**) and put it away in draw (**HOW**).

[Click here](#) to see examples of goal setting using the tip above.

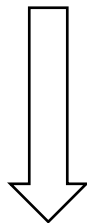
Set your goals below:

[ultimatamember form_id=7013]



Complete

Prev
Quiz



Next
Level 1 Complete

After Modification

Goal Setting Tips (S.M.A.R.T) (click-through)

SleepWise HOME ABOUT US CONTACT US MY PROFILE LOGOUT

GOAL SETTING

- ▶ Setting easy and realistic goals can help you make healthy sleep habits and improve your sleep
- ▶ SleepWise will help you set and print your goals to help you stay on track
- ▶ Your goals will also show on your profile, so you can check them during the week if you like

[Click here](#) to see more information about goal setting and for tips on making good goals

Click the Next button to get started

BACK Save Page As NEXT

Edit Edit with WPBakery Page Builder

SleepWise HOME ABOUT US CONTACT US MY PROFILE LOGOUT

SETTING GOALS

- ▶ Scientists have shown that making goals is a good way to sleep better, because overtime your goals can turn into habits
- ▶ Goals can help you stay motivated to make healthy changes. By setting your own goals, you make sure you are in charge of your health and wellbeing!
- ▶ Be SMART with your goals. SMART means having goals that are: specific, measurable (set a time to achieve your goal), achievable (so your goal is realistic), rewarding and trackable (track your progress).

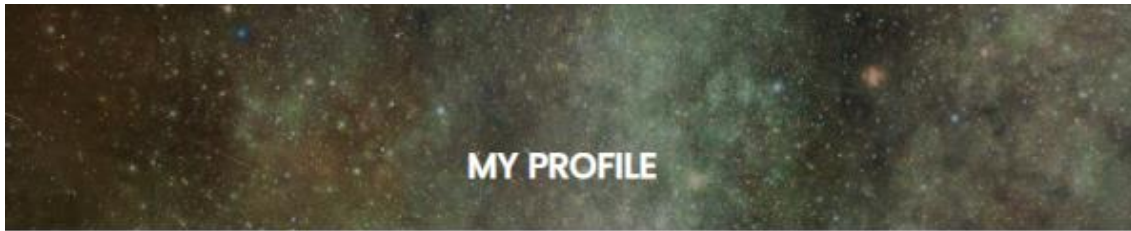
Tip: print out your goals and put them somewhere where you can see them every day!

BACK

Note. From SleepWise.org.uk © 2020 SleepWise

Appendix S

Profile Dashboard Example



Welcome to your SleepWise Profile! From your profile page you can manage your [Goals](#) and [Sleep Logs](#), and [Log Your Sleep](#) everyday!

You can also [Edit Your Profile](#) and access your [Weekly Sessions](#). If you click on a session that you don't yet have access to, please click back on your browser to return to the previous page. If you haven't got access to a session, and you think you should, please contact us.

If you were short on time and saved a page, you can access it under [My Saved Pages](#).

Enjoy!



Profile Dashboard
Record of Goals and Sleep Logs
Edit Profile
Log Your Sleep

Hello BHOK OM, (not BHOK OM? [Sign out](#))

My Saved Pages

No Saved Pages

My Weekly Sessions

Week 1

Week 2

Week 3

Week 4

Note. From SleepWise.org.uk © 2020 SleepWise

Appendix T

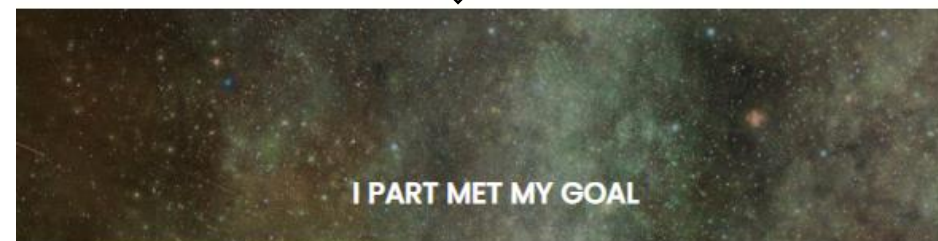
Goal Review Example

SleepWise

[HOME](#) [ABOUT US](#) [CONTACT US](#) [MY PROFILE](#) [LOGOUT](#)



Did you meet last week's goals ([click here](#) to see goals – this will open as a separate window)?



WELL DONE FOR PART MEETING YOUR GOAL!

- ▶ You have done a great job getting as far as you have! You can always stick to the same goal this week or try setting a different goal!
- ▶ You will have the chance to stick to the same goal/s, or change up your goal/s, later in this session

[Click next](#) to continue

NEXT

Note. From SleepWise.org.uk © 2020 SleepWise

Appendix U

Instructions to Access SleepWise

Please sign up to SleepWise using the following link: <https://sleepwise.org.uk/sign-up/>

Upon signing up, you will have access to your own SleepWise account and the researcher will be notified that a new user has signed up. Upon receiving this notification, the researcher will grant you access to each weekly session, which you can access using the links below. Please do not share the links below, or your access, with anybody else, as SleepWise is not yet intended for public use and its software is regularly updated (and thus may not perform to full capacity). If you experience any difficulties, please get in touch with the researcher (email: info@sleepwise.org.uk).

Session 1: <https://sleepwise.org.uk/welcome/>

Session 2: <https://sleepwise.org.uk/welcome-back/>

Session 3: <https://sleepwise.org.uk/welcome-back-2/>

Session 4: <https://sleepwise.org.uk/welcome-back-week-4/>

Appendix V

SleepWise Save Page/Progress Example

IMPORTANCE OF SLEEP

When you sleep, your body starts on some important work, including:

- ▶ Boosting your immune system (so you're less likely to become ill)
- ▶ Recovering from daily activities
- ▶ Improving your concentration, mood and energy
- ▶ Controlling your body temperature
- ▶ Keeping your heart healthy
- ▶ Controlling your hunger, weight and blood sugar levels



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NEXT

Save Page 11

MY PROFILE

Welcome to your SleepWise Profile! From your profile page you can manage your [Goals](#) and [Sleep Logs](#), and [Log Your Sleep](#) everyday!

You can also [Edit Your Profile](#) and access your [Weekly Sessions](#). If you click on a session that you don't yet have access to, please click back on your browser to return to the previous page. If you haven't got access to a session, and you think you should, please contact us.

If you were short on time and saved a page, you can access it under [My Saved Pages](#).

Enjoy!

Profile Dashboard

Hello BHOK OM. (not BHOK OM? [Sign out](#))

[Record of Goals and Sleep Logs](#)

[Edit Profile](#)

[Log Your Sleep](#)

My Saved Pages

My Weekly Sessions

Importance of Sleep

Week 1

Week 2

Week 3

Week 4

Note. From SleepWise.org.uk © 2020 SleepWise

Appendix W

Ethical Approval (Study 3)



UNIVERSITY OF
WINCHESTER

Tel: 01962 841515
Fax: 01962 842280
www.winchester.ac.uk

Winchester
Hampshire
SO22 4NR

Ms. Shokraneh Oftadeh Moghadam
Psychology
Faculty of HSS
University of Winchester

4 December 2019

Dear Shokraneh,

RE.: Sleep Quality and Health: an Online sleep intervention for adolescents Phase 2: amendment (RKEEC190204_Moghadam_Fac_Amendment 2).

Thank you for your email requesting a minor amendment to your ethics approval for the project named above, which you described on the response table for the phase 2 approval, the amended information sheet /consent form and in email correspondence to me. The amendment concerns giving those participants who take part in an interview a £20 voucher. I have reviewed the information you have sent, and I am writing to give you the outcome.

I can confirm that the amendment you have requested is approved, which means you can progress your work. However, as per my email dated 22 November, the amendment needs to be outlined in section 6 of the approved (old system) form and resubmitted (to ethics1@winchester.ac.uk) for the Committee's records. Please ensure this document also reflects the changes made in the light of feedback given in March 2019.

On behalf of the Committee, I wish you well in your research.

Best wishes,

Samantha Scallan
Chair, RKE Ethics Committee
CC Shokraneh Oftadeh Moghadam; Debra.Gray; GL; Ethics1



Chancellor: Alan Titchmarsh MBE VMH DL
Vice-Chancellor: Professor Joy Carter BSc PhD CGeol FGS

University of Winchester, a private charitable company limited by guarantee in England and Wales number 3046250 Registered Office: Sparford Road, Winchester, Hampshire SO22 4NR

Appendix X
Recruitment Email Template

Dear [site name]

I am a researcher at the University of Winchester and currently conducting research on the topic of sleep quality and wellbeing in young people. I'm getting in touch to find out whether [insert site name] would be interested in taking part in this research. As a token of appreciation, a psychology related talk will be offered to your [insert either school/college]. If there is interest in participation, pupils/students can collect a consent form from tutors/reception, which I will provide. The research is due to start [insert date] and run for [insert time period]. Research activities are mainly managed by me, the researcher, and those who partake will be awarded a £20 voucher on completion [only applicable to trial 1 intervention participants]. I have attached a brief outline of this research for your information. Please do not hesitate to contact me if you have any questions.

Many thanks for your time in reading this email.

Best wishes,
Shokraneh

Appendix Y
Recruitment Poster (Study 3)

HOW WELL DO YOU SLEEP?

If you are between the ages of **13-19** years then I want to hear from you!

My name is Shok and I am a psychology researcher looking at sleep and health in **young people**

Your help would involve participating in a 4-week web-based programme looking at sleep and health

If you are interested email info@sleepwise.org.uk

THANK YOU!



UNIVERSITY OF
WINCHESTER

Appendix Z

Participant Information Sheet and Consent Form (Study 3)

Hello!

My name is Shok and I am a researcher at the **University of Winchester**. My research is about how well young people sleep. This is important because young people's sleep can influence their mental and physical health. To look at this more closely I have developed a website called SleepWise but I need **YOUR** help and would therefore like to ask you to take part in my research.

Before you carry on reading, please answer the question below:

- ❖ Are you between 13 and 19 years?

- ❖ If you said **YES** then I would like to invite you to take part in my project. You will need to agree to participate by signing the consent form at the **back of this page**. If you are **under the age of 16**, your parent/guardian will also need to agree for you to participate.

What do you need to do?

Once you have agreed to take part, you will be asked some questions about yourself, like age and gender, and then questions about your sleep and health. The questions about your health will include eating patterns, how active you are and mental health questions (depression and anxiety). There is no feedback from these questions and they should take around 20-30 minutes. You will also be asked for your email address and phone number so we can send you reminders and contact you (if you want). I will then divide all participants into two groups. One group will be the **control** group, who will be asked to do nothing different and carry on as normal. The other group will be the **experimental** group, who will have access to the SleepWise website and asked to work through it for 4-5 weeks. The website will include tips, information and activities to help better sleep, for example eating well, being active, cutting down on screen time and more. The website usually takes around 20-30 minutes a week (but you can spend as much time on it as you want). Some participants in the experiment group will be asked to wear a sleep-tracking wristband (but can say no if they

don't wish to). After 4-5 weeks both groups will be asked the same questions again. The experiment group will also be asked how much they liked using the website. 5-10 weeks later some participants in **both groups will be contacted via phone calls** to let me know how they found the study and how I can improve it. Those who take part in the interview will be emailed a £20 voucher at the end of it. 3 and 6 months later I will ask both groups the same health questions again (link sent by email). It is **important** for those who use the website to **not share** it with friends or family (apart from parents). If you're not in the experiment group you carry on as normal but can have access to the website later on if you like.

The results will be used for research and teaching but your name and personal information will be kept anonymised so no one will know your answers or who you are. There is a small chance that you might feel sad during your time using SleepWise, so if at any point you feel sad or upset then stop taking part in this study and contact me, your GP, or your school's/college's/university's/youth group's help services. You can stop taking part in the study at any point if you wish, without explaining why; you just have to let me know by contacting me on my email address below.

SleepWise.



If you would like to take part, please give consent at the **back of this page**. If you are under the age of 16, your parent/guardian will also need to give consent. If you have any questions please contact me, Shok, at s.oftadehmoghadam.17@unimail.winchester.ac.uk

Information Sheet for Parent/Guardian (16 years and under) (Version 2)

Dear Parent/ Guardian,

I am Shokraneh Oftadeh Moghadam, a researcher at the University of Winchester. I am conducting a research project, along with my supervisors, Dr Debra Gray, Dr Margaret Husted and Dr Ana Aznar, all experts within the field of Psychology and very experienced in working with participants from different age groups and backgrounds. My research involves developing a website called SleepWise, which aims to help young people sleep better. This is important as adolescence (13-19 years) is a particularly important time where aspects of physical and mental health vulnerability may be worsened by poor sleep quality. Some examples in research show that poor sleep is associated with poor diet choices/weight-gain and low levels of physical exercise, and that these problems can have long-term effects into adulthood. Before you decide about your child's participation in this study, please read through this sheet giving you more information about the study. If you have any questions please do not hesitate to contact me. My contact details are provided below.

Why has your child been selected?

This study aims to test if the SleepWise website is feasible for young people to use. I am inviting your child to participate because he or she is between the ages of 13-19 and his/her school/college/youth group has agreed to participate in the study. I have been DBS checked prior to starting this study. This study has been approved by the University of Winchester's ethics committee.

Does your child have to take part?

No. Participation is voluntary and it is completely up to you and your child to decide if he/she wants to participate.

How can you agree for your child to participate?

If you agree for your child to participate in the study, there is a consent form at the **back of this page** for you to sign. You can either email the consent form to the email address below or print and give this to your child to take to their school for the researcher to collect. Your child can decide to stop taking part in the study at any point without having to give a reason. You can withdraw your child's data by emailing me and I will immediately delete his or her data.

What does the study involve?

This study's aim is to test whether the SleepWise website is feasible for young people to use. Your child will be asked to use SleepWise for 4-5 weeks. The website unlocks a new session weekly and participants can spend as little or long on it as they want. On average, one session lasts 20-30 minutes if completed in one sitting. SleepWise includes lots of tips, information and activities to help better sleep. Once consent has been sought, your child will receive a link to the intervention via email (email address will be collected as part of the consent process and again as part of the online questions). They are then asked questions about their sleep and health via SleepWise. These questions will ask about sleep quality, anxiety and depression, eating patterns and physical activity levels, which will take approximately 20-30 minutes to complete. As part of the online questions, your child will also be asked for their email address and phone number. This information will be used for study reminders and contact only (at the end of the study) and will be destroyed once the study has finished. There will be an option to opt out of these email/text reminders once participants have logged into the website. This will be made clear on the consent form. Participants do not receive feedback about their scores and therefore your child's responses cannot be used in any way to diagnose any illness/health condition. However, if you are at all worried about your child's answers or subsequent physical or mental health whilst undertaking the study, we recommend you seek help from your GP or other appropriate health professional. For this study, participation will be **randomised**. This means that some participants will be randomly selected to use the website (**experiment group**), while other participants will be asked some questions about their sleep and health (as mentioned above) but will not use the website (**control group**). This is to allow us to work out whether the website has the potential to be effective or not, so we can compare those participants using the website to those that are not. Participants who do not use the website in the first instance will be given the opportunity to use it after 6 months.

Some participants who have access to the website straightaway will be encouraged to wear a wrist device to measure their sleep quality, which will be provided by the research team. Participants in both groups will be asked the same sleep and health questions again at 4-5 weeks (post-signing up). The experiment group will also answer questions about how much they liked using the website and awarded a SleepWise completion certificate (optional). Your child (regardless of group allocation) might be contacted 5-10 weeks after the study for phone call feedback about their experience with the study. On completion, they will be emailed a £20 voucher for either online or high street stores.

After 3 and 6 months, your child (regardless of group allocation) will be asked (via email) to complete the same questionnaires on sleep and health, which will allow us to see whether any effects of the website were longstanding.

What if there is a problem?

Some of the topics covered in the intervention, such as feelings of depression or anxiety, may be sensitive for some participants. In the unlikely event that your child becomes anxious and/or upset during their time using SleepWise, he/she is encouraged to stop using the website and get in touch with me, their GP or their school's/college's/youth group's help services. If you want to, I will discuss any worries with you or your child. Should you have any queries or worries please contact me (Shokraneh Oftadeh Moghadam) at The University of Winchester on s.oftadehmoghadam.17@unimail.winchester.ac.uk

Will your child's responses be kept confidential?

Yes. All data collected will be kept confidential. All personal data will be handled in accordance with the General Data Protection Regulation 2018. In certain exceptional circumstances where your child or others may be at significant risk of harm, the researcher may need to report this to an appropriate authority, in accordance with the General Data Protection Regulation 2018. The findings from this study will be used for research and teaching purposes, but no names will be included in the report so participants will remain anonymous.

Who has reviewed the study?

This study has been reviewed and received a Favourable Ethical Opinion from the University of Winchester Ethics Committee. If you have any concerns about the way in which the study has been conducted, you can contact the Psychology Research Ethics Officer, Gary Lancaster gary.lancaster@winchester.ac.uk or the Chair of Research Ethics, Samantha Scallan samantha.Scallan@winchester.ac.uk

You can also contact Joseph Dilger, the Data Protection Officer, at the University of Winchester on joseph.dilger@winchester.ac.uk or on 01962 841515, ext. 7306.

If you are happy for your child to participate in this study, please complete the attached consent form and return it via email (below), or give it to your child to hand in to their tutor/teacher for the researcher to collect.

Yours faithfully,

Shokraneh Oftadeh Moghadam
Department of Psychology
University of Winchester

Email: s.oftadehmoghadam.17@unimail.winchester.ac.uk

Privacy Notice for Psychology Research Participants

The University of Winchester treats very seriously both the personal data and the sensitive personal data it processes on behalf of primarily its students and staff members, and also a wide range of other people who it works with and has contact with, including alumni. The University has been and is continuing to work hard to comply fully with the new General Data Protection Regulation (GDPR), which is enforceable from 25 May 2018. The GDPR makes a number of key changes to data protection law in the United Kingdom and within the European Union (EU) and potentially beyond the EU. More information on these changes, which include strengthening of some individual rights and some new individual rights can be found on The Information Commissioners' Office (ICO) website at: <https://ico.org.uk/>

Psychology research at the University of Winchester also conforms to GDPR. The University processes both personal data and sensitive personal data under a range of different 'lawful bases' depending on the nature of the respective 'processing purposes'. For the 'personal data' of Psychology Research Participants, the 'lawful basis' here is 'Consent'.

In addition, for psychological research, before we collect your personal data, we will always:-

- i) provide you with information about the study in advance
- ii) tell you how and why we will use your data
- iii) tell you who will have access to your data
- iv) tell you how long your data will be stored for
- v) ask for signed written consent to collect your data (via a consent form).

We will only ask for personal data which is necessary for our stated research and teaching purposes and we will never sell your personal data to any 3rd party.

The 'purposes of the processing' for research include:

- Retaining proof of written consent to participate in our research.
- To manage your appointment(s) within the study; during initial sign up for the study and, subsequently, where there arose a need to cancel or re-arrange an already agreed time-slot.
- For the purposes of testing research predictions (Hypotheses) in order to answer the research question(s) as described on the study Participant Information sheet

Linked to its above mentioned 'processing purposes', the University processes a specific amount of participants' personal data, which includes, for example: A participants name;

student number, email address; demographic information; visual and/or audio data; questionnaire responses.

Personal data will be kept for no longer than necessary, and these decisions will be made in line with legal requirements, the relevant University policies and in light of relevant best practices.

There are a number of individual rights available, and more information on these can be found at <https://ico.org.uk/> In particular, as 'consent' is being used here as the lawful basis for the particular 'processing purpose' for Psychology Research Participants, there is a right to withdraw consent (if applicable). If you wish to withdraw your consent for the processing of your personal data for Psychology Research Participants, you should in the first instance, contact the researcher(s) named on the Participant information sheet. However, if required, you can also contact the psychology departmental ethics officer: Dr Gary Lancaster: psychologyethics@winchester.ac.uk

Even after signing a consent form, you still have the right to withdraw your consent, at any time during your research participation and for a specified period of time after participating in a study. The time period for withdrawing varies between studies, but will always be stated on the information sheet and/or the consent form.

All research projects at the University of Winchester are reviewed and approved by either a Departmental Research Ethics committee or the University Research Ethics committee. All psychological studies at the University of Winchester are conducted according to the code of practice set out by the British Psychological Society (BPS). (See www.bps.org.uk)

There is a right to lodge a complaint with a supervisory authority. This is the ICO, who can be contacted in various ways as listed at: <https://ico.org.uk/global/contact-us/>

We review and update (where necessary) this policy statement in line with current guidance and developments.

The data protection officer for the University is:

Joseph Dilger, Data Protection Officer,
The University of Winchester, Sparkford Road
Winchester, Hampshire.
SO22 4NR.
United Kingdom.

Tel: +44 (0) 1962 841515, Ext. 7306.

Email: Joseph.Dilger@winchester.ac.uk

The name and contact details of our organisation are:

The University of Winchester,

Sparkford Road
Winchester, Hampshire.
SO22 4NR.
United Kingdom.

Tel: +44 (0) 1962 841515

Fax: +44 (0) 1962 842280

Consent form

The purpose of this form is to make sure that you, and your parent/guardian/carer (if under the age of 16), have received all the information about the research project that you need, and that you want to take part. Please read the information letter and the privacy notice that comes with this form before signing it. Also, please give the information letter to your parent or guardian so that they can read it. The important points to remember are:

- You do not have to take part in this research.
- You do not have to answer any questions that you do not want to.
- You can change your mind about taking part in the research even if you have already agreed to take part. If you do change your mind then please contact me at the contact details below.
- The data will be used for research and teaching purposes, however all information will be kept anonymised and confidential, so no one apart from the researcher will know who took part in the study.
- Any information about acts that could lead to likely harm may be reported to parents, the school, or police/medical professionals. In all cases, the researcher will talk with the participant about what to do. This may mean that the researcher will encourage the participant to talk to someone who could help, or agree to talk to someone on their behalf.
- If the participant (your child) does not want a concern to be raised with the parent, then the participant's confidentiality will be kept unless there is a clear and likely risk to the participant from not informing parent(s)/guardian.
- Your child's email address and phone number (optional) will be collected to send reminders about the study and contacted for feedback (as described above)

If there is anything that you do not understand, or if you have any questions, then please ask before signing this form (by contacting me on the email address below). Otherwise, please sign below in the spaces provided. Please note that if you are **under the age of 16** then you and **your parent, carer or legal guardian** must sign the consent form.

I have read and understood the information presented in the Participant Information Sheet.

I have had the opportunity to discuss it with the researcher and to ask any questions.

I understand that: [Please initial each box that you agree with – if you are 16 years and under your parent/guardian will need to initial some of the boxes below, as indicated in brackets]

My participation is entirely voluntary

I am free to refuse to answer any question

I am free to remove myself from the research (see the Participant Information Sheet for further details on how to do this)

I have read and understood the privacy statement and the participant information sheet

I agree to my (my child's) data being collected, stored and processed as described in the participant information sheet **(parent/guardian initial required if 16 years and under)**

I understand that sensitive personal information about my gender, age, background and health are needed for this project and I consent to my sensitive personal data being collected, stored and processed as described in the participant information sheet

I understand that I will not be named or identified in any output resulting from this study

I am happy for my (my child's) email address to be used for sending the website link to - send this link to the email address below **(parent/guardian initial required if 16 years and under): Participant email address (if writing by hand, please write clearly)**

: _____

I am happy for my (my child's) email and/or phone number to be collected as part of the online (study) questionnaires and for them to be contacted for feedback/questions **(parent/guardian initial required if 16 years and under-** if you do not consent to this please ensure that your child does not give this information when completing the online questions at the start of the study).

On these bases, I agree to take part in this project and I give my permission for my data to be used for research and teaching purposes.

Signed (Participant) : _____

Date:

Signed (Parent/Guardian if 16 years and under): _____

Date:

Signed Researcher: _____

Date:

You **cannot** take part in the research without a signed form.

Thank you for your time and help,

Shokraneh Oftadeh Moghadam

Department of Psychology

University of Winchester

Email: s.oftadehmoghadam.17@unimail.winchester.ac.uk

Appendix AA

Short Pittsburgh Sleep Quality Inventory (PSQI)

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

(1) During the past month, when have you usually gone to bed? —

(2) During the past month, how long (in minutes) has it taken you to fall asleep each night? —

(3) During the past month, when have you usually gotten up in the morning? —

(4) During the past month, how many actual hours of sleep did you get at night? (This may be different than the number of hours you spend in bed.) —

For each of the remaining questions, check the one best response. Please answer all questions.

(5) During the past month, how often have you had trouble sleeping because you...

(a) Cannot get to sleep within 30 minutes

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

(b) Wake up in the middle of the night or early morning

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

(c) Cannot breathe comfortably

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

(d) Cough or snore loudly

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

(e) Feel too hot

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

(f) Have bad dreams

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

(g) Have pain

Not during the past month

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

(6) During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

(7) During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?

Not during the past month —

Less than once a week —

Once or twice a week —

Three or more times a week —

Appendix BB

International Physical Activity Questionnaire (IPAQ)

I am interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at school/college, work, house work, to get from place to place, and in your spare time for fun, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities means activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

No vigorous physical activities → **Skip to question 3**

2. How much time did you usually spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

No moderate physical activities → **Skip to question 5**

4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

No walking → Skip to question 7

6. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Appendix CC

Eating Behaviour Frequency Questions

Snacking is defined as foods that you eat between your main meals. Please answer the following questions as honestly as you can.

How confident are you that you can resist unhealthy snacks like cake, chocolate, biscuits (including breakfast bars), sweets and crisps (and any other fried foods) when they are available? Please respond by sliding the circle on the line from 0 to 100.

0 = Not at all confident

100 = Strongly confident

0 ————— ● ————— 100 (Visual Analogue Scale)

To what extent do you normally intend to NOT snack on unhealthy foods like cake, chocolate, biscuits (including breakfast bars), sweets and crisps (and any other fried foods)? Please respond by sliding the circle on the line from 0 to 100.

0 = Do not intend

100 = Strongly intend

0 ————— ● ————— 100 (Visual Analogue Scale)

How many times per week do you currently snack on foods like cake, chocolate, biscuits (including breakfast bars), sweets and crisps (and any other fried foods)?

- Never
- 1-2 times per week
- 3-4 times per week
- 5-6 times week
- Everyday

How many times per day do you snack on foods like cake, chocolate, biscuits (including breakfast bars), sweets and crisps (and any other fried foods)?

- None
- 1 snack a day
- 2-3 snacks a day
- 4-5 snacks a day
- 5 or more snacks per day

How many sugary, caffeinated/energy type drinks (for example Coke, Ribena, Redbull, Monster, tea/coffee) do you normally have per day?

- None
- 1 drink a day
- 2-3 drinks a day
- 4-5 drinks a day
- 5 or more drinks per day

Appendix DD

Depression, Anxiety, and Stress Scale (DASS-21)

For each statement below, please circle the number in the column that best represents how you have been feeling in the last week.

Statement did not apply to me at all= 0

Applied to me to some degree or some of the time= 1

Applied to me a considerable degree or a good part of the time= 2

Applied to me very much or most of the time= 3

1. I found it hard to wind down 0 1 2 3
2. I was aware of dryness of my mouth 0 1 2 3
3. I couldn't seem to experience any positive feeling at all 0 1 2 3
4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion) 0 1 2 3
5. I found it difficult to work up the initiative to do things 0 1 2 3
6. I tended to over-react to situations 0 1 2 3
7. I experienced trembling (eg, in the hands) 0 1 2 3
8. I felt that I was using a lot of nervous energy 0 1 2 3
9. I was worried about situations in which I might panic and make a fool of myself 0 1 2 3
10. I felt that I had nothing to look forward to 0 1 2 3
11. I found myself getting agitated 0 1 2 3
12. I found it difficult to relax 0 1 2 3
13. I felt down-hearted and blue 0 1 2 3
14. I was intolerant of anything that kept me from getting on with what I was doing 0 1 2 3
15. I felt I was close to panic 0 1 2 3
16. I was unable to become enthusiastic about anything. 0 1 2 3
17. I felt I wasn't worth much as a person 0 1 2 3
18. I felt that I was rather touchy 0 1 2 3
19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat) 0 1 2 3
20. I felt scared without any good reason. 0 1 2 3
21. I felt that life was meaningless 0 1 2 3

Appendix EE

Satisfaction with the Website: Acceptability E-Scale

(Only applicable to those in the intervention group – i.e., not those in the control group)

1. How easy was this website for you to use?
 - a. 1—very difficult
 - b. 2
 - c. 3
 - d. 4
 - e. 5—very easy

2. How understandable was the language used in this website?
 - a. 1—difficult to understand
 - b. 2
 - c. 3
 - d. 4
 - e. 5—easy to understand

3. How much did you enjoy using this website?
 - a. 1—not at all
 - b. 2
 - c. 3
 - d. 4
 - e. 5—very much

4. Was the amount of time it took to complete this website acceptable?

a. 1—very unacceptable

b. 2

c. 3

d. 4

e. 5—very acceptable

5. How would you rate your overall satisfaction with this website?

a. 1—very dissatisfied

b. 2

c. 3

d. 4

e. 5—very satisfied

Appendix FF

Sleep Wristband (Acrigraph) Participant Instructions

What to Do

- Please wear your sleep wristband from **the day that you get it and please keep it on for 24 hours a day (all day, every day)** until your time with SleepWise has ended. **Please keep the box and envelope that came with the sleep wristband**
- If you want to take off your sleep wristband for a short time then you can do so, but please keep it on **most of the time** because this will give us the best information about your sleep and activity
- The sleep wristband does not know your location or store personal data; it only collects information based on your movement and body temperature. It has no screen or camera, so it is completely safe and secure to wear
- When you are ready, put the wristband around your wrist (on the arm that you use the least. If you are right-handed please put it on your left wrist, if you are left-handed please put it on your right wrist). Now press down on the button on the front of the wristband (where there is a set of numbers). The button is firm so make sure you press down hard. When the button is pressed, a green light will give a long flash to show that recording has started. You can now carry on as normal
- You will receive text/email reminders to remind you about keeping your wristband on in case you forget. If you do not wish to receive these reminders please let us know by email (info@sleepwise.org.uk)
- Once you have completed SleepWise, you will be emailed and asked to return your wristband back to your school reception. **Please return in the box and envelope that you received it in**
- If you do not wish to use the sleep wristband please let us know by email

If you have any questions please email us at info@sleepwise.org.uk

Thank you ☺

Caring for Your Sleep Wristband

- You **do not** need to charge your sleep wristband
- Please store your sleep wristband at a temperature between 5-35 Celsius (around normal room temperature) and return it in the box you received it in
- The sleep wristband is waterproof so you can for example shower or swim with it on. Water-resistant to 10m. There should be no reason at all to remove the sleep wristband for the entire time using SleepWise. The only times where you should take it off are if you enter a sauna or have a medical scan
- Cleaning: We recommend removing the strap to clean separately. Wipe or scrub with warm soapy water or a mild cleaner solution. Alcohol wipes and some sterilising solutions are also appropriate. **Do not** clean with strong alkali solutions or solvents. Please take care of the straps, and keep them in one piece

Frequently Asked Questions

- **Is the wristband safe to wear alongside other medical equipment?**

Yes, the wristband is safe to wear alongside other medical equipment. The sleep wristband will not interfere with other equipment, such as pacemakers and blood pressure monitors. You should however take the wristband off for a medical scan.

- **Is it waterproof?**

Yes, it is fully waterproof and robust, so you can for example, swim or shower with the wristband on. Water-resistant to 10m. There should be no reason at all to remove the wristband for the entire time using SleepWise. The only times where you should take it off are if you enter a sauna or have a medical scan

How do I know it is working?

The wristband will continuously record data. It purposefully does not provide any feedback at all. The sleep wristband does not need any charging or maintenance whilst in your possession.

- **How can I clean the wristband?**

Hot water and sponge, or antibacterial wipe. It is not suggested to spray perfumes or use lotions directly on the sleep wristband.

- **What is the wristband made of?**

The sleep wristband is constructed from medical grade plastics. The buckle and backplate are stainless steel. In the unlikely event that you do experience any skin

irritation then we recommend you **take the wristband off and inform your healthcare professional.**

- **What is the wristband measuring?**

It measures movement and provides lifestyle information based on scientifically proven systems to give information about your physical activity and sleep. The sleep wristband senses up to 10 basic activities with estimates of steps, movement and energy expenditure.

- **Why measure my behaviour?**

Lifestyle measurement is important in understanding the details of people's daily lives and how behaviours impact health. One week of data collection is enough to provide screening information or see differences in diagnosis.

- **Does it know my location?**

No, the wristband does not have GPS or any other location recording ability. Once the activity data is uploaded, only the researcher can match the behaviour data with your identifying personal information that you provided at the start.

- **Is the data safe?**

Yes, the wristband carries no information that can identify you directly. The sleep wristband uses the Coelition global standard to give confidence and security to both users and researchers.

What happens if I lose it?

Do not worry. Let the SleepWise team know and continue to look for the wristband. Importantly, any data is safe; the wristband carries no information that can identify you directly.

Who should I contact if I have any questions?

If you have any questions at all about the wristband, or SleepWise, please contact the SleepWise team at info@sleepwise.org.uk

Appendix GG

Sleep Wristband (Actigraph) Email/Text Reminder Template

Hi!

You were selected to wear a **sleep wristband** [x] days ago. The purpose of the wristband was to measure your sleep.

The wristband has now stopped recording and it will need to be dropped off at your school reception. Please return the sleep wristband in its original packaging (in white box and labelled plastic wallet). If you decided not to use the wristband, and have already returned it to reception, ignore this email/text.

If you have any questions or experience any problems please get in touch!

SleepWise Team 😊

Appendix HH

SleepWise Usage Data Charting Example

USER ID NUMBER	WEEK	Main (1) vs Additional Page (0) Visits	TIME SPENT	NOTES
X		1	13 minutes	
		2	21 minutes	
		3	25 minutes	
		4	54 minutes	
DATE & TIME	PAGE		SLEEP LOGS	GOALS
02/08/2019 15:53	My Profile Page		Tuesday 18th June 2019	Week 1 Goals 18th June 2019
02/08/2019 15:48	My Profile Page		Tuesday 18th 2019 (last modified Monday 24th)	(Week 2) Goals 10th July 2019
02/08/2019 15:43	My Profile Page		Wednesday 19th June 2019 (last modified Monday 24th)	(Week 3) Goals 23rd July 2019
02/08/2019 15:41	My Profile Page		Thursday 20th June 2019 (last modified Monday 24th)	
02/08/2019 15:41	My Profile Page		Friday 21st June 2019 (last modified Monday 24th)	
02/08/2019 15:41	Edit Profile Page		Saturday 22nd June 2019 (last modified Monday 24th)	
02/08/2019 15:41	Edit Profile Page		Sunday 23rd June 2019 (last modified Monday 24th)	
02/08/2019 15:40	Edit Profile Page		Monday 24th June 2019	
02/08/2019 15:40	My Profile Page		Tuesday 25th (last modified Wednesday 26th)	
02/08/2019 15:40	Edit Profile Page		Wednesday 26th June 2019	
02/08/2019 15:40	My Profile Page		Thursday 27th June 2019 (last modified 2nd July 2019)	
02/08/2019 15:40	Edit Profile Page		Saturday 29th June (last modified 2nd July 2019)	
02/08/2019 15:40	Edit Profile Page		Sunday 30th June (last modified 2nd July 2019)	
02/08/2019 15:39	Edit Profile Page		Monday 1st of July (last modified 2nd July 2019)	
02/08/2019 15:39	My Profile Page		Tuesday 2nd July 2019	
02/08/2019 15:38	My Profile Page		Wednesday 3rd July (last modified 10th July 2019)	
02/08/2019 15:32	My Profile Page		Thursday 4th July (last modified 10th July 2019)	
02/08/2019 15:22	My Profile Page		Friday 5th July 2019 (last modified 10th July 2019)	
02/08/2019 15:18	My Profile Page		Saturday 6th July (last modified 10th July 2019)	
02/08/2019 15:13	My Profile Page		Sunday 7th July (last modified 10th July 2019)	
02/08/2019 15:08	My Profile Page		Monday 8th July 2019 (last modified 10th July 2019)	
02/08/2019 15:08	My Profile Page		Tuesday 9th July 2019 (last modified 10th July 2019)	
02/08/2019 15:01	My Profile Page		Wednesday 10th July 2019	
02/08/2019 15:00	My Profile Page		Thursday 11th July 2019 (last modified 23rd July 2019)	
02/08/2019 15:00	My Profile Page		Friday 12th July 2019 (last modified 23rd July 2019)	
02/08/2019 15:00	Congratulations Week 4 Page	1	Saturday 13th July (last modified 23rd July 2019)	
02/08/2019 15:00	Week 4 Goal Setting Instructions	1	Sunday 14th July (last modified 23rd July 2019)	
02/08/2019 15:00	Goal Setting Introduction Page Week 4	1	Monday 15th July 2019 (last modified 23rd July 2019)	
02/08/2019 14:59	Friends and Family Page Week 4	1	Tuesday 16th July 2019 (last modified 23rd July 2019)	
02/08/2019 14:59	Mindfulness Page Week 4	1	Wednesday 17th July 2019 (last modified 23rd July 2019)	
02/08/2019 14:59	Write Page Week 4	1	Thursday 18th July 2019 (last modified 23rd July 2019)	
02/08/2019 14:59	Sleep Routine Page Week 4	1	Friday 19th July (last modified 23rd July 2019)	
02/08/2019 14:59	Weekends Page Week 4	1	Saturday 20th July (last modified 23rd July 2019)	
02/08/2019 14:59	Balance Page Week 4	1	Sunday 21st July (last modified 23rd July 2019)	
02/08/2019 14:59	I Part Met My Goal Week 4	1	Monday 22nd July (last modified 23rd July 2019)	
02/08/2019 14:59	Goal Review Week 4	1	Tuesday 23rd July 2019	
02/08/2019 14:59	Welcome Page Week 4	1	Wednesday 24th July (last modified 2nd August 2019)	

Appendix II

Interview Guides (Study 3)

Intervention Group Interview Guide [low vs high users]

[For intervention users] before undertaking the interview, check usage data from each session.

Participant introductions and set-up:

- Introduction
- Outline the purpose of this interview (e.g., to find out how you got on with using SleepWise and the study procedures)
- I just want to check that you are still happy to take part (participant has already provided consent).
- Most interviews last between 20 to 60 minutes, this will be up to you depending on how much you have to say. We can do the interview in 2 parts if you prefer, so just let me know if you want to stop at any point and we can always arrange another day to finish.
- There are no right or wrong answers, so please say any thoughts which spring to mind, even if you think they might not be important. Your experiences of using SleepWise and being involved in this study are really important so the more you can tell me about your experiences the better.
- This might be different from surveys or questionnaires that you have done before, as I really want to hear as much as you have to say. I will leave some pauses so you can think as you're talking, and so you can tell me the detail of what it was like for you, but I want to reassure you that I am always listening.
- If you have any questions while we are going through the interview, I will be very happy to answer them but it's probably best if I answer them at the end.
- If you are happy, I will record the interview, so I can listen again to what is said. We will not keep anything on record that identifies you, or where you live or anyone else that you mention, so you will be anonymous. Also, everything we talk about here will be confidential.
- We can take a break at any time you like, please just let me know and I can pause the recording, or I can always call back to finish the interview another time if that is better for you.
- You can choose not to take part at any time.
- Is there anything you would like to ask me at the moment?

- If you are happy, I will start recording now.

Key follow-up prompts:

Can you tell me a bit more about that?

Can you tell me what that was like for you?

You mentioned xxxxxx/ You said about xyz... (mimic their words).

What does 'xxxxx' mean to you?

START

1. Can you tell me about what it is like for you to be a pupil (or student) at a secondary school (or college)?
2. Can you tell me why you agreed to take part in this study?
3. Can you tell me what your sleep was like for you back when you were deciding to sign up for this study?
4. Can you tell me about anything that you have liked about your experiences of using SleepWise [or being in this study]? Probe: And was there anything else that you liked?
5. Can you tell me about anything that you have disliked/ found off-putting? E.g. anything you found tricky? Annoying? Confusing? Less relevant? [Low users: were there any other things that you may have found off-putting?]
6. [Intervention group] Can you tell me what you think about the 4 weekly sessions? (what do you think about having all the sessions given to you in one go) [Low users: even if you didn't get time to look at later sessions. If not, why not?]
7. [Intervention group] Thinking a bit more about the parts of SleepWise, I can see that you looked at (describe each part in turn, starting with session 1, then any other additional bits they looked at – Click through options, Sleep Diary logs, Games, quizzes, extra information pages etc). What did you think of X (ask about each one in turn). What did you like about X? What did you dislike about X? [Low users: If you didn't get time to look at later sessions, what stopped you/why not?]

8. [Intervention group] SleepWise gives some support with making healthy changes like changing your diet, physical activity, or managing your sleep environment e.g., sleep chart, mindfulness exercises. Can you tell me about any of these changes/tools that you might have tried? [Low users: if not, why not? E.g., what things were off-putting, or got in the way?]
9. **If they tried one or more change:** What was that like? Why did you choose (insert name of change). How did it make you feel to try (insert name of change)? (ASK THESE QUESTIONS FOR EACH CHANGE THEY MENTION).
10. **If they didn't try out any of these changes:** Can you tell me why you decided not to make any changes?
11. Has anything changed as result of you using SleepWise [or being part of this study]?
12. Can you tell me what your sleep and health behaviour/s are like for you now, since you used SleepWise [or started this study]? [Are you still or planning to carry on those behaviours/long-term changes]
13. [Intervention group] What time did you usually use SleepWise? Probe: what time felt better for using SleepWise? [if they didn't, why not? And what could be done to help?]
14. [Intervention group] Where did you use it? E.g., bedroom, lounge etc
15. [Intervention group] How did you use it? E.g., iPad, Computer
16. [Intervention group] How long did you usually spend on it?
17. [Intervention group] What parts did you find more relevant to you and why? [Low users: what parts may have been more relevant to you?]
18. [Intervention group] Which of the techniques/suggestions did you find more relevant to you and why? [Low users: which techniques/suggestions may have been more relevant to you?]

a) Anything that you didn't find relevant?

19. [Intervention group] What parts did you think were more effective/useful/helpful for sleep (or other health behaviours)? [Low users: which parts do you think would have been more useful for your sleep/health behaviours?]
20. What motivated you to carry on [with the study]? Low users: what got in the way?- see below]
21. What things got in the way of carrying on [with the study]? [Low users: were there any other things that got in the way?]
22. What was your impression/experience of getting email and text reminders - and which did you prefer (and why)? [check that participant opted in for reminders]
23. [Intervention group] What was your impression or experience with the sleep diary logs and goal setting and things like sleep chart, mindfulness recording if you looked at it (check their usage for each one)? [Low users: were there any things that made it difficult to experience these tools?]
24. What was your impression or experience with the questionnaires that you had to complete before and after the study? [and what do you think about answering them again at 3 and 6 month]
25. [Intervention group] Was there any situation or at any time where you shared your access or login details with someone else? If so, can you explain how and why
26. [Intervention group] Do you think you would choose to keep on using the SleepWise if it was still available after this study? (Why/ Why not?)
27. [Intervention group] Would you recommend SleepWise to other young people/friends/family?
28. Is there anything else you would like to tell me about the SleepWise study that we haven't already talked about?

Sleep Wristband [only relevant to selected individuals]

Experiences of wearing sleep wristband (actigraph):

1. Can you tell me about what it was like for you to collect and drop off the sleep wristband?
2. Can you tell me about what it was like when you were learning how to use your sleep wristband at home?
3. Can you tell me about the first time you used your sleep wristband at home?
4. Can you tell me about what it was like to wear the sleep wristband?

Probe: How did it make you feel?

5. Did you keep the device on for the whole duration that you were given it?
 - a) Can you tell me about any time when you took it off and why?
6. How do you feel about the instructions that SleepWise gave you for wearing the sleep wristband?
7. Was there anything that made it harder to wear the sleep wristband?
 - a) Anything that made it easier?
8. Can you tell me about any concerns that you had about wearing the sleep wristband?
9. Is there anything else you would like to tell me about the SleepWise study that we haven't already talked about?

OK I'm going to stop the recording now.

End of interview

Control Group Interview Guide

Participant introductions and set-up:

- Introduce myself to the participant
- The purpose of this interview is to find out how you got on with the study
- Most interviews last between 20 to 40 minutes, this will be up to you depending on how much you have to say
- There are no right or wrong answers, I want to hear about any positive or negative views, so please say any thoughts which spring to mind, even if you think they might not be important. Your experiences of being involved in this study are really important so the more you can tell me about it the better.
- This might be different from surveys or questionnaires that you have done before, as I really want to hear as much as you have to say. I will leave some pauses so you can think as you're talking, and so you can tell me the detail of what it was like for you, but I want to reassure you that I am always listening.
- If you have any questions while we are going through, I will be very happy to answer them but it's probably best if I answer them at the end.
- I will record the interview, so I can type up the interview to keep a record. I will remove anything that identifies you, like your name or where you live or anyone else that you mention, so it will all be anonymous. Also, everything we talk about here will be confidential.
- We can take a break at any time you like, please just let me know and I can pause the recording, or I can always call back to finish the interview another time if that is better for you.
- You can choose not to take part at any time.
- Is there anything you would like to ask me at the moment?
- If you are happy, I will start recording now.

Key follow-up prompts:

Can you tell me a bit more about that?

Can you tell me what that was like for you?

You mentioned xxxxxx/ You said about xyz.... (mimic their words).

What does 'xxxxx' mean to you?

START

1. Can you briefly tell me about what it is like for you to be a pupil at a secondary school?
2. Can you tell me why you decided to take part in this study?
3. Can you tell me what your sleep was like for you back when you were deciding to sign up for this study?
4. Can you tell me about anything that you have liked about your experiences of taking part in this study? Probe: And was there anything else that you liked?
5. Can you tell me about anything that you have disliked/ found off-putting? E.g. anything you found tricky? Annoying? Confusing? Less relevant?
6. Can you tell me about any advantages of taking part in this study?
7. And can you tell me about any disadvantages?
8. What motivated you to carry on with the study (e.g., answer the questionnaires)?
9. What things got in the way of carrying on?
10. What was your impression/experience of getting email reminders?
11. What was your impression or experience with the questionnaires that you had to complete before and after the study? [and what do you think about answering them again at 3 and 6 month]
12. Was there any situation or at any time where you had access to the website? If so, can you explain how

13. Do you think you would choose to use the SleepWise website when it is made available to you after this study? (Why/ Why not?)

14. Is there anything else you would like to tell me about the SleepWise study that we haven't already talked about?

End of interview

Facilitator Interview Guide

Participant introductions and set-up:

- Introduce myself to the participant
- The purpose of this interview is to find out how you got on with facilitating the SleepWise study at your school/college
- Most interviews last between 20 to 40 minutes, this will be up to you depending on how much you have to say.
- There are no right or wrong answers, so please say any thoughts which spring to mind, even if you think they might not be important. Your experiences of facilitating SleepWise are really important so the more you can tell me about it the better
- If you have any questions while we are going through, I will be very happy to answer them but it's probably best if I answer them at the end.

MENTION: I'll record the interview, so I can listen again to what is being said – do you mind if I start recording now? – we will not keep anything on record that identifies you, any personal information about gender, age, and background that you've provided for this project, or anything else where you live or anyone else that you mention, will all be anonymous. Also, everything we talk about here will be confidential.

- You can choose not to take part at any time.
- Is there anything you would like to ask me at the moment?
- If you are happy and consent, I will start the interview now

Key follow-up prompts:

Can you tell me a bit more about that?

Can you tell me what that was like for you?

You mentioned xxxxxx/ You said about xyz.... (mimic their words).

What does 'xxxxx' mean to you?

START

1. Can you tell me about what it is like for you to be a [staff member etc] within your secondary school/college?

2. Can you tell me why you agreed to take up the study?

3. I'm really interested in hearing about your experiences of facilitating SleepWise/this study within your school/college, can you tell me all about it?

4. Can you tell me about anything that you have liked about your experience of facilitating this study at your school/college?

Probe: And was there anything else that you liked?

5. Can you tell me about anything that you have disliked?
E.g. anything you found tricky? Annoying? Confusing? Less relevant?

6. Can you tell me about any advantages of using SleepWise within an education setting like [insert school/college name]?

7. And can you tell me about any disadvantages?

8. How feasible do you think it is to run a programme like SleepWise in education settings?
E.g., anything tricky - like consent forms, email contact, assemblies (if applicable) etc

9. Did taking part in the study affect your workload?

10. Do you think you would choose to keep on using the SleepWise if it was still available after the study?

a. Why/ Why not?

11. Would you recommend SleepWise to other schools/colleges?

12. Is there anything else you would like to tell me about the SleepWise study that we haven't already talked about?

OK I'm going to stop the recording now.

End of interview

Appendix JJ

Actigraph Supplier Instructions for Setting up Actigraph Device

Please click [here](#) to see instructions from GENEActiv at Activinsights Ltd

Appendix KK

Actigprah Visual Output Summary Example

Report

Created for : Example
Date created : 06/04/2017
Data file : 18474 60s epoch file.csv

Subject Information

Subject code :
Date of birth : 14/02/1970
Sex : male
Height (m) : 1.72
Weight (kg): 65.5
BMI : 22.1
Handedness : right

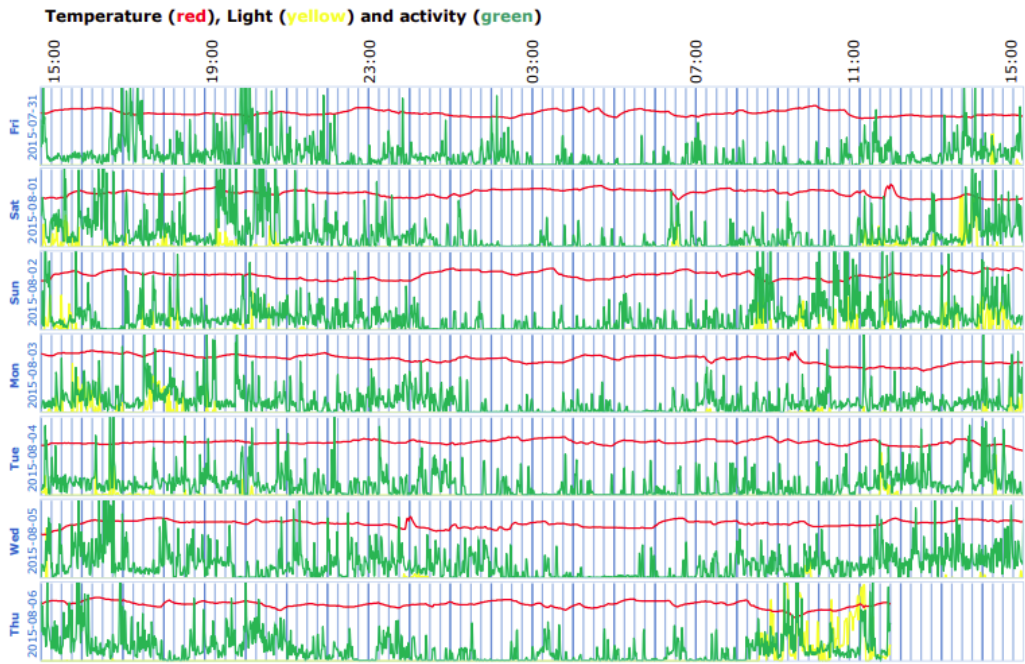
Trial Information

Original sample frequency (Hz) : 30.
Device location :
Start time : 2015-07-31 10:17
End time : 2015-08-07 11:45
Elapsed time (days) : 7.1
Total wear time (days) : 7.0
Study centre :
Study code :
Exercise type :

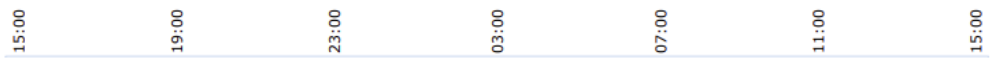
Baselines

Sleep sensitivity : 8

Notes



Temperature (red), Light (yellow) and activity (green)



Summary

Day / date	Bed time	Rise time	Elapsed Sleep time (mins)	Sleep time (mins)	Sleep efficiency	# Activity periods	Median activity period (mins)	Previous Day total energy (MET.mins)	Previous day total light exposure (Lux.mins)
Fri night 2015-07-31	11:59	11:28	1409	266	18.9%	20	6.5	1991	692
Sat night 2015-08-01	12:30	11:07	1357	266	19.6%	20	6.5	2172	5822
Sun night 2015-08-02	16:14	08:04	950	115	12.1%	10	58	620	8174
Mon night 2015-08-03	20:53	09:14	741	199	26.9%	13	8	1514	18328
Tue night 2015-08-04	21:12	10:56	824	133	16.1%	13	42	1065	3277
Wed night 2015-08-05	19:30	08:51	801	80	10.0%	10	40	1038	2072
Thu night 2015-08-06	17:33	08:22	889	209	23.5%	21	14	1187	816

Appendix LL
Actigraph Output Summaries

Summary 1

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-11-07	23:05	07:17	08:11	06:03	02:07	74.0	33	73
2019-11-08	22:56	08:59	09:54	08:42	01:12	87.9	36	78
2019-11-09	23:20	09:32	10:11	07:57	02:13	78.1	36	119
2019-11-10	23:52	07:12	07:17	06:35	00:42	90.2	19	94
2019-11-11	21:58	07:52	09:53	06:57	02:56	70.3	78	69
2019-11-12	23:11	07:34	08:22	06:12	02:10	74.1	32	103
2019-11-13	22:34	07:15	08:35	07:11	01:24	83.6	37	113
2019-11-14	22:55	07:28	08:30	06:25	02:05	75.4	23	146
2019-11-15	23:26	08:30	08:59	06:25	02:34	71.3	38	181
2019-11-16	22:51	09:10	10:18	07:11	03:06	69.8	89	74
2019-11-17	23:06	07:25	08:15	06:44	01:30	81.7	27	93
2019-11-18	22:45	07:40	08:53	07:11	01:42	80.8	22	156
2019-11-19	23:11	07:28	08:16	06:54	01:21	83.6	27	107
2019-11-20	23:41	07:24	07:39	05:41	01:57	74.4	34	139
2019-11-21	22:40	07:38	08:53	07:24	01:28	83.4	35	78

2019-11-22	00:32	09:41	09:07	07:33	01:34	82.8	34	108
2019-11-23	23:39	10:35	10:55	08:31	02:23	78.1	59	97
2019-11-24	00:01	07:53	07:50	06:08	01:42	78.3	27	133
2019-11-25	22:56	07:47	08:48	06:34	02:13	74.7	24	146
2019-11-26	23:16	07:04	07:43	05:51	01:52	75.8	29	141
2019-11-27	23:43	07:34	07:50	06:02	01:47	77.1	27	172
2019-11-28	23:58	08:43	08:41	07:45	00:56	89.2	17	106
2019-11-29	21:47	09:23	11:34	08:58	02:35	77.6	87	72
2019-11-30	23:54	09:35	09:38	07:23	02:15	76.6	51	104
2019-12-01	23:22	07:32	08:07	06:58	01:09	85.8	21	109
2019-12-02	23:29	07:19	07:37	06:14	01:23	81.7	32	88
2019-12-03	23:00	07:41	08:37	08:02	00:34	93.3	21	60
2019-12-04	22:28	13:20	14:49	12:20	02:29	83.2	66	80
2019-12-05	22:07	15:00	15:53	02:31	13:22	15.9	8	43
Mean	23:10	08:32	09:17	07:03	02:14	77.5	37	106

Summary 2

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-11-06	22:09	08:15	10:06	08:00	02:05	79.4	47	94
2019-11-07	22:35	07:46	09:06	06:38	02:28	72.9	43	149
2019-11-08	22:35	07:30	08:52	06:56	01:55	78.3	33	157
2019-11-09	22:46	07:45	08:57	07:24	01:33	82.6	36	119
2019-11-10	23:01	07:53	08:48	07:45	01:02	88.1	26	115
2019-11-11	22:35	08:05	09:25	08:09	01:15	86.6	33	97
2019-11-12	22:33	07:57	09:18	08:04	01:13	86.8	25	125
2019-11-13	23:07	07:44	08:33	05:51	02:41	68.5	46	115
2019-11-14	22:40	07:57	09:14	06:54	02:19	74.8	46	156
2019-11-15	23:11	07:44	08:31	06:33	01:58	76.9	40	142
2019-11-16	00:00	10:49	10:48	08:21	02:26	77.4	30	190
2019-11-17	22:58	07:44	08:44	06:41	02:03	76.5	51	120
2019-11-18	22:39	07:53	09:10	07:02	02:08	76.7	51	92
2019-11-19	22:54	07:44	08:49	07:03	01:46	79.9	31	171
2019-11-20	23:16	07:47	08:27	06:52	01:34	81.4	36	128
2019-11-21	22:46	07:35	08:47	07:06	01:40	80.9	24	98
2019-11-22	02:27	08:02	05:32	04:36	00:56	83.1	16	141

2019-11-23	22:56	09:00	10:00	07:11	02:48	71.9	55	133
2019-11-24	22:34	08:15	09:40	07:10	02:29	74.2	58	84
2019-11-25	22:32	06:43	08:10	05:10	02:59	63.4	61	118
2019-11-26	22:41	07:41	08:49	07:23	01:26	83.6	29	100
2019-11-27	22:49	08:01	09:10	06:54	02:15	75.4	55	136
2019-11-28	22:33	08:04	09:30	06:41	02:48	70.4	44	111
Mean	22:58	08:00	08:58	06:58	02:00	77.8	40	126

Summary 3

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-25	20:08	06:28	10:18	08:09	02:08	79.2	61	84
2019-06-26	18:43	06:25	11:40	10:06	01:34	86.6	24	116
2019-06-27	20:56	06:29	09:12	07:45	01:26	84.3	49	75
2019-06-28	22:36	14:17	15:35	10:09	05:25	65.2	198	67
2019-06-29	22:50	08:15	09:23	07:34	01:49	80.6	52	63
2019-06-30	16:24	20:33	04:07	00:59	03:07	24.2	10	185
2019-07-01	22:28	06:59	08:28	06:52	01:36	81.1	40	94
2019-07-02	19:30	06:21	10:31	09:21	01:10	88.9	45	67
2019-07-03	22:26	06:31	08:02	06:06	01:56	75.9	24	97
2019-07-04	20:50	06:59	10:06	07:32	02:33	74.7	108	63
2019-07-05	22:42	07:05	08:22	07:11	01:10	85.9	28	75
2019-07-06	23:19	15:00	16:55	11:10	05:44	66.1	129	77
2019-07-07	22:39	06:37	07:55	07:06	00:49	89.6	27	88
2019-07-08	00:19	06:41	06:18	04:52	01:26	77.2	34	109
2019-07-09	22:45	06:39	07:47	05:49	01:57	74.8	21	114
2019-07-10	23:14	06:39	07:22	06:27	00:55	87.5	12	118
2019-07-11	15:11	15:00	23:48	01:04	22:44	4.5	543	66

2019-07-12	17:22	22:26	05:02	03:34	01:28	70.8	34	141
2019-07-13	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-07-14	22:36	07:13	08:34	05:56	02:37	69.3	28	132
2019-07-15	20:49	07:13	10:23	08:05	02:17	77.9	71	77
2019-07-16	21:53	06:58	09:01	06:56	02:04	77.0	55	94
Mean	21:13	07:05	00:00	00:00	00:00	72.4	76	91

Summary 4

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-25	23:08	07:10	08:01	06:26	01:34	80.4	24	100
2019-06-26	22:55	06:55	07:56	07:09	00:46	90.1	8	178
2019-06-27	22:58	07:30	08:30	07:07	01:22	83.8	51	60
2019-06-28	21:56	15:04	17:07	12:08	04:59	70.9	197	66
2019-06-29	15:04	15:05	00:01	07:54	16:07	32.9	54	127
2019-06-30	15:05	18:50	03:42	02:25	01:17	65.3	39	84
2019-07-01	22:32	07:09	08:32	07:38	00:53	89.5	16	148
2019-07-02	22:37	07:10	08:19	07:35	00:44	91.1	14	143
2019-07-03	23:48	07:04	07:14	05:54	01:19	81.7	22	171
2019-07-04	22:33	07:17	08:43	07:33	01:09	86.7	20	169
2019-07-05	22:59	09:11	10:03	07:16	02:46	72.3	75	92
2019-07-06	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-07-07	22:54	08:15	09:21	07:25	01:55	79.4	82	65
2019-07-08	23:58	06:43	06:42	05:53	00:48	87.9	21	111
2019-07-09	15:00	15:00	00:00	00:52	23:08	1.8	123	62
2019-07-10	23:00	07:00	00:00	00:00	00:00	0.0	0	0
Mean	21:28	08:01	00:00	00:00	00:00	72.4	53	99

Summary 5

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-11-06	23:45	07:36	07:45	07:08	00:37	92.0	18	79
2019-11-07	22:23	08:18	09:54	08:06	01:48	81.8	74	63
2019-11-08	23:39	09:00	09:20	07:37	01:42	81.7	38	72
2019-11-09	23:53	09:38	09:40	08:14	01:25	85.2	35	89
2019-11-10	22:30	07:29	08:58	07:12	01:46	80.3	69	65
2019-11-11	23:45	07:31	07:30	05:15	02:14	70.1	20	164
2019-11-12	23:34	07:59	08:23	06:52	01:30	81.9	19	142
2019-11-13	22:51	06:48	07:55	06:24	01:31	80.8	59	74
2019-11-14	23:21	07:54	08:32	06:36	01:55	77.4	66	60
2019-11-15	23:59	09:17	09:17	07:36	01:40	82.0	40	86
2019-11-16	01:10	08:35	07:03	06:44	00:18	95.7	8	85
2019-11-17	23:38	07:24	07:45	05:59	01:45	77.3	42	77
2019-11-18	23:37	07:28	07:46	06:39	01:06	85.7	28	135
2019-11-19	22:23	07:59	09:34	07:04	02:29	73.9	99	69
2019-11-20	23:53	07:38	07:39	06:14	01:25	81.5	22	88
2019-11-21	23:53	06:59	06:52	05:50	01:02	85.0	16	84
2019-11-22	23:13	07:00	07:44	07:20	00:24	94.8	14	75

2019-11-23	23:59	07:57	07:55	07:16	00:38	92.0	24	74
2019-11-24	23:40	07:18	07:34	05:23	02:11	71.0	16	259
2019-11-25	22:12	07:23	09:09	07:18	01:50	79.9	39	74
2019-11-26	00:29	07:20	06:48	05:21	01:27	78.6	25	121
2019-11-27	23:32	08:18	08:44	07:26	01:17	85.1	32	80
2019-11-28	23:05	08:59	09:50	08:23	01:27	85.3	44	66
2019-11-29	23:51	11:11	11:17	07:03	04:14	62.5	150	72
Mean	23:31	08:02	08:27	06:52	01:34	81.7	42	94

Summary 6

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-25	19:08	06:42	11:32	09:28	02:03	82.2	73	62
2019-06-26	22:42	06:37	07:50	07:23	00:26	94.4	8	56
2019-06-27	21:27	06:49	09:19	06:40	02:39	71.5	82	82
2019-06-28	22:01	07:25	09:23	06:18	03:04	67.2	84	78
2019-06-29	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-06-30	15:00	15:00	03:22	01:15	02:07	4.6	4	1755
2019-07-01	13:15	15:00	01:31	00:34	00:56	38.1	45	54
2019-07-02	22:25	06:30	08:01	07:17	00:44	90.8	21	86
2019-07-03	23:18	06:57	07:21	06:13	01:07	84.8	36	86
2019-07-04	21:16	06:03	08:46	06:53	01:53	78.5	64	69
2019-07-05	22:39	07:20	08:38	07:02	01:36	81.3	36	98
2019-07-06	14:59	15:00	00:00	00:00	00:00	0.0	0	0
2019-07-07	15:00	07:06	15:55	10:17	05:38	64.6	232	66
2019-07-08	22:29	06:39	08:06	06:27	01:39	79.6	32	109
Mean	23:20	08:35	00:00	00:00	00:00	69.8	55	200

Summary 7

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficienc y	Num.Active.Period s	Median.Activity.L ength
2019-11-06	23:11	07:31	08:18	07:20	00:58	88.3	28	93
2019-11-07	23:07	07:03	07:54	06:04	01:49	76.9	36	136
2019-11-08	01:29	08:46	07:04	05:26	01:38	76.8	37	116
2019-11-09	23:43	08:48	08:54	06:20	02:33	71.2	43	127
2019-11-10	23:09	06:52	07:41	05:20	02:21	69.4	35	149
2019-11-11	23:45	07:29	07:43	06:30	01:12	84.4	28	82
2019-11-12	23:14	07:32	08:17	06:25	01:52	77.5	31	134
2019-11-13	23:17	07:33	08:12	06:15	01:56	76.3	30	79
2019-11-14	22:10	07:31	09:20	06:59	02:21	74.8	65	62
2019-11-15	23:39	08:38	08:58	06:48	02:10	75.8	34	115
2019-11-16	23:41	09:27	09:40	07:42	01:58	79.6	29	88
2019-11-17	23:23	07:30	08:05	06:05	01:59	75.4	32	108
2019-11-18	23:08	07:37	08:25	06:19	02:06	75.0	34	146
2019-11-19	22:38	07:21	08:40	06:26	02:13	74.4	47	60
2019-11-20	23:10	07:31	08:19	05:47	02:31	69.6	38	160
2019-11-21	23:27	07:13	07:44	06:43	01:01	86.8	19	169
2019-11-22	23:11	08:40	09:26	06:29	02:57	68.7	29	147

2019-11-23	23:38	08:56	09:17	07:15	02:02	78.0	43	101
2019-11-24	23:18	07:31	08:11	06:32	01:38	79.9	36	92
2019-11-25	23:51	07:40	07:46	05:43	02:02	73.7	35	103
2019-11-26	23:15	07:00	07:42	04:52	02:49	63.3	30	135
2019-11-27	23:15	06:57	07:39	05:12	02:27	67.9	36	178
2019-11-28	23:19	08:34	09:13	07:14	01:58	78.6	49	80
2019-11-29	23:14	08:53	09:39	06:53	02:45	71.4	51	95
2019-11-30	23:49	09:35	09:44	07:04	02:40	72.6	51	129
2019-12-01	23:22	07:32	08:07	06:42	01:24	82.6	23	117
2019-12-02	18:23	15:00	00:24	00:08	00:15	0.6	66	58
2019-12-03	10:54	15:00	03:58	02:51	01:06	72.0	29	93
2019-12-04	15:01	14:55	23:51	07:54	15:57	33.2	72	107
2019-12-05	15:24	15:01	23:33	06:23	17:10	27.1	63	135
Mean	23:04	08:51	09:52	06:07	03:44	70.0	39	113

Summary 8

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-25	23:49	06:58	07:04	05:58	01:06	84.3	19	187
2019-06-26	00:22	06:56	06:31	05:16	01:15	80.8	18	118
2019-06-27	23:46	06:40	06:51	05:41	01:10	83.0	26	146
2019-06-28	00:28	09:38	08:57	05:27	03:30	60.9	72	103
2019-06-29	23:43	10:03	10:19	08:03	02:16	78.0	81	73
2019-06-30	01:49	06:45	04:51	04:00	00:51	82.4	15	154
2019-07-01	23:45	06:55	07:07	05:57	01:10	83.6	17	94
2019-07-02	00:19	06:59	06:37	05:22	01:14	81.2	24	78
2019-07-03	00:26	06:44	06:10	05:36	00:34	90.8	13	90
2019-07-04	23:05	07:33	08:26	05:58	02:28	70.7	95	72
2019-07-05	23:42	08:34	08:40	07:17	01:22	84.2	29	117
2019-07-06	23:46	06:56	07:04	06:00	01:03	85.1	22	116
2019-07-07	23:19	06:52	07:30	06:16	01:13	83.6	18	140
2019-07-08	23:51	06:50	06:56	06:00	00:56	86.5	23	153
Mean	00:01	07:27	07:22	05:55	01:26	81.1	34	117

Summary 9

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-25	23:36	07:38	07:56	06:36	01:19	83.3	53	64
2019-06-26	22:17	07:52	09:34	08:05	01:29	84.5	27	119
2019-06-27	23:32	07:48	08:06	06:35	01:31	81.1	24	106
2019-06-28	22:52	08:05	09:10	07:06	02:04	77.5	55	94
2019-06-29	00:54	07:47	06:52	04:53	01:59	71.1	64	78
2019-06-30	22:24	07:40	09:14	08:10	01:03	88.5	27	88
2019-07-01	22:00	07:11	09:09	06:48	02:20	74.3	72	74
2019-07-02	23:27	07:34	07:54	06:37	01:16	83.9	44	70
2019-07-03	21:23	07:40	10:14	07:26	02:48	72.6	88	78
2019-07-04	21:53	06:49	08:54	06:59	01:55	78.4	56	71
2019-07-05	23:14	08:09	08:47	07:33	01:14	86.0	16	170
2019-07-06	22:45	08:38	09:52	08:20	01:32	84.5	59	62
2019-07-07	22:58	07:24	08:24	06:55	01:29	82.2	44	78
2019-07-08	23:03	06:14	06:52	05:20	01:32	77.6	21	153
2019-07-09	23:09	07:24	08:07	06:11	01:56	76.1	29	99
Mean	22:54	07:35	08:36	06:54	01:42	80.1	45	94

Summary 10

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-11-11	02:46	08:24	05:37	04:35	01:01	81.8	13	169
2019-11-12	01:14	08:18	07:02	05:12	01:50	73.9	44	130
2019-11-13	00:58	08:27	07:27	05:41	01:46	76.2	24	123
2019-11-14	02:09	08:27	06:14	05:23	00:50	86.5	25	108
2019-11-15	01:36	13:01	11:24	08:21	03:03	73.2	68	129
2019-11-16	04:35	13:56	09:19	06:25	02:54	68.8	63	109
2019-11-17	02:47	08:12	05:13	03:54	01:19	74.8	15	145
2019-11-18	00:01	08:29	08:26	06:19	02:06	74.9	45	103
2019-11-19	01:32	08:24	06:49	06:09	00:39	90.4	19	106
2019-11-20	23:15	08:28	09:12	07:33	01:38	82.1	64	65
2019-11-21	23:35	08:30	08:52	07:17	01:35	82.1	58	67
2019-11-22	00:40	13:54	13:12	10:12	03:00	77.3	99	72
2019-11-23	02:59	11:05	08:04	06:16	01:48	77.7	43	112
2019-11-24	02:56	08:08	05:10	03:44	01:26	72.2	37	108
2019-11-25	01:21	08:42	07:19	06:42	00:36	91.6	16	128
2019-11-26	19:45	08:31	12:36	08:20	04:16	66.1	126	68
2019-11-27	01:05	08:28	07:22	05:29	01:52	74.6	66	71

2019-11-28	03:32	15:14	11:37	09:22	02:14	80.7	65	96
2019-11-29	15:14	15:05	23:41	01:47	21:53	7.5	202	59
2019-11-30	02:18	11:55	09:35	05:39	03:56	59.0	124	74
2019-12-01	22:06	08:29	10:21	07:31	02:49	72.7	95	75
2019-12-02	23:25	08:25	08:57	05:48	03:09	64.8	111	75
2019-12-03	15:00	15:00	00:00	00:11	23:48	0.8	411	69
2019-12-04	22:56	08:26	09:29	05:44	03:44	60.6	101	90
2019-12-05	02:42	08:28	05:44	04:24	01:19	76.8	35	79
2019-12-06	15:00	15:00	08:25	00:04	08:20	1.0	389	63
Mean	23:59	10:17	09:39	05:42	03:57	67.2	91	96

Summary 11

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-25	23:09	06:22	07:12	03:08	04:03	43.6	57	129
2019-06-26	21:55	06:21	08:24	05:47	02:36	68.9	73	88
2019-06-27	22:49	06:29	07:37	05:37	01:59	73.8	41	107
2019-06-28	23:48	09:03	08:20	06:03	02:16	72.6	38	96
2019-06-29	23:10	08:57	09:46	07:35	02:11	77.6	57	121
2019-06-30	23:13	06:34	07:16	05:24	01:51	74.4	52	98
2019-07-01	23:06	06:15	07:08	05:14	01:53	73.5	45	76
2019-07-02	23:16	06:13	06:30	03:59	02:31	61.3	29	133
2019-07-03	21:46	06:32	08:45	05:51	02:54	66.8	86	80
2019-07-04	22:28	06:05	07:37	05:38	01:59	74.0	37	135
2019-07-05	00:27	09:13	08:44	06:39	02:04	76.3	33	136
2019-07-06	23:03	09:58	10:52	07:21	03:31	67.6	133	67
2019-07-07	00:12	06:27	06:14	04:03	02:11	64.9	30	86
2019-07-08	22:25	06:00	07:33	05:12	02:20	68.9	50	70
2019-07-09	22:54	06:00	07:03	05:33	01:29	78.8	25	112
2019-07-10	22:29	06:15	07:44	06:09	01:35	79.5	29	100
2019-07-11	21:43	06:15	08:31	06:17	02:14	73.8	94	63

2019-07-12	21:50	07:56	10:05	07:22	02:42	73.2	88	74
2019-07-13	23:40	07:40	07:58	06:15	01:42	78.6	52	104
2019-07-14	22:17	05:38	07:15	05:10	02:05	71.1	44	88
Mean	22:53	07:01	08:02	05:43	02:18	71.0	55	98

Summary 12

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-27	22:05	07:16	09:02	06:49	02:13	75.4	87	73
2019-06-28	01:25	08:32	07:00	05:01	01:58	71.7	72	71
2019-06-29	01:10	07:47	06:34	03:55	02:39	59.6	27	112
2019-06-30	21:18	07:24	10:05	07:57	02:07	78.9	58	86
2019-07-01	19:16	06:28	11:07	08:40	02:27	77.9	94	77
2019-07-02	20:32	08:07	11:32	08:47	02:44	76.2	110	74
2019-07-03	21:46	07:58	10:11	07:18	02:52	71.7	54	98
2019-07-04	23:04	07:31	08:24	06:02	02:22	71.8	54	109
2019-07-05	23:02	08:47	09:28	06:34	02:54	69.3	61	113
2019-07-06	03:20	09:09	05:44	03:48	01:56	66.2	35	106
2019-07-07	23:42	07:37	07:41	06:03	01:38	78.7	29	111
2019-07-08	22:17	07:00	08:37	05:42	02:55	66.2	28	165
2019-07-09	22:45	07:21	08:31	06:12	02:18	72.8	34	206
2019-07-10	20:21	15:00	18:32	04:44	13:47	25.6	14	80
Mean	22:43	08:17	09:28	06:15	03:12	68.7	54	106

Summary 13

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-11-13	22:47	08:21	09:33	06:39	02:54	69.7	65	81
2019-11-14	23:44	08:12	08:23	07:33	00:49	90.2	14	79
2019-11-15	23:07	09:12	10:04	07:22	02:42	73.2	44	135
2019-11-16	01:10	09:44	08:26	07:27	00:59	88.3	13	132
2019-11-17	23:38	08:17	08:37	07:23	01:14	85.7	31	73
2019-11-18	23:19	08:10	08:49	06:02	02:46	68.5	50	90
2019-11-19	23:27	08:31	09:01	06:35	02:26	73.0	39	69
2019-11-20	23:40	08:24	08:39	07:01	01:38	81.1	36	100
2019-11-21	23:21	08:03	08:35	05:58	02:37	69.5	23	197
2019-11-22	23:47	09:45	09:55	07:51	02:04	79.1	33	92
2019-11-23	22:42	15:32	16:49	10:32	06:16	62.7	276	64
2019-11-24	15:32	08:19	16:08	10:52	05:16	67.4	66	87
2019-11-25	19:01	23:18	04:15	03:45	00:30	88.1	15	104
2019-11-26	00:09	08:43	08:32	06:21	02:10	74.5	40	74
2019-11-27	22:03	00:37	02:30	02:30	00:00	100.0	0	0
2019-11-28	00:52	09:01	07:57	05:21	02:36	67.3	30	135
2019-11-29	22:38	09:19	10:39	07:53	02:46	74.0	56	120

2019-11-30	23:34	09:12	09:36	06:41	02:55	69.6	52	81
2019-12-01	23:11	08:11	08:59	06:28	02:30	72.0	52	108
2019-12-02	15:21	20:21	04:10	03:32	00:38	84.7	16	67
2019-12-03	22:33	09:06	10:31	07:42	02:48	73.3	91	69
2019-12-04	16:15	15:00	22:44	01:23	21:21	6.1	473	63
2019-12-05	16:36	15:00	22:22	00:37	21:44	1.4	63	68
2019-12-06	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-07	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-08	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-09	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-10	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-11	15:00	15:00	00:11	00:14	23:57	1.0	1	40
Mean	21:53	08:17	00:00	00:00	00:00	67.5	66	76

Summary 14

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-11-17	22:30	07:47	09:15	07:02	02:13	76.0	59	85
2019-11-18	23:05	07:07	08:01	05:29	02:31	68.5	54	89
2019-11-19	23:15	07:26	08:07	06:14	01:53	76.8	37	86
2019-11-20	22:47	08:00	09:09	08:05	01:04	88.3	34	75
2019-11-21	23:38	07:37	07:56	05:53	02:02	74.2	28	144
2019-11-22	23:52	08:38	08:45	06:29	02:16	74.1	68	57
2019-11-23	23:40	15:43	15:59	09:18	06:40	58.3	99	81
2019-11-24	15:43	08:46	16:26	08:07	08:19	49.4	121	63
2019-11-25	23:16	07:27	08:07	06:44	01:22	83.0	23	150
2019-11-26	23:04	07:37	08:21	07:06	01:14	85.1	17	89
2019-11-27	00:23	07:21	06:55	05:30	01:25	79.5	22	108
2019-11-28	23:14	09:44	10:29	07:45	02:43	74.0	87	82
2019-11-29	23:11	09:02	09:50	06:32	03:18	66.4	92	80
2019-11-30	23:53	08:10	08:16	06:35	01:40	79.8	25	105
2019-12-01	23:32	08:37	08:54	05:50	03:03	65.6	102	64
2019-12-02	23:42	06:40	06:52	05:45	01:07	83.8	16	146
2019-12-03	23:51	07:41	07:47	05:05	02:42	65.2	33	106

2019-12-04	23:19	07:26	08:02	05:36	02:26	69.7	50	94
2019-12-05	23:12	10:25	10:31	07:33	02:57	71.8	71	84
2019-12-06	23:09	09:16	10:06	07:49	02:16	77.5	49	93
2019-12-07	00:35	12:26	11:46	08:42	03:04	73.9	65	72
2019-12-08	01:02	08:04	06:59	05:33	01:26	79.4	29	77
2019-12-09	10:36	14:55	04:06	02:23	01:43	58.0	43	113
2019-12-10	15:09	15:00	23:49	09:10	14:38	19.2	61	125
2019-12-11	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-12	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-13	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-14	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-12-15	23:00	07:00	00:00	00:00	00:00	0.0	0	0
Mean	23:16	08:49	00:00	00:00	00:00	70.7	54	78

Summary 15

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-11-12	22:18	07:20	09:00	05:49	03:11	64.7	82	107
2019-11-13	21:35	07:37	09:58	06:53	03:04	69.2	72	76
2019-11-14	01:16	07:35	06:18	03:44	02:33	59.3	78	91
2019-11-15	00:38	09:01	08:20	05:32	02:47	66.5	75	108
2019-11-16	00:22	15:40	15:13	08:12	07:00	53.9	146	87
2019-11-17	23:26	08:10	08:41	05:51	02:49	67.4	71	96
2019-11-18	00:03	07:26	07:19	04:57	02:21	67.7	58	123
2019-11-19	23:20	06:59	07:27	04:55	02:32	66.0	66	96
2019-11-20	23:05	08:11	09:03	06:21	02:42	70.2	77	93
2019-11-21	23:32	07:01	07:25	04:47	02:37	64.6	97	78
2019-11-22	21:48	08:54	11:05	07:16	03:48	65.6	107	90
2019-11-23	23:41	07:48	08:05	06:22	01:42	78.8	43	99
2019-11-24	23:35	07:50	08:12	07:04	01:08	86.2	37	77
2019-11-25	22:45	07:39	08:52	07:03	01:49	79.4	41	117
2019-11-26	01:02	07:57	06:53	05:23	01:30	78.2	46	88
2019-11-27	22:15	23:50	00:53	00:52	00:01	98.1	1	60
2019-11-28	20:19	15:00	18:22	02:10	16:11	11.8	173	56

2019-11-29	00:09	07:33	07:17	04:54	02:22	67.3	55	119
2019-11-30	00:15	10:01	09:41	06:35	03:06	68.0	92	77
2019-12-01	01:20	08:14	06:51	04:59	01:51	72.8	46	95
2019-12-02	23:16	07:31	08:13	06:22	01:51	77.4	49	111
2019-12-03	22:05	07:30	08:28	05:08	03:20	60.7	117	76
2019-12-04	16:40	15:00	22:10	01:31	20:38	6.9	423	65
2019-12-05	23:02	12:21	13:17	09:52	03:24	74.4	68	93
Mean	23:04	08:40	09:28	05:31	03:56	65.6	88	91

Summary 16

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-25	23:02	07:08	08:02	06:46	01:16	84.2	35	65
2019-06-26	22:12	07:45	09:31	07:01	02:29	73.8	98	73
2019-06-27	23:30	07:32	08:00	05:57	02:03	74.4	58	95
2019-06-28	00:06	08:07	07:59	06:18	01:40	79.0	38	86
2019-06-29	04:42	09:11	04:19	04:03	00:15	93.9	10	96
2019-06-30	23:07	08:43	09:34	07:47	01:47	81.4	68	70
2019-07-01	23:52	07:46	07:53	06:43	01:10	85.2	39	70
2019-07-02	23:10	07:17	08:03	05:58	02:05	74.0	37	90
2019-07-03	22:22	07:11	08:47	06:54	01:53	78.5	74	61
2019-07-04	23:45	07:15	07:29	06:02	01:27	80.7	40	78
2019-07-05	19:30	09:49	14:13	11:07	03:06	78.2	78	99
2019-07-06	21:17	15:12	17:54	08:25	09:29	47.0	22	113
2019-07-07	15:00	11:24	20:11	03:30	16:41	17.3	375	67
2019-07-08	23:46	07:16	07:26	06:32	00:53	88.0	28	92
2019-07-09	23:35	07:44	08:08	05:52	02:15	72.3	75	76
2019-07-10	23:23	14:39	15:15	06:00	09:14	39.4	313	68
2019-07-11	15:11	15:01	23:47	12:30	11:16	52.6	43	93

2019-07-12	15:01	15:25	00:24	10:42	13:41	43.9	58	79
2019-07-13	15:25	05:01	13:12	04:39	08:33	35.2	6	231
2019-07-14	15:00	12:09	20:03	00:09	19:54	0.8	193	66
2019-07-15	23:18	07:40	08:17	06:26	01:51	77.6	65	73
2019-07-16	22:40	07:43	09:01	06:56	02:04	77.0	105	57
Mean	21:24	09:24	11:53	06:39	05:14	65.2	84	86

Summary 17

Night.Starting	Sleep.Onset.Time	Rise.Time	Total.Elapsed.Bed.Time	Total.Sleep.Time	Total.Wake.Time	Sleep.Efficiency	Num.Active.Periods	Median.Activity.Length
2019-06-25	22:29	06:58	08:27	05:54	02:32	69.9	61	83
2019-06-26	23:28	06:16	06:42	05:21	01:21	79.8	17	91
2019-06-27	23:07	06:33	07:18	06:25	00:52	88.0	17	106
2019-06-28	23:45	06:05	06:18	05:30	00:48	87.3	9	132
2019-06-29	00:37	07:04	06:18	04:50	01:27	76.8	54	69
2019-06-30	23:13	06:22	07:07	05:25	01:42	76.1	17	176
2019-07-01	00:04	06:23	06:17	04:43	01:34	75.0	26	140
2019-07-02	23:13	06:18	07:00	06:52	00:07	98.1	5	59
2019-07-03	15:00	20:44	05:42	00:24	05:17	7.3	213	72
2019-07-04	22:06	07:16	09:07	06:38	02:28	72.8	76	68
2019-07-05	15:00	15:00	23:59	00:13	23:46	1.0	543	67
2019-07-06	22:19	07:24	08:58	07:51	01:07	87.5	27	115
2019-07-07	23:17	06:40	07:18	05:21	01:56	73.5	60	69
2019-07-08	23:06	06:20	07:07	06:12	00:55	87.1	25	78
2019-07-09	22:30	06:01	07:26	05:38	01:47	75.9	19	219
2019-07-10	21:21	05:45	08:21	05:53	02:28	70.4	77	84
2019-07-11	23:01	06:28	07:13	06:26	00:47	89.1	21	75

2019-07-12	23:56	06:57	06:57	06:15	00:42	89.8	32	61
2019-07-13	15:00	15:00	23:24	00:00	23:24	0.0	1	12
2019-07-14	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-07-15	23:00	07:00	00:00	00:00	00:00	0.0	0	0
2019-07-16	23:00	07:00	00:00	00:00	00:00	0.0	0	0
Mean	21:59	06:56	00:00	00:00	00:00	68.7	68	81