YOUNG ADOLESCENT SLEEP: A STUDY INTO THE RELATIONSHIP BETWEEN SLEEP, WELL-BEING, AND ELECTRONIC MEDIA USE

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Elizabeth Ann Milne

College of Science

University of Canterbury

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Abstract

Within the sleep literature there is limited data on the normative sleep patterns of young adolescents. The current study will look at the relationship between sleep patterns, well-being, and electronic media use among children of young adolescent age living in Aotearoa/New Zealand. Participants included 164 young adolescents aged 11-12 years-old from intermediate schools in Christchurch and Dunedin. Participants were required to fill out a sleep and activity diary to measure their sleep/wake patterns and electronic media use across a typical school week. Parents and teachers filled out a variety of measures to collect data on anxiety symptoms, externalising and internalising problems, peer relationships, and academic performance. Results showed a number of findings: first, nearly half of participants were taking more than 20 minutes to fall asleep and as a possible consequence were sleeping for less than the recommended nine hours; and less than 10% of children meet criteria for problematic night wakings. This suggests that young adolescents experience problems in initiating sleep rather than maintaining sleep. Second, multiple sleep variables were found to be associated with hyperactive/inattentive behaviours, pro-social behaviours, peer problems, and problems engaging in appropriate behaviours for the classroom environment. Third, exceeding the two hour recommended limit for electronic media use on mobile phones and tablet/MP3 players was associated with later sleep onset times and insufficient sleep. Computer/game console use was associated with a delayed sleep phase, whilst television viewing was only associated with later wake up times and night wakings. The results of the present study indicate that sleep is crucial for young adolescent school time well-being, with many young adolescents obtaining insufficient sleep possibly due to their use of electronic media.

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List of Abbreviations

AAP	American Psychological Association
ADHD	Attention Deficit Hyperactivity Disorder
BASC-2 PRS	Behavioural Assessment System for Children, 2nd ed. Parent rating scale
BT	Bed Time
CCDRG	Canterbury Child Development Research Group
CSP	Canterbury Sleep Programme
EMD	Electronic Media Device
EMU	Electronic Media Use
LSP	Longest Sleep Period
NSF	National Sleep Foundation
SDQ	Strengths and Difficulties Questionnaire
SE	Sleep Efficiency
SOD	Sleep Onset Delay
SOL	Sleep Onset Latency
SOT	Sleep Onset Time
TIB	Time in Bed
TST	Total Sleep Time
WUT	Wake up Time
RT	Rise Time

Overview of Thesis

There has been a rapid growth in investigations into sleep behaviours within the field of human development and functioning, as sleep has been shown to be important to everyday well-being and adaptive functioning. The current study investigates the relationship between sleep patterns, well-being, and electronic media use among children of young adolescent age (11-12 years-old) living in Aotearoa/New Zealand. Young adolescence is classified as between the ages of 9-13 in the current study and literature review. Throughout the thesis if the term child/children is used this will refer to children younger than this age, and adolescents/adolescence will refer to children older than this age range.

Important to our understanding of what constitutes good sleep is an integrative approach exploring the influence of factors that may lead to children and adolescents failing to meet their sleep needs and the outcomes of insufficient sleep. The use and availability of personal media devices (e.g., computers, tablets, mobile phones) has increased over recent years and has become a normal part of everyday life for children, adolescents and adults (Statistics NZ, 2013; Prime Minister's Chief Science Advisor Report [PMCSA], 2011). Contemporary devices are now personal, portable, and interactive, meaning that young people can now have their personal device(s) on them at all times and be available for contact with others continually. As electronic media becomes more prevalent in the lives of children and adolescents, research studies suggest this may negatively impact on children and adolescents sleep patterns. In particular, given that young adolescence is a critical period of development where major biological changes are taking place (i.e., puberty) research suggests that this age group is particularly vulnerable to the negative outcomes of receiving insufficient sleep, in particular socio-emotional and behavioural problems, mood disturbances, impaired cognitive functioning, and reduced academic performance (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010; Johnson, Chilcoat, & Breslau, 2000; Soffer-Dudek et al., 2011).

Chapter One describes and reviews the literature on normative child and adolescent sleep, with the intention to provide evidence that the target population is at risk for insufficient sleep. The review provides i) an operational definition of the population of interest and their sleep behaviours; ii) to describe theory on the role of sleep in the context of developmental literature; iii) to describe the development of sleep patterns from infancy through to adolescence; iv) to review the sleep literature on the developmental period of young adolescent; v) to provide an operational definition of problematic sleep, and to finally describe the various measures used in sleep research with youth.

The second chapter of this introduction is devoted to reviewing the literature on functional outcomes of poor and insufficient sleep. It will describe empirical findings relating to socio-emotional and behavioural adjustment for each of the following domains of functioning: internalising behaviours, externalising behaviours, interpersonal relationships, and academic achievement, with a particular emphasis on the young adolescent developmental period where possible.

In Chapter Three, the literature about electronic media and its association with children and adolescents sleep is reviewed. The prevalence of electronic media in the everyday lives of youth will be described, followed by the American Academy of Paediatrics recommendations (AAP; Hirshkowitz et al, 2015). Electronic media access in the bedroom and pre-bedtime use will be discussed, alongside the impact of specific electronic media devices and overall screen time on sleep.

Chapter One

Sleep

1.1. Definitions of Main Terms in Developmental Sleep Literature

Studies that address the sleep of children and adolescents often fall into two categories: those that aim to describe normal sleep and those that explore problematic sleep. This introduction reviewing sleep/wake patterns is based on clear and definable operational definitions of sleep variables of use in both domains. It provides an overview of terms used in the developmental sleep literature and a definition of how they are used within this thesis. As this research is conducted as part of the developmental arm of the Canterbury Sleep Programme (CSP) it will follow terminology used by the CSP. The terms used will be compared to similar terms in the literature, because several key terms have been defined differently by researchers within the field (Henderson, 2001). Where discrepancies arise, a rationale for the utilised terminology will be provided.

1.2. Terms Used in Studying the Development of Normal or Problematic Sleep

1. *Bed time (BT).* The time a child goes to bed.
2. *Sleep onset latency (SOL).* This is the duration (in seconds or minutes) it takes for the child to fall asleep and is measured from when the child tries to initiate sleep (often noted as the time children turn out the lights in diary measures) to sleep onset. Within the literature, a long SOL or sleep onset delay (SOD) for children and adolescents is defined as either 20+ or 30+ minutes, depending on researchers' criteria and measures used. For example, if studies employ the Children's Sleep Habit's Questionnaire (CSHQ; Owens, Spirito, & McGuinn, 2000) >20 minutes is considered a long SOL (Canet, 2010), whereas the School Sleep Habits Survey (SSHS; Wolfson & Carskadon, 1998) considers difficulties falling asleep to be >30 minutes. A recent

review found the SSHS to be the most popular sleep questionnaire used (Gradisar, Gardner, & Dohnt, 2011).

3. *Sleep onset time (SOT).* Time child falls asleep (normally reported in 24hr clock time – e.g., 9.30pm = 21.30hr).

4. *Night wakings (NW).* Night wakings count the frequency of awakenings occurring at any time from the initial onset of sleep to the final awakening time in the morning. It includes both the duration and number of night wakings. Problematic night awakenings have been defined as 30 minutes in duration and more than 3 night wakings a week (American Academy of Sleep Medicine [AASM], 2014; APA, 2013; Kahn et al., 1989; Smedje, Broman, & Hetta, 2001[b]).

5. *Wake up time (WUT).* Final awakening time in the morning (expressed in 24hr clock format).

6. *Rise time (RT).* Time child rises from bed for daily activities (in 24hr clock format).

7. *Time in bed (TIB).* A measure of the total time spent in bed both awake and asleep over the 24 hour period. TIB is the duration between bedtime and rise time.

8. *Total sleep time (TST).* A measure of the number of hours and minutes slept over a 24 hour period (Galland, Taylor, Elder, Herbison, 2012; Buysse, 2014). TST and sleep duration are terms used interchangeably. A recent review found that TST/sleep duration was the most common sleep measure, used in 82% of articles (Galland et al., 2012).

9. *Longest sleep period (LSP).* The longest period of sustained sleep between one awakening and the next. It measures the person's ability to sustain a long period of unbroken sleep (i.e., continuous sleep) and is used as a measure of sleep consolidation (Henderson, France, & Blampied, 2011). The measurement period begins with the

onset of any sleep episode and is terminated by any transition into wakefulness. The LSP is more often than not used only in research on infant sleep as "the longest sleep period is not a variable of interest once night time consolidation has been reached; thus data beyond 2 years of age are rare" (Galland et al., 2012. p. 220). However, some extant literature has begun reporting this variable for older age groups (Sadeh, Raviv, & Gruber, 2000) as the developmental process of sleep consolidation is directly linked to night wakings (Mindell, 1993). Developmentally, the night waking phenomenon is expected to gradually decline with age as sleep is consolidated, but substantial objective and subjective findings beyond early childhood to support this expectation are lacking (Sadeh et al., 2000). Thus, the LSP is an informative variable to the night waking phenomenon in young adolescence (Sadeh et al., 2000) and problems with sleep maintenance seen in those with insomnia.

10. *Sleep efficiency (SE).* The percent of time spent asleep whilst in bed. The formula used is SE = TST ÷ TIB × 100. SE can be used as a primary measure of sleep quality because it can be quantified using a unit of time (Akerstedt, Hume, Minors, & Waterhouse., 1994). SE is closely related to subjective sleep quality and is central to our understanding of "good sleep," because one would expect a subjectively good sleep to be one that contained sufficient sleep without awakening (Akerstedt et al., 1994). Scores equal to or above the 90^{th} percentile are considered to be healthy for this age range (Sadeh et al., 2000). Falling below 90% has been suggested to be characteristic of poor sleep in children (Sadeh et al., 2000). However, this may be stringent as actigraph was used. Less than 85% is considered problematic in adults.

1.3. Definitions of the Development Period Young Adolescence (9-13 years-old)

For the purpose of this research and literature review, the young adolescent period is defined as being between 9-13 years of age. The National Sleep Foundation's (NSF) age banding of developmental stages for sleep recommendations has been utilised in this review with the addition of a ‘young adolescence’ age band. Within the NSF recommendations, the ‘young adolescent’ age group falls into the more general ‘school aged children’ category (6 to 13 years; Hirshkowitz et al., 2015). International literature specifically considering young or pre-adolescent sleep deals with participants with age ranges between 9-14 years of age. There is however no consensus in the literature to arrive at a clear definition for this age group. We tried to encompass the developmental period that falls between middle childhood and adolescence as it is a critical developmental period that prepares children for adolescence and later adulthood (Dingham & Rowe, 2007). This research is confined to the period of young adolescence because:

1. There is substantial evidence to suggest that sleep behaviour during this time period differs from both middle childhood and later adolescence. Carskadon et al., (1993, 1998) propose that between the ages of 10-14 youth are particularly vulnerable for sleep problems resulting from psychosocial influences and changes in the bio-regulatory systems controlling sleep.
2. The schooling system in New Zealand is unique relative to other countries in that children in this age range may attend an intermediate school (as distinct from primary [elementary] and secondary school) resembling but not identical to junior high school, which is a distinct form of schooling that bridges the transition from primary school to high school (Dinham & Rowe, 2007). Although some primary, intermediate, and high schools are integrated together to varying degrees in contemporary NZ. Nevertheless in intermediate classes, not only will young adolescents encounter new teachers and new peer groups during these schooling years, but intermediate schooling is structurally different to primary schooling and also introduces a new curriculum called National Standards that carries on to high

school level education. This makes the transition from primary to intermediate school a big change in most children's experience of school. Research on whether students find this transition to be a difficult one or a welcomed change has been inconclusive so far (Dingham & Rowe, 2007).

3. Although a number of international studies have investigated young adolescent sleep and highlighted the importance of this specific developmental stage, limited data exist on the sleep of New Zealand young adolescents (Foley, Maddison, Jiang, Marsh, Olds, & Ridle, 2013; Landhuis, Poulton, Welch, Hancox, 2008). New Zealand and international literature does not always differentiate the young adolescent period from middle childhood or later adolescence.

1.4. The Role of Sleep

Sleep plays an important role in the regulation and preparation of emotional and cognitive brain processes (Walker, 2009). Behaviourally, sleep presents as a state of decreased responsiveness and interaction with external stimuli, yet physiologically, sleep is not simply rest but an active process for various brain regions which show the same or increased activity during wakefulness (Dahl & Lewin, 2002). Sleep is primarily a brain phenomenon that is made up of various sleep stages controlled by numerous neurological mechanisms (Walker, 2009). Sleep architecture (viz., the patterns of activity in the brain revealed by electroencephalography [EEG]) is broadly grouped into two distinct types of sleep: rapid eye movement (REM) sleep, and non-rapid eye movement (NREM) sleep, the latter of which is further divided into four substages (1-4) corresponding to depth of sleep (Peigneux, Urbain, & Schmitz, 2011). Different patterns of brain activation and reduced activation are associated with NREM and REM sleep that can potentially support the modulation, regulation, and preparation of numerous brain functions. There are multiple theories concerning the role of sleep and why humans (and other animals) need sleep. These are not necessarily mutually exclusive, but highlight the vast range of neural processes implicated in the brain's "daily transit through sleep stages," (Walker, 2009. p.170). Theories on the supportive role of sleep in sustaining behaviour as well as cognitive and emotional processing in normal child development will be described and these theories primarily follow from Astill and colleagues (2012) review on the role of sleep in cognitive and behavioural problems.

First, the *trace reactivation* or *replay* theory (Born & Wilhelm, 2012) proposes that sleep aids memory consolidation by the reactivation of neuronal activity patterns that encode information during the prior waking period (Astill, Van der Heijden, Van Ijzendoorn, & Van Someren, 2012). Simply put, this promotes consolidation, enhancement, and reorganisation of explicit memory processes. There is evidence that both REM and NREM sleep play important roles in memory consolidation. REM sleep is thought to be implicated in procedural learning (Stickgold, Hobson, Fosse, & Fosse, 2001) while NREM sleep may assist in declarative memory consolidation. The developmental role of memory consolidation is important for our ability to learn and remember new information.

Second, the *synaptic homeostasis* theory proposes that sleep is necessary to offset the increase in synaptic connectivity that occurs when learning during wakefulness (Tononi & Cirelli, 2006). This downscaling prevents synaptic overload of neocortical and limbic systems. Sleep deprivation, in turn, predicts cognitive and emotional impairments because synaptic overload should cause metabolic overload, neuropil crowding, and a reduction in capacity for plastic change (Tononi & Cirelli, 2006). Tononi and Cirelli (2006) suggest that functional impairments found in individuals with primary insomnia such as fatigue, difficulty concentrating, cognitive impairment, and irritability, may be a result of impaired synaptic homeostasis. Frank and Benington (2006) argue that if sleep contributes to synaptic plasticity, then this is especially true for young, developing individuals. Sleep requirements are higher for maturing versus fully mature individuals and seems to be particularly important during periods of brain maturation and development (Dahl & Lewin, 2002).

Third, the *overnight therapy* hypothesis (Walker & Van der Helm, 2009) proposes that the role of sleep is to maintain optimal emotional reactivity and emotional information processing, resulting in sleep deficits presenting as externalising and internalising problems (Astill et al., 2012). For example, sleep loss effects the consolidation of positive emotional memories but not negative memories which are more resistant to sleep deprivation (Walker & Tharani, 2009 as cited in Walker & Van der Helm, 2009), creating an imbalance in negative emotional memory dominance. Furthermore, participants subjected to sleep restriction over a one week period showed a progressive increase in emotional disturbance (Dinges et al, 1997 as cited in Walker & Van der Helm, 2009). Taken together, sleep may be a preferential time in which emotional memories and affective states are consolidated and modulated.

1.5. Sleep Development Across Childhood

Infants, children, and adolescents all have different sleep needs with developmental age related processes influencing sleep regulation. This section will discuss the development of sleep patterns from infancy through to adolescence and pay particular attention to the developmental trajectory of the young adolescent period.

1.5.1. New-borns, infants, toddlers, and pre-schoolers (0 months-5 years).

Over the first few weeks of life, new-borns have a total sleep time of approximately 16 hours which continuously decreases over development. Night time sleep consolidates between 2-12+ months of age, with infants sleeping longer stretches at night and decreasing daytime naps from four to one per day (Henderson et al., 2011; Iglowstein, Jenni, Molinari, & Largo, 2003; Mindell & Owens, 2015). Toddlers (aged 1-3 years) typically sleep for 12 hours per day including naps (Mindell & Owens, 2015), and pre-schoolers (3-5 years) typically sleep on average 9-10 hours during the night and progressively eliminate daytime naps

(Mindell & Owens, 2015). The toddler and preschool years are typically associated with a decrese in night wakings, however most children experience at least one night waking a week to which their parents are alerted (Goodlin-Jones, Sitnick, Tang, Liu, & Anders 2008). The establishment of consistent sleep schedules is important at this age to regulate the sleep-wake schedule and preparing children for school time routines (Mindell & Owens, 2015).

1.5.2. School aged children (6-13 years) including young adolescents (9-13 years).

School age children are recommended to have 9-11 hrs of night time sleep (Hirshkowitz et al., 2015) and are expected to spontaneously and consistently wake early in the morning irrespective of school schedule (Carskadon, Viera, & Acebo, 1993). A recent review of international literature reported that children are meeting the lower end of this duration recommendation with a mean of 9.2 hours of sleep (range 7.6 to 10.8 hours; Galland et al., 2012). Due to the large age band for the school-age period, this information does not capture the developmental changes in sleep behaviours, i.e., the sleep patterns of a 6 year-old is quite different to that of a 12 year-old (Sadeh et al, 2000; NSF, 2004; 2006). Longitudinal studies have reported overnight sleep duration gradually declining by nearly an hour over childhood, with children age 6 sleeping on average 9.8 hours compared to age 10 sleeping for 9.1 hours (NSF, 2004). Sleep duration further decreases noticeably over the young adolescent period between ages 10-12 with children sleeping on average 8.5 hours of sleep during 6th grade (11-12 years; NSF, 2006; Anders, Carskadon, Dement, 1978), resulting in a difference of nearly 2 hours difference between 6 and 12 year-olds. This decrease in sleep duration results from a delay in bedtime and consequent sleep onset coupled with wake up time remaining stable during the routine school week across ages (Sadeh et al., 2000; Spruyt, O'Brien, Cluydts, Verleye, & Ferri, 2005; NSF, 2004). This is referred to as sleep phase drift and there is ample evidence documenting a developmental delay of later sleep onset associated with puberty that begins during young adolescence (Carskadon et al., 1993; Dorofaeff & Denny, 2006; Gardisar, Gardner, & Dohnt, 2011; Laberge et al., 2001; Thorleifsdottir, Bjornsson, Benediktsdottir, Gialason, & Kristbjarnarson, 2002; Spruyt et al., 2005; For a full description and review see Crowley, Acebo, & Carskadon, 2007). Evidence for this hypothesis has been demonstrated in studies investigating adolescent pubertal status (Andrade, Benedito-Silva, Domenice, Arnhold, & Menna-Barreto, 1993; Carskadon et al, 1993; Carskadon, Acebo, & Jenni, 2004; Carskadon, Acebo, Richardson, Tate, & Seifer, 1997).

1.5.3. Adolescents (14-17 years).

In an experimental paradigm, Carskadon and colleagues (1983, as cited in Carskadon 2011) found that adolescents with unrestricted nocturnal sleep opportunities slept on average over 9 hours. This is in stark contrast to the results of a recent meta-analysis reporting that adolescents worldwide typically experience less than 8 hours of sleep on school nights (Gradisar et al., 2011). During adolescence, sleep duration continues to decline with age at a rate of 14 minutes less per year (Olds, Blunden, Petkov, & Forchino, 2010). The NSF's (2006) recent sleep poll reported that 8th graders (13-14 years) obtain 8.1 hours of sleep compared to 12th graders (17-18years) who obtain 6.9 hours of sleep on school nights. Amounts of sleep reported by adolescents vary across countries, yet the overall pattern of later sleep timing and reduced sleep duration is reported by most investigators (Carskadon, 2011).

Alongside biological factors, a number of environmental factors have been associated with this age related change in bedtime and sleep duration. Much of the literature concentrates on the issue of school start times as the main contributor to sleep restriction in adolescence (Carskadon, 1990; Colrain & Baker, 2011). Yet this pattern is also evident in countries with later school starting times and when sleep duration is measured during the weekend or when youth are on vacation and unconstrained by school schedules (Crowley et al., 2007; Spruyt et al., 2005). Other environmental factors that may partly drive a shift in sleep timing are parental influence on bedtimes (Carskadon, 1990; NSF, 2006; Russo, Bruni, Lucidi, Ferri, & Violani, 2007), increased homework, extra-curricular activities, part-time employment (Carskadon, 1990; Crowley et al., 2007) and stimulating activities that affect bedtime and sleep onset such as electronic media use (Carskadon, 2011; Crowley et al., 2007; Cain & Gradisar, 2010). Ultimately, the biobehavioural shift of sleep patterns does not represent a lower need of sleep, but most likely arises from a convergence of biological and socio-cultural influences (Carskadon, 2011). Parents, paediatricians, and school teachers alike have long mistakenly assumed that this sleep decline is an inevitable part of growing up and a normative expectation (Carskadon, 2011).

1.6. Normal Sleep in Young Adolescents

This section summarizes the worldwide extant literature describing sleep norms with particular emphasis on young adolescent sleep.

1. *Bedtime.* Reported bedtime for 11-12 year-olds is variable, with bedtimes falling between 20:46 and 22:59 pm. Belgium (Spuyt et al., 2005) and Canadian (Laberge et al., 2001) children go to bed around 21:00, whereas Spanish (Canet, 2010), Australian (Dollman, Ridley, Olds, & Lowe, 2007), North American (Lee, Mcenany, & Weekes, 1999), Italian (Russo et al., 2007), and Korean (Seo et al., 2010) adolescents go to bed more than an hour later.
2. *Sleep onset latency.* The time it takes young adolescents to fall asleep has been reported in a multitude of ways. Canet (2010) reported 58% of Spanish children took longer than 20 mins to fall asleep. This is comparable to Italy (Russo et al., 2007) where 46% of 11 year-olds and 38% of 12 year-olds took < 16 mins to fall asleep, and

20% of 11 year-olds and 15% of 12 year-olds took more than 30 mins to fall asleep. Reported mean SOL ranges from 12-25 mins (Seo et al., 2010; Spruyt et al., 2005).

3. *Sleep onset time.* The time young adolescents' fall asleep has only been reported to date by two articles that this author is aware of. Sadeh et al., (2000) reported a SOT of 22.7 for Israeli 11-12 year-olds, and Foley and colleagues (2013) reported New Zealand 5-12 year-old girls falling asleep between 19:41-22:03pm and boys falling asleep between 19:38-22:02pm.

4. *Time in bed.* Two studies have reported TIB as derived from BT and WT measures (Leberge et al., 2001; Meijer et al., 2001). Meijer et al (2001) found 9-13 year-olds from the Netherlands spent 616 mins or 10.3 hours in bed. Canadian 11 and 12 year-olds spent 612 mins and 596 mins in bed, or 10.2 hours and 9.9 hours, respectively (Laberge et al., 2001).

5. *Total sleep time.* Young adolescents were found to obtain between 7.5 to 10.8 hours of TST during weekdays, with Spanish young adolescents sleeping on average around 9 hours of sleep (Canet, 2010). Belgian and Swiss youth obtain longer than 9 hours of total sleep (Iglowstein et al., 2003; Spruyt et al., 2005), and New Zealand 11 year-olds reported 10.8 hours of TST on average (Landhuis et al., 2008). Icelandic, Israeli, Korean, Italian, and Australian youth obtain less than 9 hours of sleep (Dollman et al., 2007; Russo et al., 2007; Sadeh et al., 2000; Seo et al., 2010; Thorleifsdottir et al., 2000). North American data are variable, with studies ranging from 8.4 hours (NSF, 2006) to 9.4 hours (Tarokh & Carskadon, 2010).

6. *Longest sleep period.* Only one study has reported young adolescents' longest sleep period. Sadeh and colleagues (2000) reported that 6^{th} graders' LSP was 184 minutes or 3.1 hours for boys and 195 minutes or 3.3 hours for girls.

7. *Wake up time*. Studies have found that young adolescents WUT ranges from 6:50 to 7:51am. Most youth wake up around 7am, with the exception of Spain and Korea where wake up time was much later by around 20-40 minutes (Canet, 2010; Seo et al., 2010).

8. *Sleep efficiency.* Studies on young adolescents in Finland, Israel, and Belgium have reported SE percentiles as 93%, 94%, and 95%, respectively (Aronen, Paavonen, Fjällberg, Soininen, & Törrönen, 2000; Sadeh et al., 2000; Spuyt et al., 2005). In one USA longitudinal study SE was 89% for 10 year-olds and 88% for 13 year-olds (Kelly & El-Sheikh, 2014).

9. *Gender.* Gender differences have not been reported during weekday sleep for children and young adolescents (Canet, 2010; Laberge et al., 2001; Russo et al, 2007; Spuyt et al., 2005). It is hypothesised that gender differences in sleep behaviours emerge with the onset of puberty (Canet, 2010; Russo et al., 2007; Spuyt et al., 2005).

10. *Sleep environment and bedtime rules.* Seventeen percent of 9-13 year-olds share a bedroom (Meijer et al., 2001) although Blader et al., (1997 as cited by Spuyt et al., 2005) have reported that room sharing is not associated with higher prevalence of sleep problems. Nine percent were allowed to decide when they went to bed and 77% could decide when to turn out the lights (Meijer et al., 2001).

1.7. Sleep Recommendations

The NSF (Hirshkowitz et al., 2015) recently introduced new age specific sleep recommendations to accommodate individual variability in sleep duration (see Table 1). These changes acknowledge that individuals may experience longer or shorter durations of sleep than the recommended times with no adverse effects (Hirshkowitz et al., 2015). The new extended hours outline what may be appropriate for individuals to obtain sufficient durations of sleep. However, individuals with outlying sleep durations exceeding the recommended and extended ranges may experience serious psychosocial health problems (Hirshkowitz et al., 2015). Currently, sleep duration is the only sleep behaviour with a recommendation offered by the NSF.

Table 1.

National Sleep Foundation Age Specific Sleep Duration Recommendations

Developmental Stage	Recommended hours of sleep	Outside recommended hours, but may be appropriate
New-borns (0-3 months)	14-17 hrs	11-19 hrs
Infants (4-11 months)	12-15 hrs	10-18 hrs
Toddlers (1-2 years)	11-14 hrs	9-16 hrs
Pre-schoolers (3-5 years)	10-13 hrs	8-14 hrs
School aged children (6-13 years)	9-11 hrs	7-12 hrs
Teenagers (14-17 years)	8-10 hrs	6-11 hrs

Note. Adapted from “National Sleep Foundation’s sleep time duration recommendations: methodology and results summary, Hirshkowitz et al., 2015, *Sleep Health*, p.41.

Alongside these recommendations, finer distinctions for adolescents have been created and used for research purposes, including optimal (more than 9 hours), borderline (between 8 to 9 hours), and insufficient durations of sleep (less than 8 hours; Gradisar et al., 2011; NSF, 2006; Short et al., 2013).

1.8. Sleep Problems

1.8.1. Definitions of sleep problems.

Within the general sleep literature, the term “sleep problems” is synonymous with and has been used interchangeably with “sleep disturbance” and there is disagreement as to the best way to conceptualise sleep problems in children (Gregory et al., 2009). Operational definitions of sleep problems are often based on criteria for formal sleep disorders such as insomnia and delayed sleep-wake phase disorder. However, there is a lack of specificity of definitions in the DSM-5 (American Psychiatric Association [APA] 5th Edition, 2013) and the ICSD-3 (AASM 3rd edition, 2014) around defining what constitutes a sleep disorder, which poses a problem for researchers. Additionally, there are no age specific criteria for sleep problems across development. Aspects of young adolescent sleep included in this area of literature are not thought to be abnormal or pathological. Instead, they are aspects of normative sleep behaviours which are considered troublesome or problematic and can be considered along with other behavioural problems. Sleep problems either refer to:

1. Sleep-wake behaviours conceptualized along a continuum (El-Sheikh, Kelly, Buckhalt, Hinnant, 2010). For example, sleep problems include shorter sleep durations (i.e., less than the recommended nine hours sleep; Hirshkowitz et al., 2015).
2. Subjective sleep problems reported by the individual. For example, self-reported difficulty falling asleep or individuals reporting they are a “poor sleeper.”
3. A composite score of overall sleep problems. These often include combined measures to create an overall composite score of an individual’s sleep problems (Kahn et al., 1989; Sadeh et al., 2000).

1.8.2. Prevalence of sleep problems.

There is a high prevalence of sleep problems in healthy school children ranging between 43% and 62% (Kahn et al., 1989; Spuyt et al., 2005). Difficulties in initiating and maintaining sleep are relatively common in young adolescents. Laberge and colleagues (2001) reported that 60% of 10-13 year-olds experienced difficulty falling asleep at least sometimes. Prevalence rates for a SOD range from 10-19% in children and young adolescents (Canet, 2010; Paavonen, 2000; Wiater et al., 2005) and SOL appears to be a significant sleep-wake parameter influencing the odds for further sleep problems, such as bedtime resistance (Spuyt et al., 2005). It has been suggested that night-waking remains stable across development from childhood to young adolescence, contrary to common beliefs (Sadeh et al., 2000). Studies employing parent reports indicate that 9% of 11 and 12 year-olds frequently wake at night (Laberege et al., 2001), and self-reports indicate that 6% of 8-11 year-olds had problems sleeping through the night (Wiater et al., 2005).

In general, 56% of 11-12 year-olds are reported to not get sufficient sleep (Canet, 2010) and those who are reportedly poor sleepers have shorter total sleep duration (Kahn et al., 1989). A New Zealand study found that 21% of students (aged 14-18) reported not getting enough sleep (Dorofaeff & Denny, 2006). Children who get less than the recommended amount of sleep are more likely to experience longer SOL, difficulty falling asleep, and waking too early in the morning (NSF, 2004).

A number of studies have reported the prevalence of poor sleepers in young adolescents. Rona and colleagues (1998) found that according to parents 12% of 11 year-old boys and 15% of girls were poor sleepers. Whilst 12% of 17 year-old males and 19% of females subjectively reported themselves as poor sleepers (Manni et al., 1997) Studies classifying poor sleep from multiple sleep variables have reported 14% of young adolescents (Kahn et al., 1989) and 17% of 7-11 year-olds to be considered poor sleepers (Sadeh et al., 2000). Prevalence rates of poor sleep in young adolescents and older adolescents appears consistent across studies, despite employing different operational definitions and measures of poor sleep.

1.9. Measurement of Sleep in Children and Adolescents

Adolescent sleep can be measured by objective measures, daily diaries, and subjective assessments. The two objective measures of sleep are polysomnography and actigraphy. These methods have a number of advantages to do with the objective nature of data collection and analyses. First, *polysomnography* (PSG) is considered to be the gold standard measure of sleep, as it provides in depth information on sleep stages. However, due to the financial expense, and the intrusive and labour intensive nature of PSG, it is seldom used with children and adolescents (Montgomery-Downs, O'Brien, Gulliver, & Gozal, 2006). Second, *actigraphy* is more common in sleep research with children and adolescents from healthy populations, and has been validated against PSG across development (Horne & Biggs, 2013). However, actigraphy does not measure actual sleep but rather infers sleep from activity level, meaning it cannot distinguish between quiet wakefulness (i.e., lying still in bed) and sleep (Horne & Biggs, 2013). Additionally, any movement during sleep may be recorded as wakefulness (Short, Gradisar, Lack, Wright, & Carskadon, 2012). Nevertheless, there has been an increase of its use in the paediatric literature (Horne & Biggs., 2013), and it has been found to be reliable in characterising normal sleep, and monitoring circadian rhythm patterns or disturbances in children and adolescents (Littner et al., 2003).

Sleep diaries, questionnaires, and interviews provide valuable information on child and adolescent sleep behaviours, subjective appraisals, and beliefs. These are commonly used in studies assessing sleep and are either completed by parents or children themselves depending on age. First, *questionnaires* are cost effective and easy to use in large scale surveys to evaluate sleep quantity, quality, and disturbances and are the most common means of collecting data on children's sleep to date. Questionnaires have been found to be valid and reliable methods in collecting sleep data, and three validated and widely used sleep questionnaires for children and adolescents are the Paediatric Sleep Questionnaire (PSQ; Chervin, Hedger, Dillion, & Pituch, 2000) and the Children's Sleep Habits Questionnaire (CSHQ; Owens, Spirito, & McGuinn, 2000), and the SSHS (Wolfson & Carskadon, 1998; Wolfson et al., 2003).

Secondly, *sleep diaries* measure typical sleep behaviours over a number of days. They are low cost, easy to administer, and able to capture weekday and weekend data (Meltzer, Mindell, & Levandoski, 2007). They are widely used in clinical and research settings and have been found to have high internal consistency and reasonable face validity (Corkum, Tannock, Moldosky, Hogg-Johnson, & Humphries, 2001). Wolfson et al (2003) compared self-report sleep diary, retrospective survey, and actigraphy in 13-19 year-olds and found results to be comparable across all three measures for weekdays. Sleep diaries are reported to have high sensitivity and specificity (92.3% and 95.6%, respectively; Rogers, Caruso, Aldrich, 1993). Self-report diaries are often used when assessing sleep/wake patterns, and have been found to be effective in discriminating between adolescents who reported a sleep problem and subsequent fatigue compared to those who did not (Short et al, 2012). This suggests that sleep diary data may be better at predicting functional outcomes of sleep problems and fatigue compared to actigraphy reports (Short et al., 2012). Although sleep diaries are not without their limitations, they provide a cost effective method to obtain a "snapshot" of sleep-wake information with a certain level of accuracy (Horne & Biggs, 2013).

1.10. Limitations in The Current Sleep Literature

Some limitations within the sleep research literature to date are within the means of the current study to take into consideration and improve upon. Few studies have examined the sleep patterns of young adolescents in a New Zealand population, with studies employing wide age ranges and not differentiating this particular critical period of development (Foley et al., 2013; Landhuis et al, 2008). Two New Zealand studies examined seven year-old children's sleep patterns (Nixon et al., 2008; Nixon et al., 2009), and one examined adolescents' sleep duration (Dorofaeff & Denny, 2006). Taken together, there is a lack of available information pertaining to New Zealand youths' sleep in general. Although a number of international studies have investigated young adolescent sleep, there remains a lack of comparable data compared to other age ranges.

Methodological limitations to consider have been reported by Short and colleagues (2013) who have identified three main limitations in relation to the measurement of sleep in research. This informed how the current study measured young adolescent sleep. First, across research in children and adolescents there is a lack of comprehensive data across a range of sleep parameters. The most popular sleep measurements are BT, TST, and WT which are often derived from questionnaires To address this issue the current study will use a self-report sleep diary, which allows for a wealth of data on multiple sleep parameters, identified in this review, to be collected over an entire school week (i.e., SO, SOL, TIB, LSP, & SE etc.).

Secondly, Short and colleagues (2013) report that studies often define school sleep as Monday morning through to Friday night, when in fact the school period is technically Sunday night through to Thursday night. Using this definition for the school week will result in a more accurate measure of sleep patterns as influenced by the schooling routine. Differentiating between children and adolescents' sleep pattern on weeknights and weekend nights is important as studies have found that sleep patterns differ between school nights and weekends, with bedtimes being more than two hours later and adolescents obtaining longer sleep durations in the weekend (Carskadon, 2011; Gradisar et al., 2011). Thirdly, some investigators employing diary and questionnaire measures calculate TST from bedtime to wake time without taking into account sleep latency or night time wakings therefore creating an inflated estimate of sleep duration (Gradisar et al., 2011; Short et al., 2013).

Additionally, operational definitions of sleep problems, and poor sleep are differently defined according to particular studies making comparability within the literature difficult. As the current study is primarily descriptive of normative sleep behaviours, it is not in the position to answer what particular factors define a sleep problem. Rather we will examine a wide range of variables that on a continuum can accumulate to becoming problematic, including a SOL of longer than 20 or 30 minutes; sleep duration of less than 9 hours; night wakings longer than 30 minutes and more than three night wakings/week; and sleep efficiency of less than 85%. We will also consider young adolescents subjective experience of whether they think they are a good or poor sleeper. Self or parent reported ‘poor sleep’ as a variable is often included in composite scores of overall “sleep problems” or “sleep quality” and is seldom reported on its own. The authors believe it will be informative to know young adolescents’ own sense of how they are sleeping, as the subjective evaluation of one’s sleep as good or poor is a defining feature in the current DSM-5 diagnosis of insomnia (APA, 2013). Taken together, the lack of sleep/wake data for young adolescents plus the small range of sleep variables often reported by parents, provides a limited picture on normal healthy sleep in this population preceding adolescence. The current study will inform our understanding of the sleep/wake behaviours that constitute normal and problematic sleep.

Chapter Two

The Relationship of Sleep with Well-being

2.1. Internalising Behaviours

Internalising behaviours are defined as behaviours where children direct negative feelings and emotions inwards (Astill et al., 2012). There is a wealth of research assessing the associations between sleep and internalising behaviours of children and adolescents. Studies that address internalising behaviours fall into two categories: Those who use a broad "internalising" or "emotional" functioning phenotype of depressive/anxiety symptoms (Aronen et al., 2000; Johnson et al., 2000; Kelly & El-Sheikh, 2014; Nixon et al., 2007) and those who assess anxiety and depression symptoms as separate constructs (Alfano, Beidel, Turner, & Lewin 2006: Alfano, Zakem, Costa, Taylor, & Weems, 2009). Both types of studies will be considered, with an emphasis on research employing the broad phenotype, followed by research specifically focusing on anxiety symptoms.

Cross-sectional studies have also provided robust findings on associations between sleep and internalising symptoms in school aged children and young adolescents (Aronen et al, 2000; Paavonen, Solantaus, Almqvist, & Aronen, 2003; Wiater et al., 2005). Shorter sleep durations in particular have been associated with teacher and parent reports of internalising problems (Aronen et al., 2000; Nixon et al., 2008). Twelve year-old children with self-reported sleep problems were rated higher in emotional problems by their teachers, and with a significant risk for clinically significant anxiety and depressive symptoms (Paavonen et al., 2003).

Developmental cumulative effects of sleep problems have been identified in longitudinal research where the longer a sleep problem persists, the more likely a child is to present with internalising symptomology (Fredriksen, Rhodes, Reddy, & Way, 2004; Gregory & O'Connor, 2002; Johnson et al, 2000; Kelly & El-Sheikh, 2014). Johnson and colleagues (2000) have found evidence for a developmental change in the magnitude of associations between troubled sleep and anxiety/depression symptoms over time, where children at age 11 who were considered troubled sleepers had greater odds of internalising symptoms compared to children aged 6 who were also considered troubled sleepers. These studies suggest a possible developmental component (i.e., puberty) to the emergence of this relationship, whereby young adolescents are more developmentally sensitive to the effects of poor sleep (Johnson et al., 2000).

Research on the co-occurrence of sleep problems and anxiety in children and adolescence from clinical and healthy populations has increased over the last decade (Leahy & Gradisar, 2012). With 88% of clinically anxious children reportedly experiencing one or more sleep related problem (Alfano, Ginsberg, Kingery, 2007), alongside reporting later bedtimes resulting in 30 minutes less sleep than non-anxious children on school nights (Hudson, Gradisar, Gamble, Schniering, Rebelo, 2009). A link between anxiety symptoms and sleep problems and duration has also been well established in healthy community samples (Gregory, Eley, O'Connor, & Plomin, 2004; Kelly & El-Sheikh, 2014; Leahy & Gradisar, 2012; Sarchiapone et al., 2014). Sarchiapone and colleagues (2014) found an association between reduced sleep on school days and increased anxiety symptoms in a sample of 11,788 adolescents aged 14 across Europe.

2.2. Externalising Behaviours

Externalising behaviours are defined as negative emotions directed outward into disruptive behaviours (Astill et al., 2012). Compared to the large number of investigations on the relationship between sleep patterns and internalising behaviour, little attention has been extended to the relationship between sleep and mild to moderate (non-clinical) levels of externalising behaviour including aggression, conduct disorder, delinquent, and hyperactivity/inattentive symptoms in young adolescents. However, researchers have concluded that associations between insufficient sleep and externalising symptoms do exist for children and adolescents (Astill et al., 2012). Three sleep variables including sleep duration, sleep quality, and sleep problems have been implicated in the association with externalising symptoms in children and adolescents so far. Reduced sleep has been reported to be associated with higher conduct problems in 14 year-olds (Sarchipone et al., 2014). Worse sleep quality has been associated with delinquent and aggressive behaviour problems in 13-15 year-olds (Meijer et al., 2010), and 8-11 year-old children identified with sleep problems by parents have greater risk of hyperactivity/inattentive symptoms and conduct problems (Wiater et al., 2005).

Longitudinal studies have reported that pervasive sleep problems predict externalising problems (Gregory & O'Connor, 2002; Kelly & El-Sheikh, 2014). Gregory and colleagues (2004) reported a concurrent and predictive association between sleep problems at age 3-4, and hyperactivity/inattention symptoms at age 7. It has been proposed that sleep problems may contribute to the aetiology and exacerbation of symptoms of attention-deficit/hyperactivity disorder (ADHD; Gregory & Sadeh, 2012). Compared to sleep-deprived adults who tend to show a lack of physical activity, sleep-deprived children may instead show hyperactivity even at a level mimicking ADHD symptoms (Aronen et al., 2000; Paavonen et al, 2003). Much research on hyperactive/inattentive behaviours has been conducted with clinical populations, such as children with sleep-disordered breathing (SDB; Owens, 2008). One such study reported that children with SDB were sleepier *and* more hyperactive than controls (Melendres, Lutz Rubin, & Marcus, 2004). It has been hypothesised that hyperactive behaviours of excessive motor activity could be a strategy to stay awake and alert, and hyperactivity symptoms could mask symptoms of sleep deprivation (Konofal, Lecendreux, & Cortese, 2010; Weinberg & Brumback, 1990).

2.3. Peer Relationships

Early and middle adolescence is a time where the prioritization of friends as sources of peer support begins to dominate over parental support (Helsen, Vollenbergh, & Meeus, 2000). There is a dearth of studies that specifically consider and explore peer relationship outcomes of poor or insufficient sleep. However, the small numbers that have taken social factors into account have found that a relationship does exist between the sleep and social functioning of children and adolescents. In an early New Zealand study of 13-15 year-olds, it was reported that those with sleep problems had lower social competence than those with no sleep problems (Morrison et al., 1992 as cited by Wiater et al., 2005). Wiater et al., (2005) found that children with sleep disturbances of SOD, night wakings, and daytime sleepiness had increased risk of social difficulties. In a recent study using a sample of 11,788 adolescents from 11 European countries, reduced school night sleep duration was associated with greater self-reported peer problems (Sarchiapone et al., 2014). These findings indicate the importance of additional studies in this particular area of young adolescent functioning.

Interpersonal relations differ depending on the context (i.e., school or home) and group (i.e., parents, family, or peers). Roberts and colleagues (2002) examined interpersonal functioning in 11-17 year-olds as indicated by social support, relations with parents, relations with peers, and relations at school. They found that insomnia at baseline poses a significant risk for all four indicators of interpersonal functioning, which was in a dose response manner, whereby moderate levels of insomnia increased risk for social problems which in turn increased risk of greater insomnia, indicating the complexity of the relationship between sleep and interpersonal relationships. Roberts et al., (2009) in a later study looked at reduced school night sleep duration (< 6 hours) in adolescents and whether it predicted interpersonal problems at home, with peers, and at school. Reduced sleep predicted increased interpersonal problems at school, but not at home or with peers. This is consistent with findings from studies showing short sleep duration and problems are associated with teacher rated social problems (Aronen et al., 2000; Paavonen et al., 2003). School may be a particular setting where interpersonal problems become more apparent.

2.4. Academic Performance

Sleep is a necessity for optimal levels of cognitive functioning including attention, memory, learning, and higher order executive functions (Astill, Heijden, Van IJzendoorn, & Van Someren, 2012) across the lifespan. Research suggests that sleep during adolescence plays a critical role in cognitive performance and specific higher-order and complex cognitive functions (Astill et al 2012; Dewald et al, 2010). In a recent meta-analysis, Dewald et al., 2010) reported that associations between sleep quality, sleep duration, and sleepiness with school performance were stronger in studies with younger adolescents compared to older adolescent participants. One explanation for this difference is that with maturation, adolescents experience a decrease in sensitivity to sleep deprivation and extended wakefulness (Jenni, Achermann, & Carskadon, 2005; Taylor, Jenni, Acebo, & Carskadon, 2005). In one study of interest, Fredricksen and colleagues (2004) found that 11-12 year-olds who experience shorter durations of sleep at the beginning of 6th grade exhibit lower grades overall. However, three years later at age 14, those who obtained less sleep no longer exhibited lower grades. This age period is characterised by dramatic prefrontal cortical changes which decline throughout adolescence (Casey et al., 2005) and has been suggested to explain young adolescents' higher vulnerability to poor academic outcomes from sleep restriction (Dewald et al., 2010).

The association between shorter sleep duration and poor sleep quality with students' lower grades has been documented in multiple cross sectional studies (Bruni et al., 2006; Short et al, 2013; Wolfson & Carskadon, 1998; Wong et al., 2013). While many studies accessing daytime functional outcomes of poor or insufficient sleep often use grades as a measure of academic performance, other studies have incorporated additional factors for successful academic performance, such as school perception and motivation. Bruni and colleagues (2006) found sleep disturbances were associated with lower school achievement and temperamental traits of task-orientation (the inability to focus attention and stay on task in order to reach a goal) and emotional reactivity (negative mood). Both temperamental traits are important in promoting optimal learning and achievement opportunities.

Chapter Three

Sleep and Electronic Media Use

3.1. Electronic Media Access and Use in New Zealand Households

A recent survey reported an increase in New Zealanders use of personal and household technology such as computers, mobile devices, games consoles and smart TVs, with the most notable changes occurring in domestic households (Statistics New Zealand, 2013). In 2009, it was common for one computer to be shared between family members whereas in 2012, most households had acquired multiple technology devices such as laptops, tablets, and smartphones. Rather than depending on a ‘household’ device, New Zealanders are choosing to have their own personalised devices instead. The New Zealand Broadcasting Standards Authority’s (BSA) report on children’s media use offers some insight into how children between the ages of 6-14 engage in electronic media use today (BSA, 2015). Out of 708 households interviewed, 98% of children had access to a TV, 88% had access to a personal computer or laptop, 84% had access to a stereo/radio, 79% had broadband internet access, 72% had access to a tablet, 64% had access to game consoles, and 48% had access to a smart phone. Seventy four percent of children watch TV, 52% listen to music, and 51% use the internet. Given that electronic media devices appear to engage a substantial proportion of children and adolescents’ daily lives, it is important to understand the functional impact that time spent on these devices may have on children and adolescents everyday functioning. Of particular interest to the current study is the relationship between the use of electronic media devices and sleep.

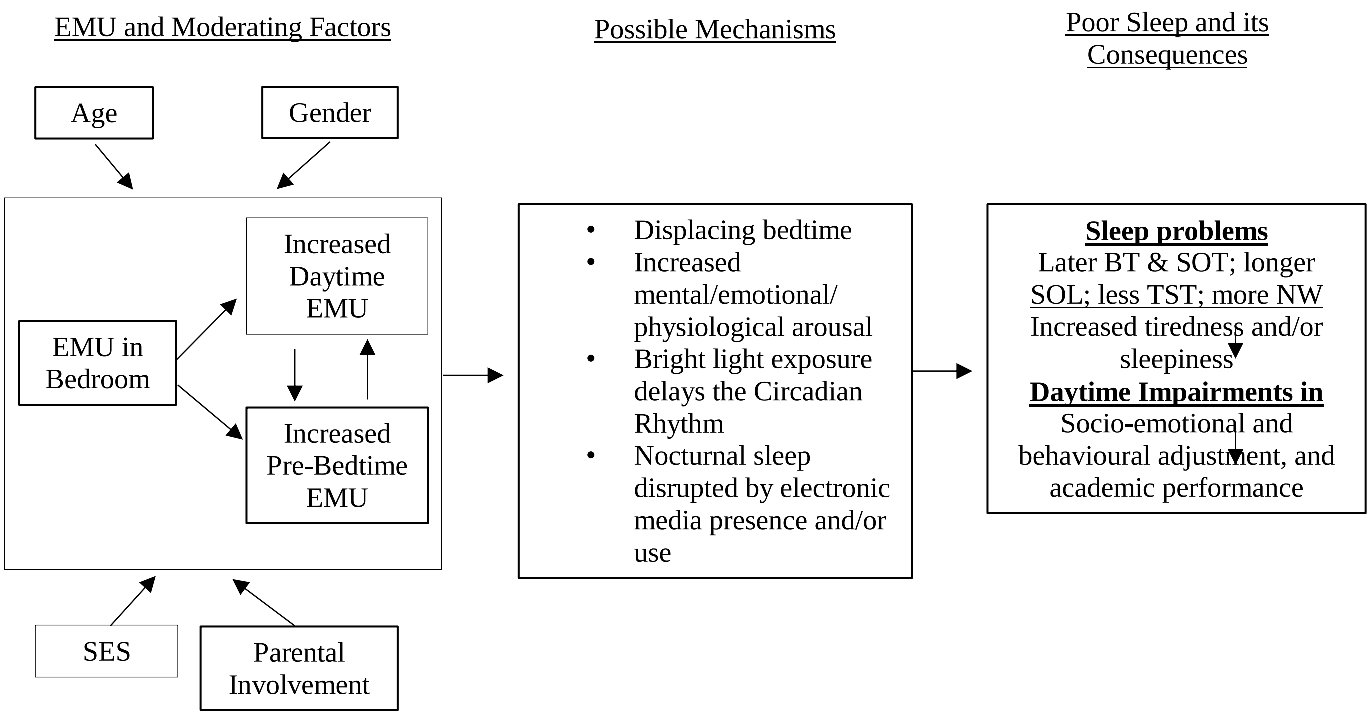
3.2. Electronic Media Use and Sleep

Any attempt to explore the negative consequences of insufficient sleep requires an investigation of factors empirically demonstrated to affect young adolescents’ quality and quantity of sleep. Healthy sleep hygiene is classified as a set of behaviours that have the propensity to be compatible with the development and maintenance of healthy sleep patterns (Bartel, Gradisar, & Williamson, 2015). It is typically associated with pre-sleep activities and routines and is a key component within treatments for sleep problems (Blampied, 2013). In a recent meta-analysis, good sleep hygiene was found to be associated with earlier bedtimes, shortened sleep onset latency, and longer sleep length (Bartel et al, 2015). Sleep related behaviours that involve electronic media use have been suggested to make up an important part of practices potentially incompatible with good sleep hygiene and thereby likely to influence sleep patterns (Gradisar & Short, 2013).

Reviews by Cain and Gradisar (2010) and Gradisar and Short (2013) propose a number of theories describing the potential mechanisms underlying the effects of electronic devices on children and adolescent sleep. Gradisar and Short (2015) state that these theories are not necessarily mutually exclusive, and mechanisms may vary in effect depending on technology use (type, timing, duration) and individual variables (age, parental influences, SES etc.). First, electronic media use may directly displace the time a child or adolescent would spend asleep (Eggermont & Van den Bulck, 2006). Because the use of electronic media devices (EMD) is an unstructured activity with no clear beginning or end point it may result in later bedtimes if used during the pre-sleep routine (Gradisar & Short, 2013). Secondly, children may become physiologically aroused when using electronic devices in the evenings, making it difficult for them to relax and experience a period of behavioural and psychological quietude before bedtime and during the sleep onset period. For example, playing computer games and using game consoles have been linked to increased physiological arousal in a number of studies (Wang & Perry, 2006; Ivarsson, Anderson, Akerstedt, & Lindblad, 2009) and listening to music has been shown to increase emotional arousal (Salimpoor, Benovoy, Longo, Cooperstock, & Zatorre, 2009). Thirdly, investigators describe the mechanism of how exposure to bright light emitted from televisions, computer screens, and mobile phones may delay the circadian rhythm by suppressing the body's production of melatonin with the consequence of delayed sleep onset (Higuchi, Motohashi, Liu, & Maeda, 2005). Taken together, these mechanisms provide an understanding of how exposure to electronic media may impact on children's sleep quantity and quality (See Figure 1).

Figure 1

Proposed model of the effects of technology use on the sleep of children and adolescents



Note. Adapted from Gradisar, M., & Short, M. A. (2013) Sleep hygiene and environment: Role of technology. In Wolfson, A. R., & Montgomery-Downs, H. E., *The Oxford Handbook of Infant, Child, and Adolescent Sleep and Behaviour*. USA: Oxford University Press. P. 123.

3.2.1. Access to electronic media in the bedroom and pre-sleep.

One particularly challenging behaviour that is incompatible with healthy sleep is children and adolescents access to and use of electronic devices in their bedrooms. Children and adolescents with one or more EMDs in their bedroom are more likely to use those devices before bedtime and after they are expected to go to sleep compared to children without them (Chahal, Fung, Kuhle, & Veugelers, 2013; Oka, Suzuki, & Inoue, 2008). In the American NSF's survey (2006), 96% of adolescents had a least one EMD in their bedroom, which is consistent with findings from New Zealand (Borlase, Gander, Gibson, 2013). Devices included music players (90%), televisions (57%), video game consoles (43%), mobiles (42%) or fixed-line telephones (57%), and computers (28%; NSF, 2008). Individual media items in children or adolescents' bedrooms have been associated with sleep disturbances. Children with a television in their bedroom have been found to have later bedtimes on weekdays and weekends, wake later on weekdays (Oka et al., 2008; Van den Bulck., 2004), and experience shorter sleep duration as well as increased bedtime resistance (Owens, Maxim, McGuinn, Nobile, & Mcall., 1999). Video games or computer presence was also found to be associated with later bedtimes both on weekdays and weekends, and shorter sleep durations (Oka et al., 2008; Li et al., 2007). Children and adolescents who have mobile phones in their bedroom run the additional risk of their sleep being disturbed by incoming text messages, calls, and social media notifications (Kubiszewski, Fontaine, Rusch, & Hazouard, 2014; Van den Bulck, 2003). A recent study found that mobile phone presence in the bedroom predicted sleep problems in a sample of 11-14 year-olds (Kubiszewski et al., 2014). Taken together, it appears that EMDs in the bedroom may detrimentally impact child and adolescent sleep patterns resulting in insufficient sleep.

3.2.2. Daytime and evening use of electronic media.

There has been a rapid increase in research examining the relationship between the technology use and sleep patterns of children and adolescents (Cain & Gradisar, 2010). It has been suggested that the increase in use of electronic entertainment and communication devices has a considerable influence on the amount of sleep obtained by children and adolescents (Cain & Gradisar, 2010). Current recommendations in New Zealand by the Ministry of Health for time spent on EMDs is less than 2 hours or 120 minutes per day for youth between the ages of 5-18 (Family First New Zealand, 2015; MOH, 2015) following The American Academy of Paediatric society recommendations (AAP, 2013). There is empirical evidence that a significant proportion of young people are exceeding this limit (AAP, 2013; Foley, Maddison, Jiang, Olds, & Ridley, 2011; Hougton et al., 2015). A recent survey on sedentary behaviour in New Zealand adolescents (10-18 years) found that on average, young people spent 181 minutes per day on screen based activities (Foley et al., 2011), which is about an hour over the recommended limit. The following section will briefly describe recent research findings on the influence of individual EMDs and overall screen time on children and adolescents sleep.

3.2.3. Specific Electronic Media Devices.

Television. A recent media use survey in New Zealand found that 9 out of 10 children aged 6-14 years old watch TV every day (BSA, 2015). Many young people watch TV in the evenings in an effort to aid sleep onset (Eggermont & Van den Bulck, 2006; Owens et al, 1999). Folly et al., (2013) found that nearly half of their New Zealand sample (5-18 years) had television viewing as part of their usual bedtime routines. Evening television viewing has been associated with shorter sleep durations as well as later bedtimes and wake up times in 11-15 year-olds (Thorleifsdottir et al., 2002). Further studies have found television viewing to be associated with delayed SOL (Alexandru et al., 2006; Owens et al., 1999), lower sleep efficiency, bed time resistance, sleep anxiety, night wakings, and sleep disturbance (Owens et al., 1999).

Computers and video gaming. The use of computer gaming software declined over the 2000's as more games were produced solely for game consoles, although more recently internet gaming has surged into popularity (Cain & Gradisar, 2010). Although computers have become more common place in New Zealand households, children still appear to spend more time watching television than playing video games or using the internet on the computer (BSA, 2015; Olds, Ridley & Dolman, 2006).

Investigators have found that excessive use of computers and video gaming is associated with negative consequences for child and adolescent sleep patterns (Oka et al., 2008). In an experimental study, participants exposed to durations of 2-3 hours of video gaming before bedtime had significantly longer sleep onset latencies, and experienced changes in their sleep architecture, resulting in less time spent in the slow wave period of NREM sleep compared to children who watched television, suggesting that video gaming may have a differential effect on the sleeping brain (Dworak, Schierl, Bruns, & Struder, 2007 as cited by Cain & Gradisar, 2010),. Overall, frequent use of computer or gaming consoles has been associated with later bedtimes (Oka et al, 2008; Van den Bulck, 2004), longer sleep latencies (Hysing et al., 2015; Alexandru et al.,2006), shorter TIB (Van den Bulck, 2004), sleep duration (Oka et al, 2008; Hysing et al., 2015, Li et al., 2007), and poor sleep quality (Mesquita & Reimao, 2007).

Mobile phones. Compared to other technology devices, the same amount of research attention has not been paid to mobile phone use and the possible impact on sleep.. Mobile phones are a common multifunctional and portable device, used to send and receive phone calls and text messages, access the internet, play games, listen to music, and take photos and videos. Due to the rapid development of technology in this area, not all studies may have included all these functions, with the majority focusing on text messaging and calling. Nevertheless, everyday mobile phone use among Japanese adolescents aged 13-15 was found to relate to later wake up times and shorter sleep durations (Harada, Morikuni, Yoshii, Yamashita, & Takeuchi, 2002). These students were also found to have their circadian rhythm aligned with a preference for eveningness and reported less satisfaction with their current sleep duration than students who did not use their phones every day. Cell phone use in the hour before bed has been shown to be linked to extended sleep onset latency and reduced sleep duration (Hysing et al., 2015).

Tablets and iPads. Many mobile phones now have similar functions to both iPad/tablets and iPod/MP3 players. So far as the current author is aware, only two studies has examined the impact of an iPad on sleep in adolescents with mixed results (Heath et al., 2014; Hysing et al., 2015). Hysing et al., found tablet use to be associated with increased risk for a delayed SOL of more than 60 minutes and less than 7 hours of sleep. In an experimental study, adolescent participants (14-19 years) used a bright tablet screen, a dim screen, and a short wavelength screen to game in the hour before bed (Heath et al.,). No significant differences were found for any sleep variables, suggesting that iPad screen brightness did not affect sleep onset latency. However, the authors state that they cannot rule out the effect of iPads on sleep when considering longer exposures (e.g., longer than 2 hours), using a bright screen beyond bedtime, repeated nightly exposure, and the type of content and activities engaged in. Tablets are particularly important to consider in the New Zealand population, as the use of these in schools, for homework, and at home is increasing (Johnson, Wood, & Sutton, 2014).

MP3 Player and iPods. The effect of listening to music on children's sleep has rarely been studied despite it appearing to be a popular past time for children and adolescents. Listening to music is not only accessible from media items specifically designed for this purpose (e.g., stereos, radios, and MP3 players) but also from multi-media devices (i.e., iPod, tablets and smartphones) that allow for music to be played, recorded, and shared. Forty two percent of American youth listen to music on an MP3 player as part of their pre-sleep routine (Calamaro, Mason, & Ratcliffe, 2009) compared to 5% of New Zealand young people aged 5-18 years (Foley et al., 2013). MP3 use in the last hour before bed has been associated with adolescents reporting a sleep onset latency of longer than 60 minutes and shorter than 7-8 hour sleep duration (Hysing et al., 2015), and predicted sleep problems (Kubiszewski et al., 2014).

Overall screen time. The majority of research assessing electronic media use and sleep involves individual media items, rather than children's overall screen time in general (Gradisar & Short, 2013). A measure of overall screen use represents how multiple media devices or activities are often employed at once over the course of the day, and gives researchers insight into the collective effects of multi-media on children and adolescents sleep patterns. Overall screen use of more than two hours in a sample of 17 year-olds was associated with longer sleep onset latency and sleep deficits, and screen use over four hours was associated with an increased risk in obtaining less than 8 hours sleep (Hysing et al., 2015). A recent New Zealand study found that within the 90 minutes before sleep onset, children and adolescents spent on average 30 minutes engaged in sedentary screen time, and a higher screen time was associated with a later sleep onset (Foley et al., 2013). The operational definition of overall screen time differs substantially, with some studies only including computer and TV use (Hense et al., 2011; Hitze et al., 2009), some including TV, playing video or computer games, and using the internet (Drescher, Goodwin, Silva, & Quan, 2011; Houghton et al., 2015) and others including all digital technologies (Hysing et al., 2015; Kubiszewski et al., 2014; Mathers et al., 2009). This difference in measures means that data from studies not including all technology devices into their definition of screen time may not reflect children and adolescents time on EMDs. Cain and Gradisar's (2010) review of the literature identified that across all media types the most consistent findings obtained have been delayed bedtime and shorter sleep duration with excessive media use. While associations have been found between sleep and electronic media use, it is currently unclear how much screen time young adolescents can have before it becomes detrimental to their overall sleep quality and quantity.

The Current Study: Rational and Methodological Considerations

In terms of well-being, the developmental period of young adolescence has been identified as a vulnerable time for negative outcomes due to insufficient sleep (Dewald et al., 2010; Friedricksen et al., 2004; Johnson et al., 2000; Soffer-Dudek et al, 2011). In particular, research has noted stronger associations between sleep problems and internalising behaviours at age 11 compared to age 6 (Johnson et al., 2000), and stronger associations with academic problems in young adolescents compared to older adolescents (Dewald et al., 2010; Friedricksen et al., 2004). The current study will assess young adolescent's socio-emotional adjustment and academic performance in the schooling context, as research suggests that behavioural and emotional problems due to sleep loss may become more apparent in the school context and teachers have been shown to be reliant informants of child and adolescent daytime behavioural functioning (Paavonen et al., 2003; Aronen et al., 2000).

One area of note in the literature on sleep and academic performance is from Wolfson & Carskadon (2003) who state that there is controversy over the best method for measuring academic performance. Many studies rely on grades for their measure of academic achievement. However, research suggests that other factors are also important for adequate academic performance in the classroom environment (Meijer et al., 2000; 2004; Wolfson & Carskadon, 2003). The current study will employ the New Zealand achievement rating system (National Standards[1]), academic abilities and skills in a range of subjects (i.e., Math, English, etc.) alongside positive classroom behaviours of listening to teachers and completing homework, and levels of participation (i.e., paying attention and engaging in class).

The availability and use of technologies has increased over subsequent years and has become a normal part of everyday life and bedtime routines (Eggermont & Van den Bulck,

[1] Discussed in further detail in Methods section. For more information on National Standards, see http://nzcurriculum.tki.org.nz/National-Standards

2006; Statistics NZ, 2013; PMCSA, 2011). Contemporary technology devices are personal, portable, and interactive, meaning that young people can now have their personal device(s) on them at all times and be available for contact with others continually. Research suggests that EMD take up a substantial amount of New Zealand children and adolescents daily lives (BSA, 2015; Foley et al., 2011), and that young adolescent media use is different to that of younger children and older adolescents (BSA, 2015). A common finding reported in the paediatric sleep literature indicates that young people's sleep patterns are particularly influenced by their use of electronic devices, and it is of concern that there is a lack of research looking at this particular age group's use of EMDs and their subsequent sleep behaviours given the proposal that young adolescents are a vulnerable population for obtaining insufficient sleep and related socio-emotional and behavioural problems.

One particular limitation in the literature of paediatric sleep and electronic media is that minimal attention has been payed to more modern and portable technology devices including mobile and smart phones, tablets, and MP3 players. These devices have increased in popularity over recent years and have become multi-functional, with users able to message, video game, and listen to music alongside other activities. Due to the current portable and multi-functional nature of EMDs and their use, the current study will include a measure of these devices and their varying functions and allow participants to record the use of multiple devices at one time.

The Current Study and Aims of Research

The current study will examine the relationship between young adolescent sleep/wake behaviours, their well-being at school, and their electronic media use. Therefore, there are three main primary aims of the current research.

1. The first aim is to describe New Zealand young adolescents' sleep/wake patterns during the school week by collecting sleep diary data on multiple sleep behaviours

prospectively across the five day school week. In addition, the current study will describe possible problematic sleep behaviours as evidenced on a continuum from healthy sleep behaviours.

2. The second aim is to assess the relationship between young adolescent's sleep/wake patterns and internalising behaviours (emotional problems and anxiety symptoms), externalising behaviours (hyperactivity/inattention and conduct symptoms), interpersonal relationships (pro-social behaviour and peer problems), and academic performance (achievement, behaviour and participation) as rated by teachers.
3. The third aim of the current study is to describe the relationship between young adolescents' school week use of individual electronic media devices, screen time, and their sleep/wake patterns.

Taken together, the current study will allow a clearer picture to form regarding New Zealand young adolescent sleep patterns and associations with school time well-being and academic performance, and electronic media use.

Chapter Four

Method

4.1. Research Design

The current study employs a cross-sectional correlational survey design.

4.2. Participants

Participants in the current study consisted of 148 Year 7 participants aged between 11-12 years (*M* = 11.4, *SD* = .99) with 74 participants from Dunedin and 74 from Christchurch. The participants comprised 62 (42%) males and 86 (58%) females. Demographic information such as parents' age, ethnicity, socio-demographic status, and family composition data is given in Table 2. Most parents identified as New Zealand European (76%, *N* = 113) at a rate consistent with Otago and Canterbury regional norms (86%). However, there was an underrepresentation of Maori and Pacific peoples (3%, *N* = 4) compared to regional norms in the current sample (10%). In general, parents were well educated, aged between the 51-60 years, and high socio-economic status families were more represented in the sample.

Out of 300 Year 7 urban students who volunteered to take part in the current study, 164 returned their sleep data packages. Of those students, 16 students' data sets were incomplete and they were subsequently excluded from further analyses. No information on non-responders was collected. Children were recruited through their intermediate school (see Procedure, below). Three intermediate schools with decile 8 ratings agreed to participate. Deciles are a measure of the socio-economic position of a school's student community relative to other schools throughout the country, with one being the lowest and 10 being the highest decile rating (Ministry of Education, 2015). A school's decile, however, does not reflect the overall socio-economic mix of the school, and is used to inform funding to schools[2]. These schools were chosen because their school zone includes a range of socio-economic areas. ‘

Table 2

Individual and Family Characteristics as a Percent of the Sample

Sociodemographic characteristics	Number *N*=148	%	Canterbury and Otago Norms[a] (%)
Child’s Sex			
Male	62	42	-
Respondent Parent/Caregiver’s Sex			
Male	28	19	-
Parents/Caregiver’s age			
20-40	17	12	25
41-50	51	35	14
51-60	71	48	14
61-80	8	5	17
Ethnicity			
New Zealand European	113	76	86
Maori/Pacific Peoples	4	3	10
Asian	16	11	6
Other	15	10	5
Educational Attainment of Parents/Caregivers			
No Qualification	19	13	19
Sixth Form/NCEA Level 3	28	19	-
Bachelor Degree	42	29	11
Other Tertiary Qualification	42	29	50
Higher Degree	13	9	6
Socioeconomic status[b]			
1-2 Professional	71	48	-
3-4 Skilled	45	30	-
5-9 Unskilled	32	22	-

[2] For more information on decile ratings, see www.education.govt.nz.

Sociodemographic characteristics	*N*	%	Norms (%)
Marital Status			
Single	10	7	25
Defacto Relationship	20	14	14
Married	107	73	43
Non-married	9	6	11
Children per family (M±SD)	2.48±.98		
Participant sharing room	28	19	

[a] Otago is the region for Dunedin and Canterbury is the region for Christchurch. Norms combined.
Note. Demographic norms are provided by statistics New Zealand (2013). See www.stats.govt.nz.

4.3. Procedure

4.3.1. School recruitment and participation.

Principals from seven co-educational intermediate and high schools were contacted by the researcher via e-mail (see Appendix A) and invited to participate in the current study. The first Christchurch Intermediate School contacted by the researcher was willing to allow their students to participate. This is a large school, and at the time had 11 Year 7 classes consisting of 307 pupils. Out of the 6 Dunedin school principals contacted, one intermediate school and one high school were willing to have students participate. Taken together, the two Dunedin schools had twelve Year 7 classes with roughly 300 Year 7 students. Each of the schools' Board of Trustees gave consent for the study to proceed. All twenty-three Year 7 classrooms were included in the study, from which only12-14 students per class could volunteer to be part of the study. This method was chosen to ensure a random selection, as New Zealand intermediate and high school classes in Year 7 are organised on levels of academic achievement. By including every classroom, this ensured a range of students with differing academic abilities would be included in the study. Furthermore, by having a small selection of students per class reduced the teachers' research related work demand.

Senior school managers (Principal, Deputy Principal, or Year 7 Deans) introduced the purpose of the study to the Year 7 teaching staff and described the teacher study requirements. The teachers were informed that participation was voluntary and all teachers agreed to participate in the study. A meeting time was facilitated by the Senior Staff member with the researcher at a time suitable with the teachers to discuss the study and address any issues or questions.

Parents were informed of the research study the week preceding data collection in the weekly school e-newsletter (Appendix B). During a Year 7 assembly the researcher introduced the study using a power point presentation (Appendix C). In all schools the assembly took place on a Friday, allowing for students to discuss the research study with their parents over the weekend. The following Monday, students who were interested in participating took a questionnaire package home. The package included i) a study information sheet for the caregivers and also one for the child participant; ii) a parental consent form; iii) a child assent form (See Appendix D-H); iv) Sleep and Activity Diary; v) parental questionnaires on technology within the home, socio-demographic information, and the BASC-2 (Reynolds & Kamphaus, 2004). Participants were informed that study data would be confidential and they could withdraw from the study at any time, and were provided with the researcher's contact details if they had any concerns about the study or completing study questionnaires. Participants returned all data packages to the school the week they completed the sleep diaries, and recieved a voucher to acknowledge their participation in the study. Teachers completed questionnaires on the participants' academic performance and SDQ. For two teachers, information was collected via telephone. As acknowledgement of their help all teachers were given a Westfield or Meridian Mall voucher.

4.4. Measures

4.4.1. Child rated measures.

Sleep and Activity Diary. The Sleep Diary and the Electronic Media Use Diary were both included in the same booklet (Appendix J). The following section describes these both separately. To ensure the Sleep and Activity diary was written at an appropriate level for participants, five 11-13 year-olds piloted the diary for five days. These children did not take part in the final study and were chosen from Intermediate schools not selected for the study.

The Sleep and Activity Diary included a set of written instructions and the researcher provided participants with verbal instructions ensure likelihood of correct item interpretation and recording of sleep behaviours. It was suggested that the electronic media use section be completed before bedtime, and sleep items the next morning after getting out of bed. The diary was formatted so that one night of sleep data could be recorded on a single diary page, following their afternoon and evening use of technology.

Sleep/Wake patterns. Sleep diaries provide valuable information on child and adolescent profiles of sleep-wake patterns (Horne & Biggs, 2013). The Sleep diary included 13 items concerning nocturnal sleep-wake parameters. The Children recorded into the sleep diary: (1) the time they went to bed; (2) behaviours before the sleep onset period, for example reading a book, or using an EMD; (3) the time bedroom light got turned off; (4) how long it took them to fall asleep from lights out (SOL; collected as a categorical variable 0-10, 10-20, 20-30 minutes etc.); (5) if they had trouble falling asleep; (6) the time and duration (> 2 minutes) of any night awakenings; (7) what woke them up; (9) what they did when awakened; (10) time awake in the morning; (11) if they were awoken in the morning by someone; and (12) time out of bed for the day. A sleep diary yields data on a number of parameters on sleep onset latency, duration of total sleep time, and sleep efficiency. A question of the children's assessment of their overall sleep was included, asking children to indicate whether they believe they are good sleeper.

Electronic Media Use. In the Electronic Media Use (EMU) diary children recorded the duration of their electronic media activities in 30 minute time slots, beginning in the afterschool period from 15:00 until they went to bed. The children recorded the duration and use of EMDs, including iPods/MP3 players, iPads/tablets, mobile phones, television, game console, personal computer. Multimedia devices, such as iPod/MP3 players, iPad/tablet, and mobile phones, were further broken up into three main activity groups, which included Skype or text messaging, listening to music, and gaming. Children could also record if they were using more than one device or activity at a time. The instructions on how to fill out the EMU diary included an example of a completed diary demonstrating that children could tick multiple devices at once.

4.4.2. Teacher rated Measures.

Socio-emotional and behavioural adjustment. The teacher-rated Strengths and Difficulties questionnaire (SDQ) was used to measure socio-emotional and behavioural adjustment in the school environment. The SDQ is a standardised and widely used questionnaire suitable for use with children aged 4 to 16 years of age (Goodman, 1997) and is well adapted for studies of the general population (Goodman & Goodman, 2009). The SDQ has been confirmed to be a reliable and valid measure from research using a large sample of 10,000 British children (Goodman, 2001). Research has supported the ability of teachers to accurately report on SDQ dimensions (Goodman, 1997; Mellor, 2005).

The questionnaire consists of 25 items equally divided across five scales measuring emotional symptoms, conduct problems, hyperactivity-inattention, peer problems, and pro-social behaviour problems experienced by the child. Teachers rated children on a three-point

Likert scale ranging from, ‘not true’, ‘somewhat true’, or ‘certainly true.’ Subscores are generated for each subscale, ranging from 0-10. The combined scale score, minus the prosocial scale, equates to the total difficulties scores (range: 0-40) which indicates the severity of the psychosocial problems the child may be experiencing. Total difficulty scores above 15 suggest that the child may have clinically meaningful adjustment problems in need of further attention.

The five SDQ subscales are further described in detail below. Pro-sociability is measured by the child’s ability to be considerate, show kindness and share with peers and younger children, and voluntarily acts helpfully with others. A subscale score below 5 suggests marked problems with pro-social skills. Peer relationship problems are suggested by a child’s preference for solitary play, having at least one good friend, unpopularity with peers, and a preference for adult company compared to similar aged peers. Subscale scores above 4 indicate children may have difficulties developing and maintaining appropriate relationships with children their own age. The emotional items focus on the presence of negative affect, characterised by somatic complaints, excessive worrying and tearfulness, lack of confidence around others, and many fears. Emotional subscale scores above four indicate that children may have internalising difficulties. A range of anti-social behaviours are the focus of the conduct problems subscale, such as temper tantrums, noncompliance, bullying, lying, cheating and stealing. Scores above 3 are indicative of problems with appropriate behavioural conduct. Problems concerning hyperactivity and/or inattention are examined through items on restlessness, fidgeting, distractibility, impulsiveness, and attention span. A subscale score above 7 suggests the child has marked problems in terms of hyperactivity and inattention.

Academic performance. This is a brief measure containing 5 items on academic ability, classroom behaviour and participation: the first and second items measured children’s academic ability in certain *areas* and *skills,* respectively. This was assessed using a 5 point Likert scale from '1 = More than 1-year delay,' '2 = Below average,' '3 = Average,' '4 = Above average,' and '5 = More than 1-year ahead.' The third item measured children's placement in the current New Zealand curriculum supported by *National Standards* (NS). NS provide a reference point for student progress and achievement. The standards are designed so that children who meet them are on track to succeed. NS set clear expectations that students need to meet in academic areas and skills over the course of their school year[3]. For the New Zealand school curriculum, it is expected that Year 7 children will be achieving at Level 3 of the National Standards. Teachers were asked what level they anticipate their student to reach by the end of the year. Responses could range from: '1 = Level 2 or lower,' '2 = Level 3,' '3 = Level 4,' '4 = Level 5,' '5 = Level 6 or higher.' Fourth, in classroom behaviours that are characteristic of the child are measured on a scale from '1=Never,' '2, 3, 4=Sometimes,' to '5=Frequently.' Examples for behaviours assessed include completing school work and listening to directions from teachers. Lastly, students were rated on how well they participate in class on 4-point scale, ranging from '1 = Not at all,' '2 = Only a little,' '3 = Quite a lot,' and '4 = A great deal.' For example, 'Asks questions' or 'Puts in effort in class.' This measure was created by the CCDRG (See Appendix K).

4.4.3. Parent rated measures.

Demographic Information. This questionnaire gathered information on parent's demographic information and household composition, including parents 1) age; 2) gender; 3) ethnicity; 4) highest form of education; 5) employment; 6) paid or unpaid work; 7) employment role; 8) number of parents in household; 9) relationship status; 10) number of children in household; 11) age of each child. Socio-economic status is worked out from items

[3] For more information on National Standards, see http://nzcurriculum.tki.org.nz/National-Standards

5-7, using the Sally-Irvine scale. In regards to the participating child, six items were included (See Appendix L), such as age and gender, and the child's sleeping arrangements.

Anxiety. The Anxiety subscale from the Behaviour Assessment System for Children Second Edition Parent Rating Scale (BASC-2-PRS; Reynolds & Kamphaus, 2004) assessed participants Anxiety levels. The BASC-2 has a child (6-11) form with items specifically targeted towards this age group and includes descriptors of behaviours that the child may have or not engaged in over the last 4 weeks. The parent respondent rates on a four-point scale of frequency, ranging from *Never* to *Almost always.* The BASC-2 is a standardized measure with well-established psychometric properties of reliability and validity (Reynolds & Kamphaus, 2004). The internal consistency of the individual scale of Anxiety is shown to be good (a=.85).

The Anxiety scale aligns with current DSM-5 diagnostic criteria, including behaviours such as excessive worry, fears and phobias, self-deprecation, and nervousness, e.g., "worries about things that cannot be changed" and "Says, "I'm not very good at this." High scores represent impaired functioning due to these characteristics. Clinically significant scores fall at 70 or higher; At-risk scores range from 60-69; Average scores range from 41-59; and Low and Very Low range from 31-40, and 30 and below, respectively. Psychometric properties of the Anxiety subscale are reported in the manual along with evidence for construct validity of each scale (Reynolds & Kamphaus, 2004). Several studies have used the Anxiety scale from the BASC-2 as a primary measure of anxiety (LeBovidge, Strauch, Kalish, & Schneider, 2009; Rueger, Malecki, Demaray, 2010; Niditch, Varela, Kamps, & Hill, 2012; Huang, Cheng, Calzada, Brotman, 2012).

Technology in the home. Parents completed a brief questionnaire describing technology in the household and the study child's access to EMDs (See Appendix M). It consisted of four items which assess number and type of technology devices i) in the household; ii) accessible to the study children in the general household; iii) child ownership; iv) and in child's bedroom. Only two items from this measure were included in the final analyses. These pertained to access to technology in the home and bedroom. For example, 'What technology devices does your child have access to?' and 'What technology devices are in your child's bedroom?'

4.5. Data Entry and Planed Data Analyses

The data was entered and managed by a range of software. Except for the BASC-2, all data was entered into Microsoft Excel. Information from the BASC-2 was entered into the BASC-2 Assist Plus Scoring and Rating System. All measures were imported into Statistical Package for Social Sciences (SPSS) version 22 for Windows XP. SPSS was used for all data analyses purposes. The 95% confidence level (i.e., a significant level of $p < .05$) was used to detect statistically significant results across all analyses.

Sleep diary variables. Each sleep variable was created by computing the average across each individual child's sleep diary data from Sunday night through to Friday morning. The following secondary variables were created from the collected sleep diary data:

1. *Sleep Onset Time.* This was calculated by adding the SOL duration to the clock time children turned off the lights, giving an estimated SOT.
2. *Time in Bed.* The duration of time in minutes between bed time and rise time.
3. *Total Sleep Time.* The duration of time in minutes between sleep onset time and wake up time minus night wakings.

4. *Longest Sleep Period*. The longest duration of time in minutes spent asleep. Depending on the longest duration, this was measured from SOT to first night waking, or last night waking till wake up time.

5. *Sleep efficiency*. SE = TST ÷ TIB × 100

EMU diary variables. Because participants could indicate using multiple devices across a 30 minute period in the EMU diary, each 30 minute period was divided by the number of devices used to avoid an inflated estimate of duration of EMU. Electronic media variables were then averaged across school days Monday through to Friday. Outliers were not removed from analyses because there was no good theoretical reason to do so, apart from one main outlier in the variable of overall screen time. This participant's duration of time spent on media use over the week was truncated to the group mean. In the case of missing data on weekdays in the sleep and EMU diary, the average was still able to be computed using the available data per participant. Two new variables were created because very similar associations were found between the dependent variables with iPad/tablet use and iPod/MP3 player use these were combined to create one variable of 'Tablet/MP3 Player'. The same was found for computer and game console use, which were also combined. It could be argued that these activities are operationally similar, considering the multi-activity nature of devices.

Data Analyses. As the main aim of the current study is to describe young adolescents sleep, EMU, and socio-emotional and behavioural functioning, and academic achievement, preliminary data analyses included an examination of central tendency and frequency distributions of all key variables alongside percentages. A Persons *r* correlation coefficient was initially used to assess the strength of relationships between all main continuous variables to determine further analyses. In the case of dichotomous variables, including gender and bedroom EMD presence, *t*-tests were performed to explore differences between groups. For analyses where sleep behaviours were the independent variable, hierarchical linear regressions were used to predict functional outcomes of socio-emotional and behavioural adjustment and academic performance.

Distributions for individual electronic media devices of tablet or/and MP3 player, computer/game console, TV, and mobile phone were highly skewed to the right, with a large proportion of the sample having daily average of 0 minutes. Thus, these variables could not be included in the models as continuous variables. These variables were trichotomized into (i) those who did not use the device, i.e., non-user (daily average equals 0 minutes); (ii) those who used the device for less than 2 hours (0 < 2); (iii) those who used the device for 2 or more hours (> 2). Two hours was chosen as a cut-off score because it is the maximum duration of electronic media use for both younger and older adolescents recommended by the American Academy of Paediatrics (AAP, 2013) and has been used in previous studies (Alexandru et al., 2006; Hysing et al., 2015; Owens et al., 1999). In analyses where individual EMDs were the independent variables, 5-factor Analyses of Variance (ANOVA) were used with factors of television use, computer/game console, mobile phone, and tablet/MP3 player, and gender to examine the differing effects of electronic media use durations on sleep. Categorical independent measures were entered into the model using dummy variables to contrast the effects between the first category (reference group of no use) and each other category (i.e., 0<2 hours and >2 hours). Previous studies within the field have also employed similar strategies to adjust for non-normalcy and used similar analyses when dealing with EMU as categorical variables (Mathers et al., 2009; Parkes et al., 2013). Average daily EMU use (screen time) was approximately normally distributed, and kept as a continuous variable, and was subsequently used as the independent variable in hierarchical linear regressions predicting sleep outcomes.

Chapter Five

Results

5.1. Nocturnal Sleep Patterns in Young Adolescence

This section describes the participants' nocturnal sleep-wake characteristics as measured by the Sleep and Activity Diary. In particular it describes participants' (i) sleep-wake characteristics; (ii) in bed activities; (iii) and sleep problems, addressing the first objective of this research, namely to contribute to the understanding of 11-12 year-old young adolescents' normative sleep-wake behaviours by providing data about sleep over the course of a 5-day school week.

Nocturnal sleep. Table 3 summarises participant reported night-time sleep and waking behaviours. The mean sleep duration was 548 minutes (9.08 hr; *SD* = 42.4), ranging from 424 (7.04 hr) to 651 (10.51 hr) minutes. Sleep onset ranged between 20:16-23:47 hr (*M* = 21:47 hr, *SD* = 0.38). The mean wake up time was 06:51 (*SD* = 0.30), which ranged from 4:47 to 8:06. Sleep efficiency ranged from 74% to 98 % with a mean of 90% (SD = 0.05).

Table 3

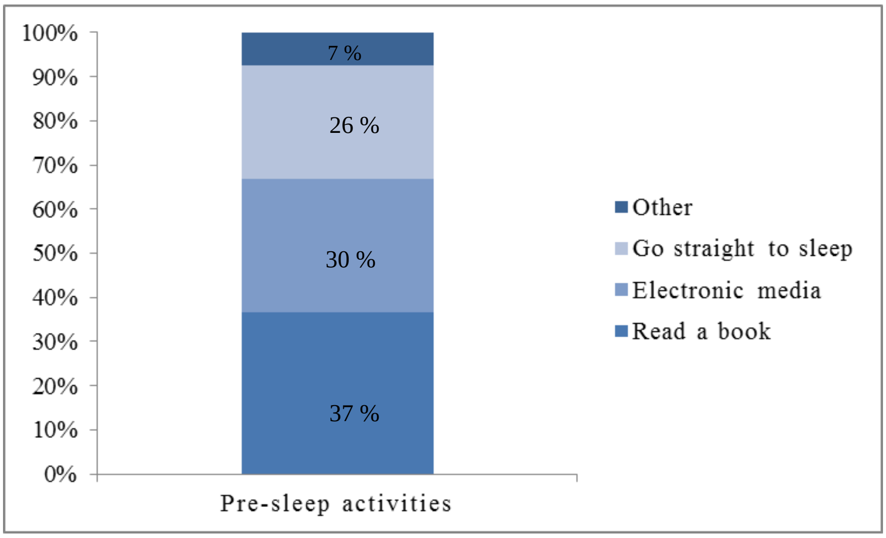
Summary of Means, Standard Deviations, and Range for Nocturnal Sleep

Sleep behaviours	*M*	*SD*	Range
	Clock Time		
Bed time	21:01	0.38	18:48-22:58
Sleep onset time	21:47	0.38	20:16-23:47
Wake up time	6:51	0.30	4:47-8:06
Rise time	7:03	0.27	5:18-8:08
	Minutes (hours)		
Total time in bed	610 (10.10)	44.7	484-790
Total sleep time	548 (9.08)	42.4	424-651
Longest sleep period	514 (8.34)	63.6	253-651
	%		
Sleep efficiency	90 %	0.05	74 %-98 %

Pre-sleep activities. Figure 2 shows participants pre-sleep bedtime activities. The most common activity was reading (37%; N = 54), followed by the use of an EMD (30%; N = 45). In contrast, 26% (N = 38) tried to go to sleep immediately upon going to bed.

Figure 2.

Percent of Participants Engaging in Pre-sleep Bed time Activities

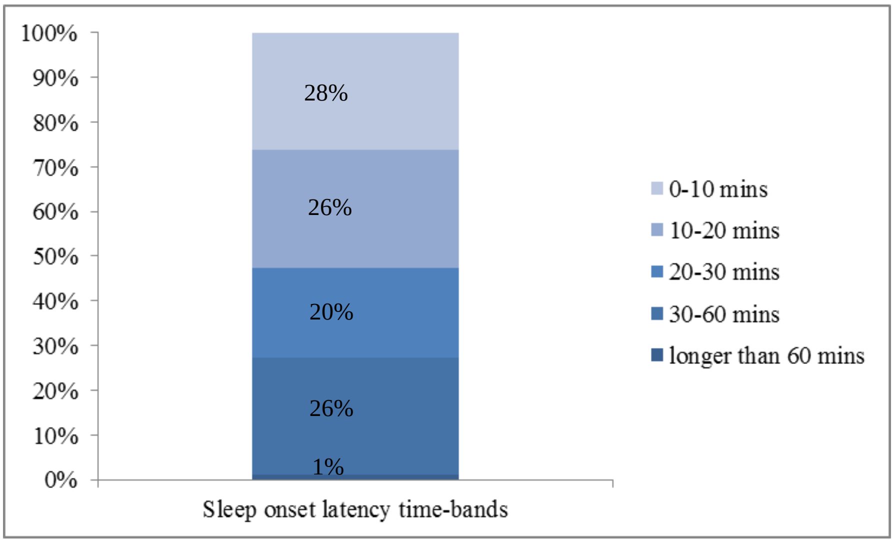


5.1.1. Possible Sleep Problems.

Sleep onset and wake up. Sixteen percent (*N* = 24) of participants reported having difficulty falling asleep during the school week. Nearly half (47%, *N* = 69) of participants took longer than 20 minutes to fall asleep, 27% (*N* = 40) took longer than 30 minutes to fall asleep, and 1% (*N* = 2) took longer than 60 minutes to fall asleep. Figure 3 shows the percentage of participants within each SOL time-band. Forty-four percent (*N* = 65) of participants had to be woken in the morning by either a parent/guardian or alarm clock.

Figure 3.

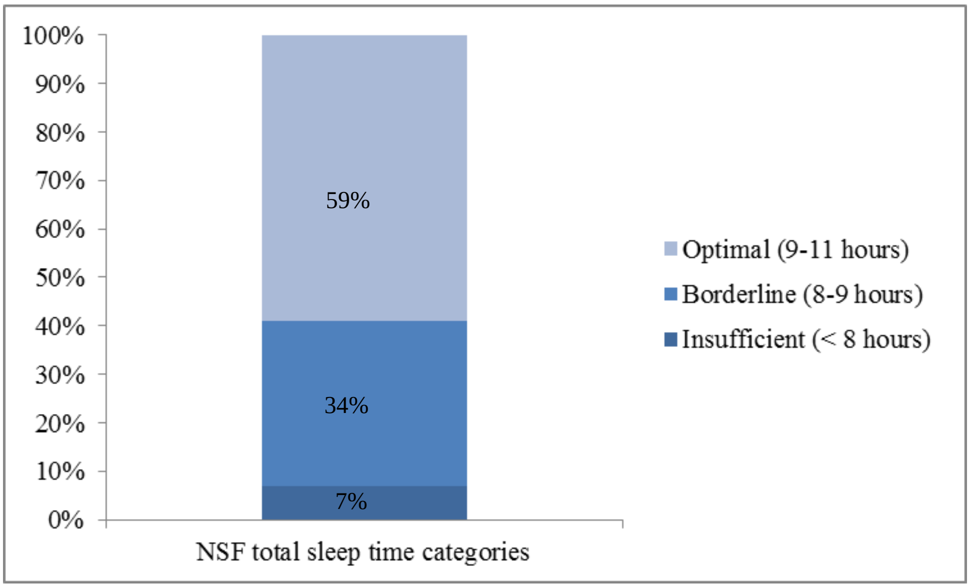
Sleep Onset Latency Time-Bands



Sleep duration and efficiency. Forty one percent of participants obtained less than the recommended 9 hours of sleep (*N* = 61; Hirshkowitz et al., 2015). Seven percent obtained insufficient sleep (*N* = 11). While 49% of participants scored lower than 90%, only 18% of participants scored lower than 85% for sleep efficiency (*N*= 26).

Figure 4.

Total Sleep Time Categories



Note. Categories retrieved from Gradisar et al., 2011; NSF, 2006; Short et al., 2013.

Night wakings. The mean number of night wakings per school week was 1.10 (*SD* = 1.11, range = 0-5). Thirty seven percent (*N* = 55) of participants reported awakening on one night during their school week; 17% (*N* = 25) reported a waking 2 nights per week; 8% (*N* = 12) reported waking up on 3 nights per school week; 2% (*N* = 3) 4 nights, and 1% (*N* = 2) woke every night of the week. For those who experienced night wakings, the mean number of night wakings per night was 1.15 (*SD* = 0.37, range = 0-3), with 5% (*N* = 5) waking twice during the night and 2% (*N* = 2) waking 3 times a night on average. Of these night wakings, only 3% were longer than 30 minutes (*N* = 5). Average night waking duration was 6.64 minutes (SD = 8.08, range = 0-49.5).

Night wake behaviours. Table 4 shows what participants did when they woke during the night. Only 2% (*N* = 2) were woken due to a portable EMD being in their bedroom.

Table 4.

Night Waking Behaviours Following a Night Waking

Night waking behaviour	*N*=97	%
Go back to sleep	65	66
Other e.g., bathroom or drink of water	29	30
Used a portable electronic media device[a]	2	2

[a]Portable electronic media device includes iPod/MP3 player, iPad/tablet and mobile phone. Stationary devices were not responsible for waking any participants.

Poor sleepers. When participants were asked if they thought they were a *good sleeper* 23% (*N* = 32) said ‘No’.

Gender differences in sleep. Using Independent samples t-tests no significant gender differences were found for any sleep variables.

5.2. Associations between Sleep and Well-Being

This section describes the participants' daily functioning in three sections: (i) anxiety levels; (ii) socio-emotional adjustment; and (iii) academic performance. Each section will describe the relationship of these factors with sleep.

5.2.1. Anxiety.

The Anxiety score grand mean was 48.27 (SD = 9.58, range = 28-82), which falls in the 'average' range (i.e., scores in the range 41-59). Three participants fell in the clinically significant range (i.e., scores > 70) and 13 participants were in the 'at risk' range (i.e., scores in the range 60-69).

Relationship between Anxiety levels, sleep. No significant correlations were found between sleep behaviours and anxiety levels and thus will not be discussed further.

5.2.2. Socio-emotional and behavioural adjustment.

This section presents the participants' socio-emotional and behavioural adjustment as measured by the teacher rated SDQ. This is followed by a summary of associations with all independent sleep variables. Hyperactivity/inattention behaviours will be referred to as hyperactivity for brevity.

Descriptive statistics of socio-emotional and behavioural adjustment. Table 5 shows the mean scores for socio-emotional adjustment and behaviour. Participants scored within the 'close to average' range on all variables. New Zealand young adolescents' scored slightly lower than Australian norms on all SDQ subscales, except for prosocial behaviour (Mellor, 2005).

Table 5.

Summary of Mean Scores, Standard Deviations, Range, and Australian Norms for Strength and Difficulties Subscale Scores

Subscales	Mean Score (*SD*)	Range	High/Very High Scores[a]	Australian Norms *M* (*SD*)
Emotional Symptoms	1.2 (1.7)	0-9	6% (*N* = 9)	1.4 (1.7)
Conduct Problems	0.7 (1.5)	0-7	7% (*N* =10)	1.0 (1.5)
Hyperactivity	2.1 (2.3)	0-10	3% (*N* = 4)	2.5 (2.6)
Peer Problems	1.1 (1.6)	0-7	5% (*N* = 7)	1.6 (1.8)
Prosocial behaviour	8.1 (2.0)	2-10	5% (*N* = 8)	7.8 (2.1)
Total difficulty score	5.1 (5.6)	0-26	7% (*N* = 11)	6.5 (6.0)

Note. All mean scores feel within ‘close to average’ range. [a]Shows the percentage and number of children who fell above the cut-off for high to very high scores.

Sleep variable correlations with socio-emotional and behavioural adjustment. This section describes the relationship between sleep, and socio-emotional and behavioural adjustment (see table x). Engagement in prosocial behaviour was most consistently associated with sleep. Results show a significant negative correlation between sleep onset and prosocial behaviour, suggesting that increases in the time participants fell asleep are associated with a decrease in prosocial behaviours at school(r = -.31, p <.01). Sleep onset time was significantly positively related to hyperactivity scores (r =.18, p <.05). This is further corroborated by the significant relationships found between total sleep time and, prosocial behaviour (r = .28, p <.01) and hyperactivity subscale scores (r = -.18, p <.05). An increase in

TST is associated with an increase in prosocial behaviour, and a decrease in hyperactivity levels.

The correlations for the total difficulties score of all adjustment areas with sleep variables were not significant, with the exception of night waking duration. The results show a small significant positive correlation between the length of time awake at night and overall difficulties at school(r = .16, p <.05). All correlations were small to moderate, however the results suggest there is a relationship between the amount of sleep young adolescents get and their socialising and hyperactive behaviours at school. This warrants further investigation.

Table 6.

Correlations between Strength and Difficulties Subscale Scores and Sleep-wake Characteristics

Sleep-wake characteristics	Total Difficulties	Prosocial Behaviour	Hyper activity	Emotional Symptoms	Conduct Problems	Peer Problems
Bed time	.06	-.30**	.15	-.08	.05	.05
Sleep onset latency	.03	-.01	.003	.05	.03	.01
Sleep onset time	15	-.31**	.18*	-.003	.09	.17*
Wake up time	.01	.01	.05	-.08	.05	.10
Total time in bed	-.08	.25**	-.18*	-.01	-.03	.03
Total sleep time	-.12	.28**	-.18*	-.05	-.05	-.06
Longest sleep period	-.08	.27**	-.14	.01	-.06	-.04
Sleep efficiency	-.06	.05	.003	-.07	-.02	-.12
Duration of night waking	.16*	-.14	.10	.10	.14	.19*

*p<.05. **p<01.

Sleep variables predictive of SDQ outcome scores. To examine if sleep variables predicted worse behavioural outcomes in young adolescents, hierarchical regressions were calculated separately for Hyperactivity, Peer Problems, and Prosocial Behaviour subscales as the predicted variable. Demographic variables in the order of gender, city, ethnicity, and SES rating were included in the first Model. In the second Model each sleep variable of interest was added separately. For example, the first hierarchical regression included gender, city, ethnicity, SES rating, and bedtime as predictor variables, and Hyperactivity as the predicted variable. Results for the second Model are shown in table x. All relationships discussed control for demographic variables.

Bed time significantly predicted hyperactivity (F(5, 142) = 4.23, p = .001) and prosocial behaviour scores (F(5, 142) = 6.64, p = .000). Participants' bedtime explained 13% of the variance in hyperactivity (R^2 = .13) and 19 % of variance in prosocial behaviour (R^2 = .19). An increase in bedtime of 10 minutes predicted an increase in hyperactivity scores of .1 point and a decrease in prosocial behaviours score of .2 points. Sleep onset predicted hyperactivity (F(5,142) = 4.43, p = .001, R^2 = .14) and prosocial behaviour (F(5, 142) = 6.42, p = .000, R^2 = .18), explaining 14% and 18% variancefor each subscale, respectively. Time of sleep onset did not significantly predict peer problems (F(5, 142) = 1.21, p = .308), despite significant t score.

Time spent in bed significantly predicted hyperactivity (F(5,142) = 4.43, p =.001, R^2 = .14) and prosocial behaviour scores (F(5, 142) = 5.30, p =.000, R^2 = .16), as did total sleep time ($F_{\text{hyperactivity}}$(5, 142) = 4.23, p =.001, R^2 = .13; $F_{\text{prosocial}}$(5,142) = 5.63, p =.000, R^2 = .17). An increase in bed time and total sleep time of 10 minutes predicted a .1 increase in hyperactivity scores and .1 decrease in prosocial scores.Night wake duration was found to significantly predict hyperactivity (F(5,142) = 3.93, p = .001, R^2 = .12), peer problems (F(5, 142) = 1.72, p = .133, R^2 = 12), and prosocial behaviour scores (F(5, 142) = 4.73, p = .001,

$R^2 = .14$). Night wake duration explained 12% of variance in participants' hyperactivity levels and peer problems, and 14% in prosocial behaviour levels. An increase in night wake duration of 10 minutes predicted a .4 increase to peer problem and hyperactivity ratings, and a .4 decrease in prosocial ratings. Night waking duration was the only sleep variable to predict total difficulties score ($F(5, 142) = 2.24$, $p = .05$). Night waking explained 7% of the variance in participants' total difficulties score, $R^2 = .7$. An increase of 10 minutes in night wake duration increased participants total difficulties score by .1 point.

Table 7.

Hierarchical Regressions Predicting SDQ Subscale Scores from Sleep Variables

SDQ Subscales	Sleep-Wake Behaviours				
	B (SE)	*β*	95% CI	*t*	*P* Value
			Bed Time		
Hyperactivity	0.11 (0.48)	.18	[0.01, 0.20]	2.21	.03
Peer Problems	0.02 (0.04)	.05	[-0.05, 0.09]	.62	.54
Prosocial Behaviour	-0.15 (0.04)	-.30	[-0.23, -0.07]	-3.82	.000
			Sleep Onset		
Hyperactivity	0.12 (0.05)	.19	[0.02, 0.21]	2.41	.02
Peer Problems	0.07 (0.04)	.17	[0.003, 0.14]	2.05	.04
Prosocial Behaviour	-0.15 (0.04)	-.29	[-0.23, -0.07]	-3.68	.000
			Time in Bed		
Hyperactivity	-0.10 (0.04)	-.19	[-0.18, -0.02]	-2.40	.02
Peer Problems	0.01 (0.03)	.03	[-0.05, 0.07]	.40	.69
Prosocial Behaviour	0.10 (0.03)	.23	[0.03, 0.17]	2.93	.004
			Total Sleep Time		
Hyperactivity	-0.10 (0.04)	-.18	[-0.18, -0.01]	-2.21	.03
Peer Problems	-0.02 (0.03)	-.05	[-0.08, 0.04]	-.62	.54
Prosocial Behaviour	0.12 (0.04)	.25	[0.04, 0.19]	3.17	.002
			Longest Sleep Period		
Hyperactivity	-0.06 (0.03)	-.15	[-0.11, 0.003]	-1.88	.06
Peer Problems	-0.01 (0.02)	-.05	[-0.05, 0.03]	-.605	.55
Prosocial Behaviour	0.09 (0.03)	.29	[0.04, 0.14]	3.66	.000
			Night Wake Duration		
Hyperactivity	0.42 (0.23)	.15	[-0.02, 0.87]	1.87	.06
Peer Problems	0.42 (0.16)	.22	[0.10, 0.73]	2.60	.01
Prosocial Behaviour	-0.48 (0.19)	-.19	[-0.86, -0.09]	-2.45	.02
Total Difficulties	0.14 (0.06)	.20	[0.02, 0.25]	2.39	.02

Note: Sleep variables were entered as predictive variables into each model separately. For example: Demographics controlled for. Model 1: Gender, city, ethnicity, and SES. Model 2: One sleep variable, e.g., bed time. Predicted variables entered separately (SDQ Subscales). Sleep variables scaled in tens of minutes.

5.2.3. Academic performance

This section will provide a descriptive overview of participants' academic achievement, classroom behaviour and participation as measured by the teacher-rated questionnaire.

Descriptive statistics on academic achievement, classroom behaviour and participation. The mean scores for participants' progress in academic areas (M = 3.31, SD = 0.55, range = 1.7-5) and skills (M = 3.40, SD = 0.69, range = 1.1-5) fell within the average range. Teachers predicted on average that their students would be at Level 3 standard by the end of the school year, which is the National Standards expected level of attainment. Teachers rated participants engagement in certain behaviours in the classroom (i.e., listens and carries out directions from teachers) at the higher end of sometimes (M = 4.27, SD = .92, range = 1.7-5). Teachers rated participants on average as participating *'quite a lot'* during class time (M = 3.19, SD = .64, range = 1.7-4). See Appendix K for Teacher Questionnaire.

Correlations between sleep and academic performance. Classroom participation was consistently associated with sleep variables. Results indicate a small significant negative correlation between bedtime and classroom participation, suggesting that as bedtime increases, classroom participation decreases (r = -.19, p <.05). A significant negative correlation was also found between SOT and classroom behaviour (r = -.19, p <.05) and participation (r = -.24, p <.01). It appears that as sleep onset time gets later, the frequency of appropriate classroom behaviour diminishes, as does classroom participation.

A significant positive relationship was found between the total time participants spent in bed (r = .21, p <.01) and TST (r = .20, p <.05), and their classroom participation. Spending longer durations in bed and getting more sleep per night were associated with an increase in classroom participation. All correlations were small. Because no relationship was found for three academic achievement variables (academic areas, skills, and national standards) these were excluded from further analyses.

Sleep-wake behaviours predictive of classroom behaviour and participation.

Hierarchical regressions were conducted to examine if sleep variables predicted worse classroom behaviour and participation. Demographic variables in the order of gender, city, ethnicity, and SES rating were included in the first Model. The second Model added the sleep variable of interest. For example, the first regression for step 1 included all demographic variables, and step 2 included a sleep variable, such as bedtime as a predictor. Predicted variables were classroom behaviour and participation. All reported analyses have controlled for demographics.

Participants' bedtime predicted their classroom participation ($F(5, 142) = 6.82$, $p = .000$). The time participants went to bed explained 20% of the variance in participation ($R^2 = .20$). An increase to bedtime of 10 minutes predicted an increase of .03 in participation scores. Sleep onset was also found to predict not only classroom participation ($F(5, 142) = 7.49$, $p = .000$) but also classroom behaviour ($F(5, 142) = 6.03$, $p = .000$). Sleep onset explained 21% variance in participation ($R^2 = .21$) and 18% variance in behaviour scores ($R^2 = .18$). An increase in SOT of 10 minutes predicted a decrease in behaviour scores of .05 and participation score of .04.

Participants time spent in bed predicted classroom participation ($F(5, 142) = 7.22$, $p = .000$), accounting for 20% of the variance ($R^2 = .20$). Participants' TST was also found to predict classroom participation ($F(5, 142) = 5.60$, $p = .000$) and behaviour ($F(5, 142) = 6.91$, $p = .000$). Both behaviour and participation scores increased by .03 points for 10 minutes longer spent in bed. TST explained 17% variance found in classroom participation ($R^2 = .17$)

and 20% of the variance in behaviour scores ($R^2 = .20$). As TST increased by 10 minutes, so too did behaviour and participation ratings of .04 and .03, respectively.

Table 8.

Hierarchical Regressions Predicting Classroom Behaviour and Participation from Sleep Variables

Academic Subscales	Sleep-Wake Behaviours				
	B (SE)	*β*	95% CI	*t*	*P* Value
			Bedtime		
CR Behaviour	-0.03 (0.02)	-.13	[-0.07, 0.007]	-1.63	.11
CR Participation	-0.03 (0.01)	-.18	[-0.06, -0.004]	-2.27	.03
			Sleep Onset		
CR Behaviour	-0.05 (0.02)	-.21	[-0.09, -0.01]	-2.63	.009
CR Participation	-0.04 (0.01)	-.22	[-0.06, -0.01]	-2.82	.006
			Time in Bed		
CR Behaviour	0.03 (0.02)	.14	[-0.002, 0.06]	1.84	.07
CR Participation	0.03 (0.01)	.20	[0.007, 0.05]	2.61	.01
			Total Sleep time		
CR Behaviour	0.04 (0.02)	.18	[0.005, 0.07]	2.25	.03
CR Participation	0.03 (0.01)	.18	[0.004, 0.05]	2.35	.02

Note. Each hierarchical regression controlled for gender, city, ethnicity, and SES. Sleep variables scaled to tens of minutes. Classroom (CR)

5.3. Association between Electronic Media Use and Sleep

This section presents information about participants' access to electronic media devices; the duration of their use of electronic media over the course of a five day school week; and the relationship between early adolescent's electronic media use and sleep patterns. Participants overall electronic media use is also referred to as 'screen time.'

Access to electronic media devices in the home. Table 9 shows the number of participants with access to specific EMDs in their home and bedroom. Ninety-three percent (*N* = 137) have access to a TV in their home, compared to 18% (*N* = 27) with access to a TV in their bedroom. A high percentage (80%, *N* = 118) of participants had access to a mobile phone in their home and nearly half (46%, *N* = 68) had access to mobile phones in their bedrooms. However, only 32% (*N* = 48) had access to smart phones with internet access in their bedrooms. The mean number of EMDs available in bedrooms was 2.71 (SD = 2.06) with a range of 0-8 devices accessible in the bedroom.

Table 9.

Number and Percent of Participants with Access to Electronic Media Devices at Home

Electronic media device	Home Access		Bedroom Access	
	N=148	%	*N*=148	%
Portable devices				
Tablet/MP3 Player	122	82	70	47
Mobile Phone[a]	118	80	68	46
Smart Phone[b]	78	53	48	32
Stationary devices				
Personal Computer	138	93	19	13
TV	137	93	27	18
Landline Telephone	124	84	2	1
Stereo	117	80	63	43

[a]Mobile phone variable is inclusive of mobile phones without internet access and smart phones with internet access. [b]Smart phone variable includes only phones with internet access

Note. Three parents specified that their children were not allowed portable tech devices in their bedroom after bedtime. Rules on EMD in the bedroom were not explicitly measured.

Table 10 summarises the number of participants who reported using these devices during a typical school week. Ninety percent (*N* = 133) reported watching TV after school and41% (*N* = 60) used a mobile phone. Fifty-seven percent of participants reported gaming (*N* = 84), followed by 51 % who reported spending time messaging friends via text, chat, or Skype on their portable devices (*N* = 76). Nearly half the participants reported listening to music after school (48%, *N* = 71).

Table 10.

Number of Participants Using Electronic Media Devices during their School Week

Electronic Media Devices	*N*=148	%
Portable devices		
Tablet/MP3 Player	94	64
Mobile Phone	60	41
Stationary devices		
TV	133	90
PC for homework	92	62
Game console or personal computer	82	55
Activities on Portable Devices		
Messaging via text of skype	76	51
Gaming	84	57
Listening to Music	71	48

Duration of time spent using electronic media devices over the school week. Duration of time spent using EMDs was measured over a five-day week from 15:00 each day till bed time. Participants on average spent a third of their time across the school week (753.22 minutes out of a possible 2250 minutes) engaged in screen time, ranging from 60 minutes to 2100 minutes (M = 753.22, SD = 370.13). Daily use times were split between afternoon (15:00-18:00) and evening (18:00-22:30) to explore when young adolescents were using electronic media. During afternoons participants spent on average 61.65 minutes out of a possible 180 minutes engaged in screen time (SD = 39.70, range = 0-168.0). From 18:00 until bedtime they spent on average 88.99 minutes out of a possible 270 minutes on screen time (SD = 49.47, range = 0-258.0). Overall, participants spent on average a third of their time after school (150.64 minutes out of a possible 450 minutes) engaged in screen time per day (M = 150.64, SD = 74.03, range = 0-258.0). This does not include time spent using EMD for homework. Table 11 summarises the average daily duration of time participants spent using specific EMDs and activities they engaged in. In a typical school day, participants spent on average 22.64 minutes on mobile phones (SD = 43.96, range = 0-249), and watched 69.68 minutes of television (SD = 52.43, range = 0-246). As discussed previously, electronic media device variables were all highly skewed to the right. Thus, Table 11 also shows the Median and Quartiles at the 25th and 75th percentile.

Table 11.

Mean and Median Duration of Time Spent on Electronic Media Devices and Activities

Electronic Media Device	Duration spent on device per day (minutes)		
	M (Minutes)	*SD*	Range
Portable Devices			
Tablet/MP3 Player	33.46	46.22	0-243
Mobile phone	22.64	43.96	0-249
Stationary Devices			
TV	69.68	52.43	0-246
Game console or Personal Computer	24.91	43.12	0-252
Homework using an electronic device	14.40	18.30	0-84
Activities on Portable Devices			
Messaging friends via text or skype	23.75	38.51	0-159
Gaming	18.88	31.39	0-168
Listening to Music	13.47	22.65	0-135.5
	Quartile 1	Median	Quartile 3
Portable Devices			
Tablet/MP3 Player	0	12	51.08
Mobile phone	0	0	24
Stationary Devices			
TV	26.25	63.6	99.75
Game console or Personal Computer	0	6	30

	Quartile 1	Median	Quartile 3
Homework using an electronic device	0	9	21
Activities on Portable Devices			
Messaging friends via text or skype	0	3	30.75
Gaming	0	6	18.43
Listening to Music	0	0	18.5

Note. Duration of time spent on electronic media devices was only measured from the time participants got home from school to the time they went to bed. These mean durations of time spent using devices do not include morning, school time, or homework use. All device use for entertainment purposes only.

Electronic media devices in the bedroom and sleep outcomes. This section describes the relationship between the number of electronic media devices participants had in their bedrooms (bedroom presence) and sleep outcomes. A very small positive correlation was found between participants' sleep onset time (SOT; time child fell asleep) and the number of devices in their bedroom (r = .16, p < .05). This indicates that there is a very slight tendency for increasing numbers of electronic media devices to predict later SOT. No other correlations between bedroom presence of electronic media and sleep variables were significant.

Electronic media use pre-sleep and sleep outcomes. Independent samples t-tests were conducted to compare sleep outcomes for participants who did not use vs. used devices *in bed* before sleep. There was a significant difference in SOT between non-users (M = 21:41, SD = 0:36, range = 20:16-23:26) and users (M = 22:01, SD = 0.38, range = 20:39-23.47) in the time they fell asleep (t(146) = 3.06, p = .003, d = .50). These results suggest that users fell asleep 20 minutes later on average compared to non-users.

Correlations between Screen time and sleep. SOT had a significant positive correlation with duration of EMU during the afternoon (r = .20, p <.05), evening (r = .36, p

<.01), and overall, (r = .30, p <.01) such that increased duration of screen time is associated with later times for falling asleep. Total sleep time had a significant negative correlation with screen time during the afternoon (r = -.17, p <.05), evening (r = -.24, p <.01), and overall (r = -.19, p <.01), indicating that as duration of screen time increases, total sleep time decreases. Nearly all sleep variables had a small to moderate significant relationship to the overall duration of electronic media use after school (See Table 12).

Table 12

Correlations between Sleep Characteristics and Duration of Electronic Media Use

Sleep behaviours	Duration		
	Afternoon electronic media use	Evening electronic media use	Total electronic media use
Bed time	.07	.29**	.18*
Sleep onset latency	.24**	.10	.18*
Sleep onset time	.20*	.36**	.30**
Wake up time	.07	.14	.15
Total time in bed	-.04	-.15	-.06
Total sleep time	-.17*	-.24**	-.19*
Longest sleep period	-.15	-.13	-.12
Sleep efficiency	-.21*	-.14	-.20*
Night wake duration	.19*	.11	.18*

Note. Afternoon technology use is from 3.00 – 6.00 pm, evening technology use is from 6.00 – 10.30 pm or bedtime, and total technology use is from 3.00 – 10.30 pm or bedtime *p<.05. **p<.01.

Correlations between duration of specific electronic media devices and sleep.

Mobile phone use had a significant positive correlation with BT (r = .21, p <.01), TIB (r = -.23, p <.01), and TST (r = -.24, p <.01), suggesting that as the duration of mobile phone use increases, participants TIB and TST decrease. SOT was positively correlated with time spent using a mobile phone (r = .20, p <.05) and game console/personal computer use (r = .29, p <.01). Night wake duration positively correlated with the time participants spent watching TV (r = .28, p <.01). Game console or/and personal computer use positively correlated with wake up time (r = .19, p <.01). In terms of activities on portable devices, time participants went to bed (r =.22, p <.05) and SOT (r = .18, p <.01) were positively correlated with engagement in text messaging.

Difference in sleep-wake variables by specific electronic media device. The effects of use of different forms of electronic media on weeknight sleep variables were examined using a 5-factor Analyses of Variance (ANOVA), using categorical electronic media measures for tablet/MP3 player, mobile phone, TV, game console/computer duration of use, and gender. Electronic media device variables were broken into 3 groups of (i) those who did not use the device, i.e., non-user; (ii) those who used the device for less than 2 hours (0 < 2); (iii) those who used the device for 2 or more hours (> 2). Two hours was chosen as a cut-off score because it is the maximum recommended amount of electronic media use for both younger and older adolescents by the American Academy of Paediatrics (AAP, 2013). All reported results have controlled for electronic media use and gender. No significant effects were found for less than 2 hours of EMD use, except for computer/game console use (Tables available in Appendix N).

Tablet/MP3 Player. The effects of the time participants spent using a tablet or/and an MP3 player on nocturnal sleep were examined. Tablet/MP3 player use was associated with LSP (F(2,138) = 5.50, p = .005). Participants with more than 2 hour use had 75 minutes less continuous sleep than non-users (t(138) = 3.29, p = .001). An association with SE (F(2,138) = 4.49, p = .01) was found, with > 2 hour users scoring 5% less on SE than non-users (t(138 = 3.05, p = .003). Tablet/MP3 player use was related to night wake duration (F(2,138) = 3.02, p

= .05), with > 2 hour users spending 6 minutes longer awake during a night waking than non-users (t(138) = 2.19, p = .03). There was no main effect of tablet/MP3 player use on participants TST during weekdays (F(2,138) = 2.56, p = .08). However, despite no significant main effect, there was a significant contrast. Those with > 2 hours of this media use experienced 32 minutes less TST than non-users (t(138) = 2.11, p = .04).

Mobile phone. Mobile phone use was related to later bedtimes (F(2,138) = 5.49, p = .005). Participants who use a mobile phone for more than 2 hours during the day went to bed 44 minutes later than participants who did not use mobile phones at all (t(138) = 3.25, p = .001). Mobile phone use was related to later sleep onsets on weeknights (F(2,138) = 3.14, p = .05), with > 2 hours uses going to sleep 32 minutes later than non-users (t(138) = 2.49, p = .01). There was a main effect of mobile phone duration on TIB (F (2,138) = 6.56, p = .002). Compared to non-users, participants that spend > 2 hours engaged on mobile phones spend 56 minutes less time in bed (t(138) = 3.57, p = .000). A main effect of mobile phones on TST was found (F(2,138) = 4.75, p = .01), with > 2 hour users spending 44 minutes less time asleep than non-users (t(138) = 3.05, p = .003).

Television. Television use was related to later WUT (F(2,138) = 3.40, p = .04). Participants who watched TV for more than 2 hours woke up 26 minutes later than participants who did not watch TV at all (t(138) = 2.45, p = .02). Television use was also related to night wake duration (F(2,138) = 4.15, p = .02). Compared to non-users, participants who spent > 2 hours watching TV spend 7 minutes longer awake during a night waking (t(138) = 2.40, p = .02).

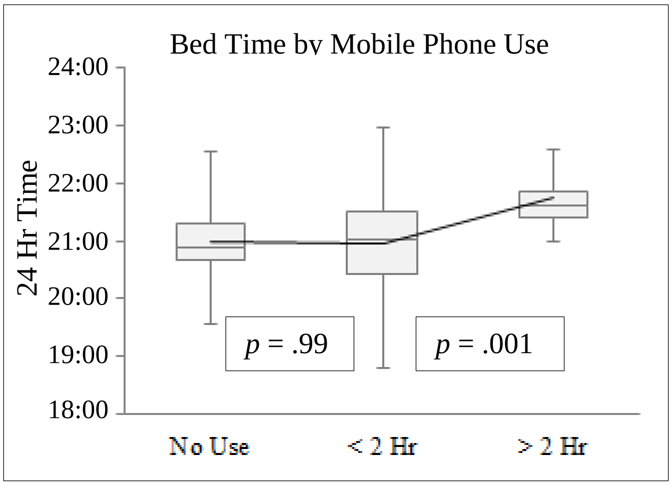
Computer/Game console. A main effect for SOT was found (F(2,138) = 8.19, p = .000). Participants who used a game console or computer for more than 2 hours went to sleep 56 minutes later than participants who did not use game consoles or computers at all (t(138)

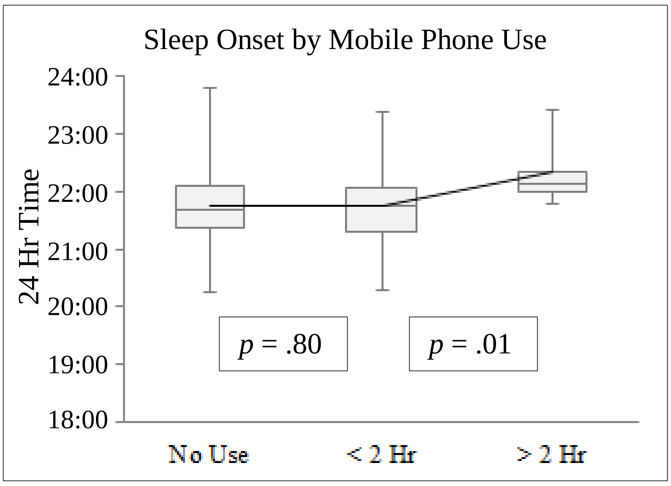
= 3.64, p = .000). Furthermore, participants who used a game console or computer for less than 2 hours went to sleep 17 minutes later than non-users (t(138) = 2.65, p = .009). Game console and computer use was also related to later WUT (F(2,138) = 4.53, p= .01), with >2 hour users waking up 38 minutes later than non-users (t(138) = 2.95, p = .000). There was no main effect of game console and/or computer use on night wake duration (F(2,138) = 2.16, p = .119). However, despite no main effect there was a significant contrast. Participants who spent less than 2 hours on game consoles and computers spent 3 minutes longer awake during a night waking than non-users (t(138) = 2.06, p= .04).

Gender. No main gender effects were found for any sleep variables, apart for night waking duration, F(1,138) = 6.08, p = .02.

Figure 5.

Box and Whisker Graphs of Significant Findings From 5-Factorial ANOVAs.


Bed Time bv Mobile Phone Use
24 Hr Time
24:00
23:00
22:00
21:00
20:00
19:00
18:00
p = .99
p = .001
No Use
< 2 Hr
> 2 Hr


Sleep Onset by Mobile Phone Use
24 Hr Time
24:00
23:00
22:00
21:00
20:00
19:00
18:00
p = .80
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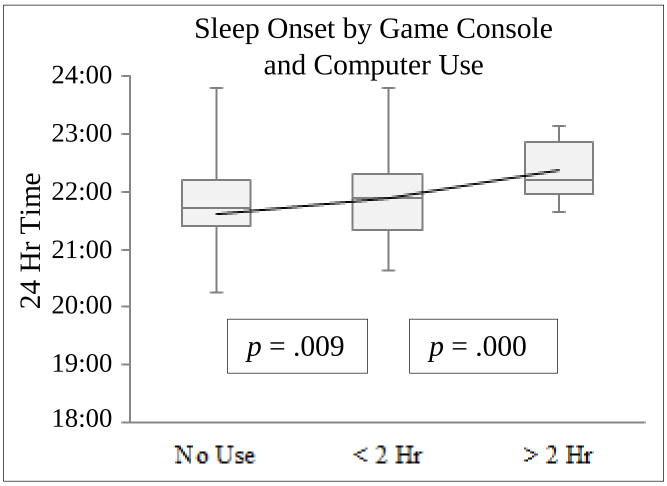
No Use
< 2 Hr
> 2 Hr


Sleep Onset by Game Console and Computer Use
24 Hr Time
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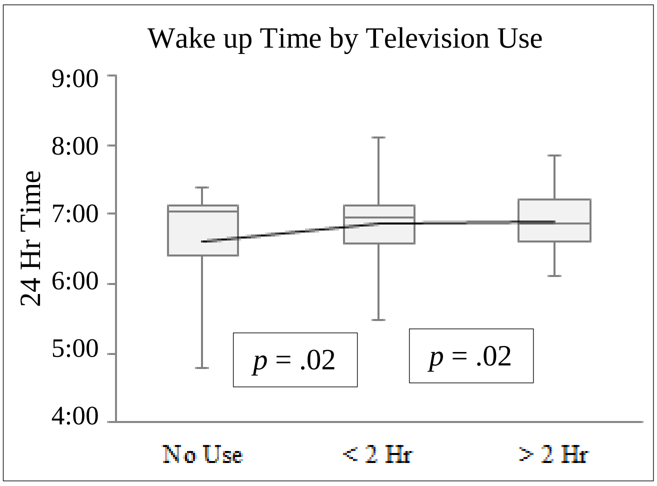
23:00
22:00
21:00
20:00
19:00
18:00
p = .009
p = .000
No Use
< 2 Hr
> 2 Hr


Wake up Time by Television Use
24 Hr Time
9:00
8:00
7:00
6:00
5:00
4:00
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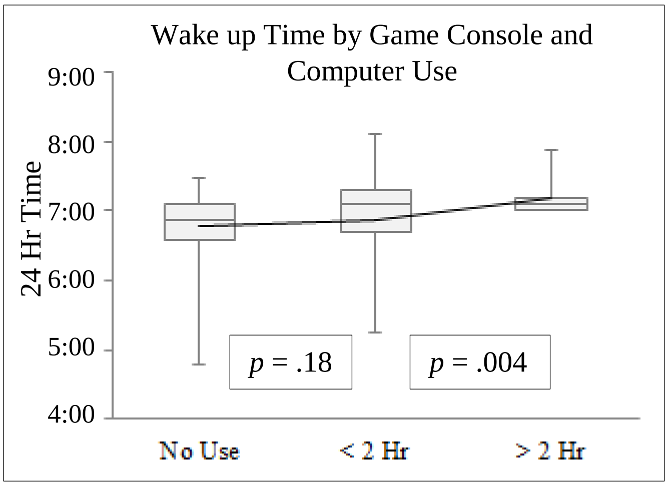
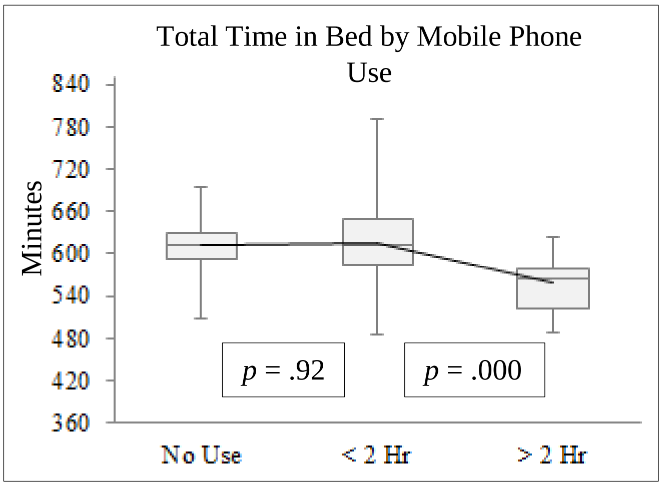
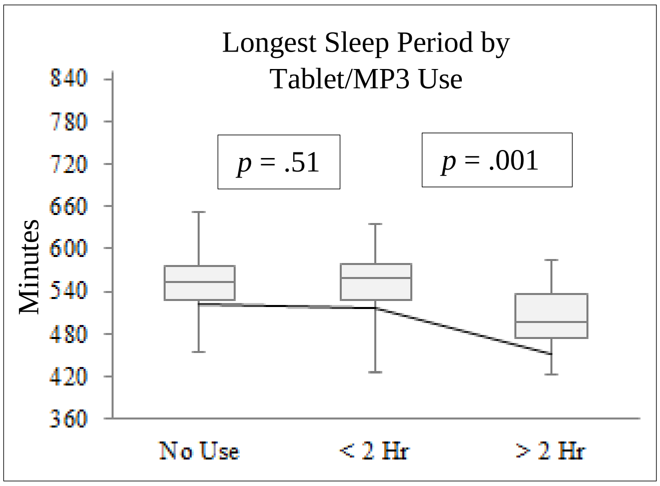
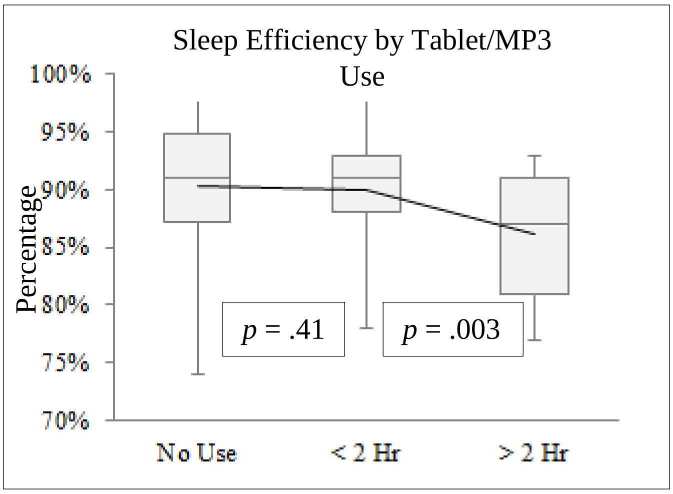
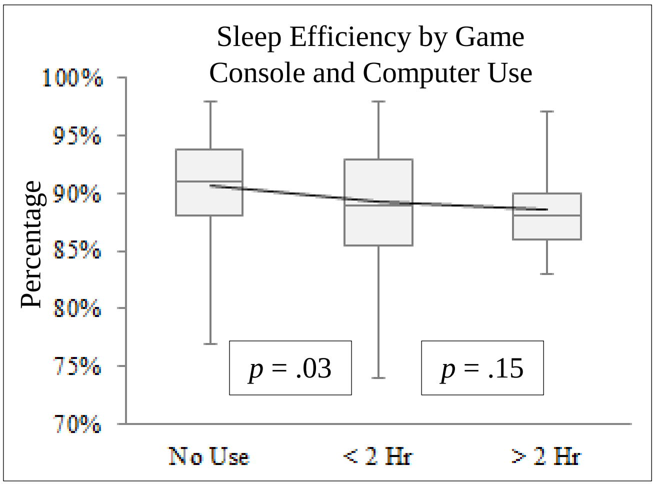
p = .02
No Use
< 2 Hr
> 2 Hr

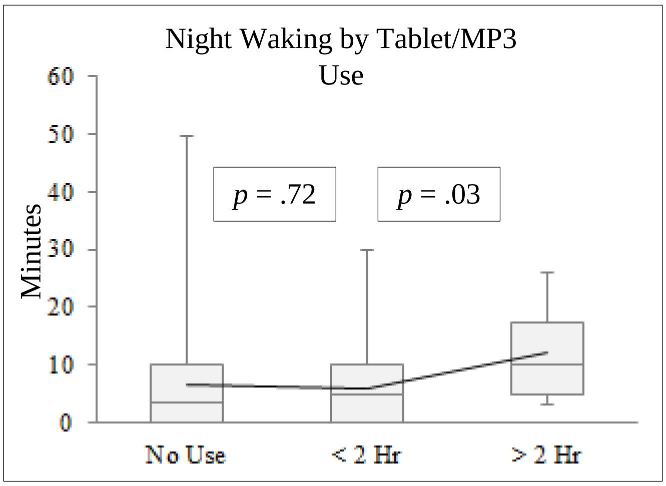

Wake up Time by Game Console and Computer Use
24 Hr Time
9:00
8:00
7:00
6:00
5:00
4:00
p = .18
p = .004
No Use
< 2 Hr
> 2 Hr

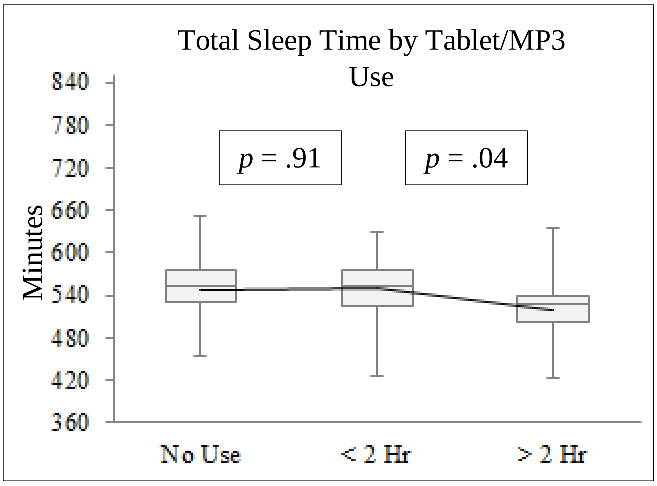

Total Time in Bed by Mobile Phone Use
Minutes
840
780
720
660
600
540
480
420
360
p = .92
p = .000
No Use
< 2 Hr
> 2 Hr

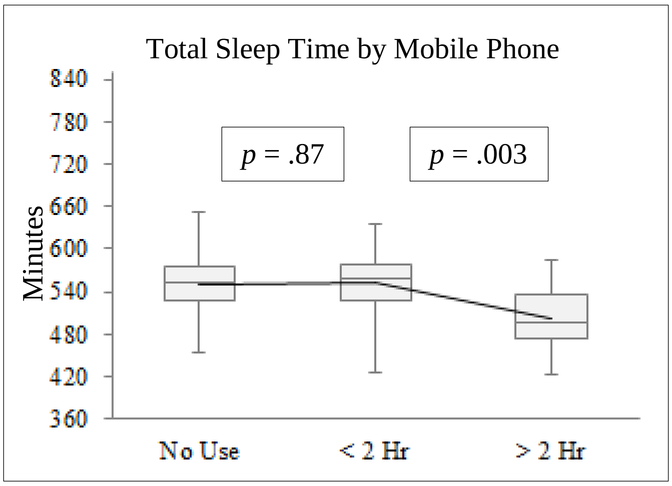

Longest Sleep Period by Tablet/MP3 Use
Minutes
840
780
720
660
600
540
480
420
360
p = .51
p = .001
No Use
< 2 Hr
> 2 Hr


Sleep Efficiency by Tablet/MP3 Use
Percentage
100%
95%
90%
85%
80%
75%
70%
p = .41
p = .003
No Use
< 2 Hr
> 2 Hr


Sleep Efficiency by Game Console and Computer Use
Percentage
100%
95%
90%
85%
80%
75%
70%
p = .03
p = .15
No Use
< 2 Hr
> 2 Hr


Night Waking by Tablet/MP3 Use
Minutes
60
50
40
30
20
10
0
p = .72
p = .03
No Use
< 2 Hr
> 2 Hr


Total Sleep Time by Tablet/MP3 Use
Minutes
840
780
720
660
600
540
480
420
360
p = .91
p = .04
No Use
< 2 Hr
> 2 Hr


Total Sleep Time by Mobile Phone
Minutes
840
780
720
660
600
540
480
420
360
p = .87
p = .003
No Use
< 2 Hr
> 2 Hr

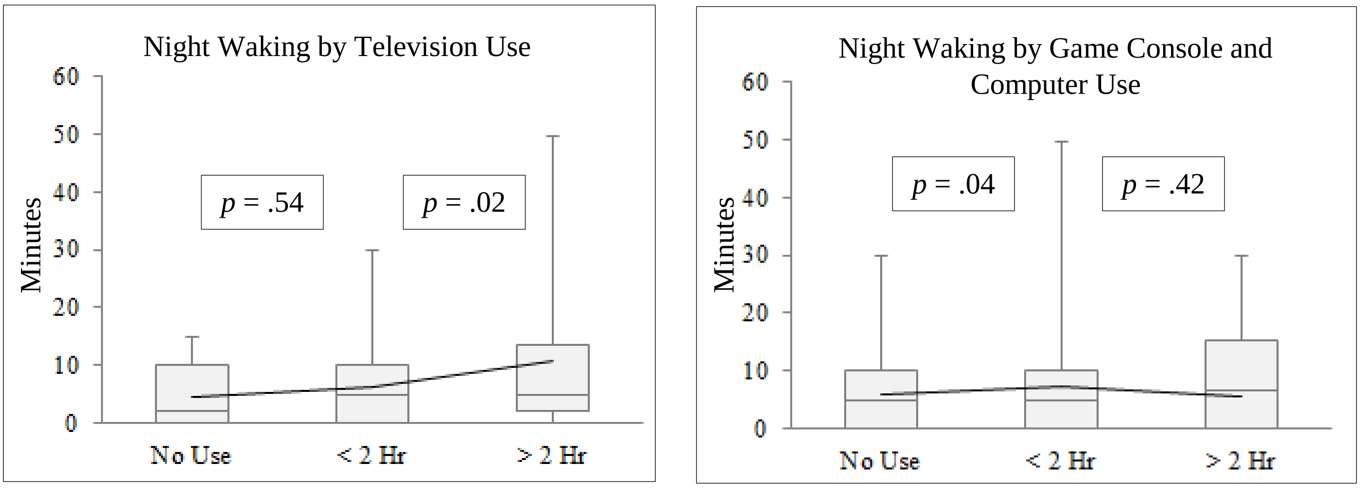


Figure X: Box and whisker graphs of significant findings from 5-factorial ANOVAs.
Note: The whiskers are error bars. The top whisker represents the Maximum value and the lowest whisker represents the Minimum value. The box represents Quartile 3, the Median, and Quartile 1. The line joining all boxes together represents the Mean value.

Screen time prediction of sleep behaviours. In these analyses participants' average overall electronic media use was treated as a continuous variable. To examine if duration of screen time accounted for the variance in sleep variables, hierarchical linear regressions were calculated for each sleep variable as the predicted variable. Included in the first Model was demographic variables in the order of gender, city, ethnicity, and SES rating. The second Model added overall duration of electronic media use. Controlling for demographic variables, overall screen time significantly predicted bed time (F(5, 142) = 4.26, p = .001), explaining 13% of variance in bed times, R^2=.13. Participant's bed time increased 7.77 minutes for each hour of electronic media used after school (see table x). A significant regression equation was also found for SOT (F(5, 142) = 6.42, p = .000, R^2 = .18). SOT increased by 11.24 minutes for each hour spent using electronic media. Total time spent asleep and LSP were found to be significantly affected by duration of electronic media use after school (F_{TST}(5, 142) = 3.91, p = .002; F_{LSP}(5, 142) = 3.28, p = .008). Electronic media use explained 12% of the variance in participants sleep duration (R^2=.12), and 10% variance in participants longest sleep period (R^2=.10). Participants sleep duration decreased by 8.99 minutes for every hour spent using electronic media devices after school. Longest uninterrupted sleep period decreased by 10.33 minutes for every increase in hour of screen time. There was a non-significant regression equation for SOL $F(5, 142) = 1.78$, $p = .121$), SE ($F(5,142) = 2.09$, $p = .07$) and night wake duration ($F(5,142) = 1.73$, $p = .13$), despite significant *t* scores (See Table 13).

Table 13.

Hierarchical Linear Regressions Predicting Sleep-Wake Outcomes from Demographic and Average Electronic Media Use

Dependent Variables of Sleep Behaviour	Average Electronic Media Use				
	B (SE)	95% CI	*β*	*t*	*P* Value
Bed time	7.77 (2.51)	[2.81, 12.73]	.25	3.10	.002
Sleep onset latency	.168 (.080)	[.010, .326]	.18	2.10	.04
Sleep onset time	11.24 (2.39)	[6.52, 15.95]	.364	4.71	.000
Wake up time	2.78 (2.06)	[-1.29, 6.86]	.11	1.35	.17
Total time in bed	-4.12 (3.04)	[-10.12, 1.89]	-.11	-1.36	.18
Total sleep time	-8.99 (2.76)	[-14.43, -3.54]	-.26	-3.26	.001
Longest sleep period	-10.33 (4.18)	[-18.59, 2.06]	-.20	-2.47	.02
Sleep efficiency	-.009 (.003)	[-.015, -.002]	-.23	-2.74	.007
Night wake duration	1.18 (.545)	[.098, 2.25]	.18	2.16	.03

Note. Each linear regression controlled for demographic variables of gender, city, ethnicity, and SES rating. Average electronic media use was divided by 60 to scale for 1 hour increment.

Chapter Six

Discussion

The present cross-sectional study extends on previous research by addressing some critical gaps in the research knowledge base on sleep patterns and the relationship with emotional and behavioural adjustment at school, school performance, and electronic media use. The discussion will be structured according to each research aim; firstly discussing findings of New Zealand young adolescent normative sleep behaviours; second, the relationship between sleep behaviours and socio-emotional and behavioural functioning, and academic achievement, classroom behaviour and participation; and lastly to describe the relationship between young adolescents' electronic media usage and their sleep/wake patterns.

6.1. New Zealand Young Adolescent Sleep

Currently, there are few studies that have focused exclusively on sleep in children between the ages of 10-13, and within this literature there are some methodological issues as described by Short et al., (2013). These include the tendency to rely on limited sleep/wake behaviours (i.e., BT, TST, and WT) to describe normative sleep patterns, and inaccurate measurement of TST and the school week (Short et al., 2013). The present study aimed to describe sleep patterns and problem sleep behaviours in young adolescents using a wide range of sleep variables derived from sleep diaries. Sleep behaviours will be discussed and compared to New Zealand and international extant literature findings on similar aged peers.

Bedtime. The current study found that young adolescents went to bed on average at 21:00. This finding is consistent with Belgium and Canadian reports of bed time (Laberge et al., 2001; Spuyt et al., 2005) and was more than an hour earlier than studies conducted in

Spain (Canet, 2010), Australia (Dollman et al., 2007), USA (Lee et al., 1999), Italy (Russo et al., 2007), and Korea (Seo et al., 2010).

Sleep onset latency. Nearly half of young adolescents from the current study had sleep onset latencies suggestive of potential sleep onset delays (> 20 mins). This is similar to reports on Italian youth (Russo et al., 2007), and is considerable higher than Spanish young adolescents where only 19% took longer than 20 minutes to fall asleep (Canet, 2010). In the current study, 27% of participants reported a SOL greater than 30 mins, which is in line with a recent review on adolescents sleep where 20-26% reported a SOL > 30minutes (Gradisar et al., 2011). This may be indicative of sleep-onset insomnia or circadian phase delay (Lichstein, Durrence, Taylor, Bush, & Riedel, 2003).

Difficulty falling asleep. From the current study, 16% of New Zealand youth reported difficulty falling asleep on average during their school week, compared to 60% of Canadian youth who reported difficulty falling asleep at least sometimes (Laberge et al., 2001). This figure may be inflated as the authors did not report the percent of participants who frequently experience difficulty falling asleep. Gradisar and colleagues (2011) reported in their review that the percent of adolescents experiencing trouble falling asleep ranges between 7-36% with a mean of 16%, which is consistent with the current findings.

Sleep onset. Young adolescents fell asleep on average at 21:47, which is about an hour earlier than Israeli youth (Sadeh et al., 2000). Sleep onset time ranged from 20:16 to 23:47 which is later than ranges reported by a recent New Zealand study (Foley et al., 2013); where girls fell asleep between 19:41-22:03 and boys 19:38-22:02. However, Foley and colleagues (2013) included younger children from age 5-12 which most likely explains this discrepancy, as younger children go to bed earlier and have longer sleep durations (Thorleifsdottir et al., 2002).

Time in bed. TIB as measured by the current study is between BT and RT, and was on average 610 minutes or 10.10 hours. This is a similar finding to studies in the Netherlands and Canada (Laberge et al., 2001; Meijer et al., 2001). However, both these studies measure TIB from BT to WUT, indicating the TIB average may be slightly longer in both studies than reported.

Total sleep time. TST (measured between SO and WT) was on average 548 minutes or 9.08 hours, placing New Zealand young adolescents total sleep on school nights within the recommended range (Gradisar et al., 2011; NSF, 2006). This is similar to results from Iceland (Thorleifsdottir et al., 2002) and USA (Lee et al., 1999). However, according to the NSF (2006), American 6th graders obtain nearly an hour less sleep than New Zealand young adolescents. Belgium (Spuyt et al., 2005) and Swiss (Iglowstein et al., 2003) young adolescents obtained between 10 – 40 minutes more sleep. In the current study, 41% of participants got less than nine hours of sleep on average over the school week, with 34% in the borderline range and 7% in the insufficient range (Criteria from Gradisar et al., 2011; NSF, 2006; Short et al., 2013). In line with the current study, the NSF (2006) found that 49% of 6th graders received less than nine hours of sleep, with 33% and 16% obtaining borderline sleep and insufficient sleep, respectively.

Longest sleep period. Young adolescents longest sleep period was on average 514 minutes or 8.34 hours in the current study. This is a longer uninterrupted sleep duration by more than 300 minutes than the LSP reported by Sadeh and colleagues (2000). This discrepancy is most likely due to the measures used. Sadeh et al., (2000) used actigraph, which has been shown to be more sensitive to periods of wakefulness compared to self-report (Short et al., 2012; Tremaine et al., 2010). A LSP of nearly nine hours, suggests that participants sleep wasn’t particularly fragmented by night wakings. However, the use of actigraphy may provide a finer distinction in young adolescents' ability to sleep uninterrupted.

Night wakings. Alongside difficulty falling asleep, the current study also looked at difficulty maintaining sleep. Thirty seven percent reported waking once per week, and 8% experienced night wakings three nights out of their school week similar to 9% of Canadian 11 and 12 year-olds who report frequent night wakings (Laberge et al., 2001) and 6% of German 8-11 year-olds reporting trouble sleeping through the night (Wiater et al., 2005). From the current study, 3% of participants' night wakings were longer than 30 minutes.

Sleep efficiency. SE was on average 90%, meaning that young adolescents spent only 10% of their time in bed in wakefulness. Sleep efficiency as reported by international studies is higher than the New Zealand average ranging between 94-95% (Sadeh et al., 2000; Spryut et al., 2005). Spryut et al (2005) relied on self-report and created their variables in a similar manner to the current study. However, they did not take into account night wakings which may explain the higher SE score. Sadeh et al (2000) used actigraphy and took into account night wakings but not time spent awake in bed before getting up. Due to these discrepancies in methodology, it cannot be concluded that New Zealand children may be spending more time in bed awake compared to other countries. Furthermore, sleep efficiency above 85% may be considered healthy in this age range.

Wake up time. New Zealand young adolescents woke up at 6:51 am and rose from bed at 7:03am on average. This is in line with research from most countries, including Australia (Dollman et al., 2007), Belgium (Spruyt et al., 2005), Canada (Laberge et al., 2001), Israel (Sadeh et al., 2000), Italy (Russo et al., 2007), and USA (Lee et al., 1999; NSF, 2006). Spanish (Canet, 2010) and Korean (Seo et al., 2010) young adolescents woke up later. In the current study 44% of participants had to be woken up, which is consistent with Meijer and colleague's (2001) findings where 44% had difficulty getting up in the morning.

Poor sleepers. Overall, twenty three percent of participants subjectively rated themselves as poor sleepers in the current study, which is a higher rate compared to findings from Belgium, Italy, UK, and Israel (Khan et al., 1989; Manni et al., 1997; Rona et al., 1998; Sadeh et al., 2000). However, all of these studies have used different measures and definitions of poor sleep. Manni and colleagues (1997) definition of poor sleep most closely resembles the current studies, where poor sleepers were those who complained of non-restorative sleep. Rona and colleagues (1998) operationally defined poor sleep as “sleeps poorly but lies quietly awake,” and others have defined poor sleep based on composites of multiple sleep parameters as measured by actigraph (Sadeh et al., 2000) or questionnaire (Kahn et al., 1989).

Gender differences. The current study found no gender differences in young adolescent sleep which is in line with previous findings (Canet, 2010; Laberge et al., 2001; Russo et al, 2007; Spuyt et al., 2005).

Summary and implications. In summary, young adolescents went to bed at 21:00; fell asleep at 21:47; and woke at 06:50 in the morning. Children spent just over 10 hours in bed with nine of those hours asleep, resulting in a sleep efficiency rating of 90%. There are a couple of concerning trends in the sleep of New Zealand young adolescents. In particular, a number of participants evaluated their sleep as poor, which may be due to difficulties in initiating sleep with nearly half of participants taking more than 20 minutes to fall asleep. This may result in insufficient sleep whereby 41% of young adolescents are obtaining less than the recommended 9 hours of sleep. Despite many participants reporting waking during the night once a week, only a very small portion could be considered to have problems with maintaining sleep, suggesting that young adolescents may obtain insufficient sleep due to difficulties in initiating sleep. This is consistent with developmental literature and theory suggesting that the biological night of preadolescents is later, resulting in longer SOL and later SOT (Crowley et al., 2007). In summary, the data collected in this study supports and adds to normative data on sleep timing and duration of healthy young adolescents. These may be used by parents and professionals to inform and guide expectations of age appropriate sleep behaviours.

The current study provides a snapshot of New Zealand South Island young adolescents sleep patterns through sleep diary data describing typical sleep behaviours during the school week. A major strength in the current study is the wide range of sleep/wake variables collected plus the adherence to Short and colleagues (2012) recommendations for the accurate measurement of weekday sleep variables. The descriptive nature of this study allows for a broad understanding of what may constitute problematic sleep in young adolescents, with the hope that future research can build upon this knowledge base to create comparable operational definitions within paediatric sleep research. This study highlights the need for a wider range of accurate sleep parameters to be collected for a more compressive understanding of sleep behaviours across development. Currently within New Zealand and internationally there is limited research on the sleep of this specific age group preceding adolescence, and this study begins to paint a detailed picture of sleep in this period of transition.

6.2. The Importance of Sleep for Young Adolescents Well-Being

Consistent with previous research this study has examined a multitude of daytime behaviours that have been found to be associated with sleep/wake patterns. This research contributes to the existing literature by identifying the relationship between New Zealand young adolescents sleep/wake patterns and i) internalising behaviours; ii) externalising behaviours; iii) peer relationships; iv) and academic performance. This allows the current study to start to formulate possible hypotheses for future research around the impact of insufficient sleep on young adolescents' well-being.

6.2.1. Internalising behaviours.

The current study did not find evidence of an association between young adolescent sleep/wake behaviours and symptoms of anxiety (as rated by parents on the BASC) or emotional problems (as rated by teachers on the SDQ), despite findings from extant literature supporting the relationship between insufficient sleep and internalising symptoms (Aronen et al., 2000; Meijer et al., 2010). It has been suggested that there is a greater association between sleep and internalising problems during the young adolescence period compared to childhood (Johnson et al., 2000), suggesting that young adolescents may be more sensitive to emotional difficulties resulting from sleep loss. Furthermore, some studies have reported greater odds of sleep problems predicting anxiety and depression, compared to externalising behaviours (Johnson et al., 2000; Kelly & El-Sheick, 2014).

There may be multiple reasons for why an association was not found. First, the current study had a small sample size compared to other studies exploring similar associations. In a sample of 11, 788 participants, Sarchiapone and colleagues (2014) reported a small association between sleep hours per night and anxiety symptoms, suggesting that perhaps a large sample is required to find a small association. Second, it has been suggested that the association between insufficient or problematic sleep and internalising symptoms is linked to developmental factors such as puberty, which not all children 11-12 years of age may have experienced (Johnson et al., 2000). Thirdly, there is evidence to suggest that a significant proportion of this association may be accounted for by shared environmental factors, such as SES, family disorganisation, and maternal depression (Gregory et al., 2004). Apart from SES, these were variables not controlled for in the current study. The homogeneous nature of the current study in terms of SES will be discussed in further detail in the overall limitations section.

Other studies have also failed to find a relationship between sleep behaviours and internalising problems. Smedje and colleagues (2001ab) in two studies with 614 and 635 participants aged 5-8 years old found no association between difficulties falling asleep and TST with emotional problems. Additionally, Moore and colleagues (2009) found no association between sleep duration and internalising symptoms in 13 year-olds. However, subjective sleepiness was correlated with adolescent's reports of anxiety and depression symptoms. The authors suggest it may be level of sleepiness, rather than absolute duration that is associated with an effect on internalising symptomology (Moore et al., 2009). Due to individual differences in sleep need, a subjective measure of sleepiness may in fact be more sensitive than a measure of sleep duration.

6.2.2. Externalising behaviours.

Hyperactivity/Internalizing behaviours. A significant association was found between multiple sleep variables and hyperactivity/inattention symptoms as rated by teachers on the SDQ. In particular, shorter sleep duration was associated with higher levels of hyperactivity symptoms. This is consistent with findings from other cross-sectional studies (Aronen et al., 2000; Fallone, Acebo, Seifer, & Carskadon, 2005; Liu & Zhou, 2002). The current study also found that young adolescents who went to bed later, fell asleep later, and had longer night waking durations were rated as having more hyperactivity/inattentive symptoms. While numerous studies have reported a similar association between sleep problems and increased hyperactivity/inattentive symptoms (Gregory et al., 2004; Paavonen et al., 2003; Wiater et al., 2005), Smedje and colleagues (2001[ab]) found no relationship between children's difficulties falling asleep and sleep duration with hyperactive behaviours as measured by the SDQ. This difference in results may be due to Smedji et al., employing parental reports on a younger sample of 6-8 year-olds' sleep problems, who have been shown to underreport children's sleep problems (Paavonen et al., 2000).Taken together it appears that insufficient and disrupted sleep is associated with increased hyperactive and inattentive symptoms.

Literature specifically exploring the relationship between sleep problems and hyperactive/inattentive behaviours below clinical threshold is rare. However, there is a wealth of literature on clinical populations diagnosed with ADHD and their sleep patterns, or those with sleep disorders and their hyperactivity symptoms. Parents of children with ADHD typically report more sleep problems of difficulty falling asleep, night wakings, and restless sleep in higher rates compared to control groups (Owens, 2008). It is proposed these problems may result in shortened sleep duration and as well as decreased sleep efficiency (Owens, 2005). The current study's findings begin to support this and suggest a similar picture of associations between insufficient sleep and ADHD type symptoms in the general child population.

The hypoarousal theory of ADHD (Weinberg & Brumback, 1990) proposes that in some children their ADHD symptoms are associated with hypoarousal rather than hyperarousal, and that hyperactivity is actually an adaptive behaviour that counteracts the effects of underlying daytime sleepiness (Owens 2008). It has been hypothesised that excessive motor activity could be a strategy used by ADHD children to stay awake and alert (Weinberg & Brumback, 1990; Konofal et al., 2010), which may be a similar strategy used by sleepy children in the general population. Given the current findings implicating hyperactive/inattentive behaviours in the expression of insufficient sleep, it would be informative for future research to include a measure on participant's feelings of sleepiness or alertness during the day. Behavioural manifestations of sleepiness in children have been described in experimental conditions of sleep restriction, including classically sleepy behaviours of yawning, rubbing eyes, and/or resting head on desk, alongside externalising behaviours, such as increased impulsivity, hyperactivity, and inattentiveness (Owens, 2005).

Bearing this in mind, it may also prove informative for future studies to delineate between inattentive behaviours and hyperactive behaviours. The SDQ uses a combination of three items pertaining to hyperactive behaviours and two items exploring inattentive behaviours. Adults and older adolescents when sleepy often demonstrate inattentive behaviours, whereas children may be more hyperactive when sleep deprived (Melendres et al., 2004). Age or puberty may be a mediating factor in the presentation of inattentive or hyperactive behaviours due to sleep restriction. Additionally, Lecendreux and colleagues (2000) hypothesise that the presentation of hypoactive or hyperactive symptoms could be situation specific due to an alteration of alertness, whereby children with ADHD would present a hypoarousal state in known situations (repetitive tasks) but would present a hyperarousal response when faced with new stimuli or immediate reward. Identifying the primary presentation of young adolescent ADHD symptoms in the schooling context will help inform our understanding of the impact sleep problems may have on this age groups' experience and behaviour in school.

The relationship between sleep and hyperactive/inattentive behaviours is most likely complex. While research on the hypoarousal theory has primarily relied on clinical populations, experimental research employing children from the general population suggest a differing pattern of results. Fallone and colleagues (2005) found that 6-12 year-old children with their sleep restricted had more reported inattention problems without hyperactivity symptoms as rated by their teachers. Children with ADHD may show sleepy and hyperactive behaviours, whilst non-clinical children may show sleepy and inattentive behaviours due to sleep deprivation. Children and adolescents with ADHD may experience symptoms of insufficient sleep differently to those from the general population, indicating the importance of further elucidating this complex association in a community sample across development.

Conduct problems. While young adolescent sleep/wake patterns were not associated with conduct problems in the current study, multiple studies have found a relationship between sleep duration and conduct problems (Aronen et al., 2000; Gregory et al., 2002, 2004; Liu & Zhou, 2002; Meijer et al., 2010; Sarchipone et al., 2014; Wiater et al., 2005). It has been suggested that children with conduct symptoms may sleep less because of problem behaviours such as refusing to go to bed or choosing other activities over sleep (Aronene et al., 2000). Consistent with the current findings, some cross-sectional studies have also failed to find a relationship between sleep/wake behaviours and conduct problems (Moore et al., 2009; Nixon et al, 2008). One experimental study that reduced sleep opportunity in 6-12 year-olds reported no effect on oppositional and aggressive behaviours as rated by teachers (Fallone et al., 2005). While, Smedje and colleagues (2001[a]) found that sleep duration was not associated with conduct problems, more global reports of sleep problems were associated with conduct problems. In particular, bedtime resistance, sleep talking, and tossing and turning during sleep were significant predictors of daytime conduct behaviours. The authors suggest that behavioural problems during the day may be associated with specific disturbances of night-time sleep (Smedje et al., 2001[a]). The current study's use of sleep diary variables may not have captured these specific sleep disturbances associated with conduct problems.

6.2.3. Peer Relationships.

Multiple sleep/wake variables were associated with the prosocial behaviour of young adolescents. The later young adolescents went to bed and fell asleep, the lower they were rated in prosocial behaviours at school. Alongside this, shorter time spent in bed, shorter sleep duration and shorter longest sleep period, and longer night wake durations were associated with less prosocial behaviour. Taken together, these results suggest that young adolescents who obtain insufficient and disrupted sleep demonstrate less prosocial behaviours at school. Literature on insufficient or problematic sleep outcomes seldom include prosocial behaviours, rather peer problems is more often the variable of choice. The current study found that later sleep onset and longer night waking durations were associated with more peer problems during the school week, suggesting that problems in initiating and maintaining sleep are associated with peer problems.

These results highlight the importance of taking into account social behaviours when examining young adolescent sleep patterns. Despite reduced sleep duration predicting less prosocial behaviours, it did not predict peer problems. This is in contrast to a number of studies that have found reduced sleep duration is associated with peer and social problems (Aronen et al., 2000; Liu & Zhou, 2002; Sarchiapone et al., 2014; Roberts et al., 2009). Liu & Zhou (2002) identified adolescents who obtained less than 7 hours of sleep at increased risk for social problems. Additionally, Roberts and colleagues (2009) reported that adolescents who get less than 6 hours of sleep were not at risk of interpersonal problems at home or with peers, but had greater risk of social problems at school, suggesting the effects of reduced sleep may become more apparent among peers within the school context. This is consistent with the current findings as derived from teacher reports and other extant literature findings suggesting the consequences of inadequate sleep may first become evident at school (Aronen et al., 2000), demonstrating the importance of assessing for sleep problems in young adolescents with challenging behaviours at school.

Sleep problems have also been implicated in less prosocial behaviours and more peer problems in cross-sectional (Wiater et al., 2005) and longitudinal research (Paavonen et al., 2003). Wiater and colleagues (2005) reported that young adolescents with sleep disturbances of SOD, NW, and daytime sleepiness had increased risk of social difficulties. Sleep problems in children aged 8 have been associated with concurrent social problems and later social problems at age 12 (Paavonen et al., 2003), indicating that both transient and long-term sleep problems may result in social difficulties. Paavonen et al (2003) suggest that sleep deprivation may cause irritability, which in turn can lower the threshold for conflict resulting in peer problems.

Maume (2013) found that current positive peer relationships were associated with fewer sleep problems and longer school night sleep duration. This research suggests that positive peer relationships could act as a buffer against sleep difficulties in adolescence. The association between interpersonal skills and social relationships with sleep is most likely bi-directional (Roberts et al., 2002), as young adolescence is a time where peer relationships become very important to an individual (Helsen et al., 2000). It may be that young adolescents who experience peer problems at school have difficulty falling asleep due to worry about social interactions resulting in increased stress and physiological arousal. Insufficient sleep may then lead to less social motivation and a lower threshold for dealing with difficult social interactions. Overall, the current study's findings are in line with previous findings and signify the importance of adequate sleep for optimal social interactions at school.

6.2.4. Academic performance.

Academic achievement. The current study found that sleep/wake patterns were not associated with academic achievement in terms of particular areas (i.e., math or English), skills, or National Standards. There is a vast literature base reporting an association between insufficient sleep and academic problems (Fallone et al., 2005; Friedrickson et al., 2004; Kronholm et al., 2014; Roberts et al., 2009; Wolfson & Carskadon et al., 1998). Studies with no association typically have older samples (Eliasson, Eliasson, King, Gould, & Eliasson, 2002), with research suggesting young adolescents' academic performance is more sensitive to the effects of sleep loss (Friedrickson et al., 2004).

There are a number of reasons why the current study may have not found a significant result. First, a number of studies examining the relationship between sleep and academic achievement classify insufficient or sleep deprivation as less than 6 hours (Fallone et al., 2005; Roberts et al., 2009). A possible reason for the lack of relationship in the current study between sleep duration and academic achievement could be that the sleep duration of young adolescents in our research is longer than 6 hours, suggesting that no severe sleep deprivation occurred. However, even modest restrictions of sleep have been shown to affect school performance (Sadeh, Gruber, Raviv, 2003; Fallone et al., 2003; Wolfson & Carskadon, 1998). Experimental studies have revealed that sleep restriction of 1 hour less per night for three days had significant effects on 9-12 year-olds neurocognitive functioning and memory (Sadeh et al., 2003), and that sleep restriction during one school week caused a significant increase in teacher rated academic problems and attention problems in 6-12 year-olds (Fallone et al., 2005). In one cross-sectional research study it was reported that obtaining 25 minutes less sleep was associated with lower grades (Wolfson & Carskadon, 1998), suggesting that even slight temporary reductions or modest restrictions in sleep may have an effect on individuals' school performance.

Second, a recent meta-analyses (Dewald et al., 2010) reported that sleep quality, sleep duration, and sleepiness were all moderately related to school performance, however sleepiness showed the strongest relationship to school performance. The authors suggest that the negative consequences of sleepiness on neurobehavioural functioning and school performance are more consistent compared to measures of sleep duration, which were found to have inconsistent effects on school achievement (Dewald et al., 2010). An experimental study revealed that the effect of sleep loss on sleepiness preceded its effects on cognitive performance (Dinges et al 1997, as cited by Short et al., 2013). Short and colleagues (2013) suggest that insufficient sleep may lead to increased sleepiness, which in turn leads to diminished school performance. The subjective experience of sleepiness may be an important mediating factor between sleep behaviours and academic achievement, as sleepiness may help explicate the sleep need of an individual. A child may receive 9 hours of sleep, yet still feel sleepy the next day, resulting in lower academic performance.

Academic behaviour and participation. In addition to academic achievement, Buckhalt and Staton (2011, p.6) state that an equally important determinant of doing well at school is the "ability and motivation to behave well, including compliance with expectations of the teachers within the constraints of the typical school environment." While the current study may not have found an association between sleep and academic achievement, it found that young adolescents who went to bed and fell asleep later, and spent shorter durations in bed and asleep were rated lower on appropriate classroom behaviours and level of participation. This suggests that young adolescents who gain insufficient sleep struggle to maintain appropriate classroom behaviours and participate in the classroom environment. Additionally, this is in line with the current studies finding that students' prosocial behaviours are implicated in sleep loss.

Similar to the current findings, Meijer and colleagues (2000) found that young adolescents who spent more time in bed and had no difficulties getting up in the morning had more achievement motivation at school. When young adolescents obtained quality sleep and felt rested, they were more receptive to the teacher's influence and had a positive image of themselves as pupils, greater achievement motivation and greater self-control. In a secondary study, Meijer & Van den Wittenboer (2004) demonstrated that longer sleep duration, greater eagerness, higher achievement motivation, and intelligence all contributed to school performance, suggesting that multiple factors are implicated in how children and adolescents do at school. It is possible that if insufficient sleep and problematic classroom behaviours and non-participation accumulate over time then effects on academic achievement (grades) may be seen (Dotterer & Lowe, 2011). The take home message is that in addition to measures of academic achievement it may be beneficial for future research to include measures of appropriate classroom behaviours, including level of participation, that are equally necessary for academic success.

Summary and implications. The results of the present study indicate that sleep is a crucial aspect of young adolescent well-being and with many young adolescents obtaining insufficient sleep this may exact a heavy cost on their daily lives during the intermediate years of schooling. In particular, New Zealand young adolescents sleep/wake behaviours were associated with hyperactive/inattentive symptoms, prosocial and peer problems, and appropriate class time behaviours and the participation required for academic performance. These results suggest that sleep is primarily implicated in the social behaviours of young adolescents in the classroom and schooling context. If young adolescents sleep is insufficient for their day-to-day well-being then the ability to maintain appropriate behaviours, participate in the classroom environment and interact with peers could become compromised. It could be hypothesised that this may further contribute to problems at school, such as peer rejection and feelings of loneliness and isolation (Becker et al., 2015), difficulties in later academic achievement (Dotterer & Lowe, 2011) and school disengagement and dropout (Archambault, Janosz, Fallu, & Pagani, 2009). These factors may make it difficult to form important ties to school and peer groups, resulting on missed opportunities for social development.

6.3. The Sleep and Electronic Media Use of Young Adolescence

Consistent with previous research this study has examined a wide range of electronic media devices that have been found to be associated with sleep/wake patterns. This research contributes to the existing literature by identifying the relationship between New Zealand young adolescents sleep/wake patterns and i) their use of EMDs in the bed and before sleep; ii) their use of individual EMDs during the day and evening, including TV, computer/video consoles, mobile phones, and tablets/MP3 players; iii) overall screen time; iv) and specific activities on portable devices, such as text messaging, video games, and listening to music. Alongside remaining consistent with past studies, the current study provides insight into avenues of exploration for future research around the impact of EMDs on young adolescents' sleep/wake patterns.

6.3.1. Electronic media access and use in New Zealand households.

The recent New Zealand BSA (2015) report indicates that most children and adolescents have access to EMDs in the household, which is consistent with findings from the current study. Compared to the NSF (2006) report on American adolescents' access to EMDs in the bedroom, New Zealand young adolescents had much lower prevalence rate of devices in their bedrooms. For example, 53% of American 6^{th} – 8^{th} grade adolescents had access to a TV in their bedroom compared to only 18% of New Zealand young adolescents. This may be due to age differences between studies, as older adolescents may begin to acquire more EMD as they gain more autonomy from their parents (NSF, 2006; Rideout, Foehr, Roberts, 2010). The one exception was mobile phones, whereby New Zealand young adolescents had more bedroom access to mobile phones (46%) compared to American adolescents (21%). This is most likely reflective of the time difference of nearly ten years between studies, as mobile phone usage has increased in popularity over the recent years (Rideout et al., 2010).

Overall, the current study found that young adolescents spent more than two hours of their free time after school on EMDs. New Zealand young adolescent spent about an hour less on overall screen time than 11-13 years-old Australians (Olds et al, 2006). This difference may be due to the current study not taking school time use or homework use, and morning use into account, whilst Olds and colleagues (2005) used a 24-hour recall format. Out of all EMDs examined, participants spent the most time watching TV, which averaged to 70 minutes per day. Australian young adolescents (Mathers et al., 2009; Olds et al., 2005) and Israeli adolescents (Shochat et al., 2010) spent more than an hour longer watching TV compared to New Zealand young adolescents. Participants spend 33 minutes engaged in tablets and MP3 players, which is consistent with the recent broadcasting report (BSA, 2015). No international literature that the author is aware of has reported time durations of tablet or MP3 player use in children or adolescents. Game consoles and computer use followed with similar durations of around 20 minutes to Australia (Mathers et al., 2009; Olds et al., 2005). Israeli adolescents' computer use was an hour longer for games and two hours longer on the internet, compared to New Zealand young adolescents (Shochat et al., 2010). This difference may be due to the Israeli study including an older sample of 13-15 year-olds. Multiple studies have found that technology use duration increases with age (BSA et al., 2015; NSF, 2006; Oka et al., 2008; Olds et al., 2005). Finally, participants spent 22 minutes a day on mobile phones, which is consistent with their Australian counterparts (Mathers et al., 2009).

6.3.2. Electronic media bedroom presence and use pre-sleep.

The current study found a cumulative effect, whereby increasing numbers of EMDs in the bedroom were associated with later sleep onset time. The current study found that 30% of young adolescents used an EMD in bed before sleep onset, and pre-bedtime users fell asleep 20 minutes later than non-users. The presence of EMDs in the bedroom and use before bed has been associated with later BT, later awakening times (Li et al., 2007), and shorter sleep duration (Chahal et al., 2013; Eggermont & Van den Bulck, 2006; Li et al., 2007). These studies did not measure the sleep onset time of participants.

While the use of EMDs before bed and there presence in the bedroom has been implicated in difficulty initiating sleep in the current study, it has also been suggested by researchers to result in problems maintaining sleep (Van den Bulck, 2003). Social communication devices have been proposed to have an especially negative effect on sleep due to their use throughout the night (Van den Bulck 2003; Hysing et al., 2015). The current study found that only 2% of young adolescents were woken during the night due to an EMD. This is similar to a recent USA study by Buxton and colleagues (2015) where 3% of 11 year-olds reported reading or sending electronic communications after bedtime. Chahal and colleagues (2013) reported a higher frequency of 31% of 10-11 year-olds using an EMD on most or all nights of the week after they were expected to go to sleep. Chahal and colleague's item question appears to have been broader in scope, asking children what activities they engaged in after they were expected to go to sleep and may reflect childrens' media use both before they went to sleep and during the night.

6.3.3. Daytime and evening use of electronic media devices

Television. Young adolescents who watched more than the recommended two hours of television per school day woke up later in the morning. This is consistent with findings from Oka and colleagues (2008) and partially consistent with other studies that have also reported later waking times in children and adolescents (Adam, Snell, & Pendry, 2007; Li et al., 2007). However, these studies also reported later bedtimes. Many studies have found that children and adolescents who watch TV for long durations during the day or in the evening have later bedtimes, sleep onset latencies, and sleep onset times (Adam et al., 2007; Alexandru et al., 2006; Owens et al, 1999;), and shorter sleep durations (Thorleifsdottir et al., 2002; Shoshat et al., 2010; Van den Bulck, 2004). This appears to be a consistent finding across a range of ages and differing methodologies, making it difficult to determine why our findings were not completely in line with the majority of literature. It may be that New Zealand has a different culture around TV viewing practices and sleep patterns. To further elucidate why TV viewing in the current study wasn't associated with later bedtimes and sleep onsets, it may be of value to consider TV viewing practices and the context in which TV is used within families.

Paavonen and colleagues (2006) explored how TV viewing practices in a Finnish sample may be differentially associated with certain sleep problems. For example, watching TV alone was associated with disorders of initiating and maintaining sleep, and watching TV at bedtime was associated with sleep-wake transition difficulties. Children scoring high in sleep problems were more likely from families who had the TV switched on for long periods, and had experienced higher passive TV exposure. Both may lead to higher exposure to adult programming which was in turn associated to sleep problems (Paavonen et al., 2006).

The current study also found that young adolescents who watched TV for long periods of time had longer night wakings. It may be hypothesised that because participants' sleep was disrupted they were sleeping in to compensate for this loss of sleep during the night. Owens and colleagues (1999) also found that weekday television viewing was associated with night wakings. The current findings suggest that excessive television viewing may not lead to insufficient sleep from long night wakings because young adolescents are compensating by sleeping in on weekdays. This may become problematic as young adolescents transition to high school where start times are sometimes earlier, leading to less opportunity to make up for disturbed sleep.

Computer and game consoles. Young adolescents who spent more than two hours on computers and/or game consoles had later bedtimes, sleep onset times, and wake up times, without reduced sleep duration. This pattern of results suggests that computer and game console use is associated with a delayed phase of sleep rather than insufficient sleep. Conversely, multiple studies have found an association between computer and/or video game use and reduced sleep duration (Arora et al., 2014; Li et al., 2007; Oka et al., 2008; Van den Bulck, 2004; Yen et al., 2008). Similar results of a later sleep phase without insufficient sleep have been found in one other study (Adam et al., 2007) and computer usage has been reported to be positively associated with an eveningness chronotype in young adults (Fossum, Nordnes, Storemark, Bjorvatn, & Pallesen, 2014; Lin & Gau, 2013). Children and adolescents who engage in activities on computers or game consoles may have later sleep onsets due to difficulty in shutting of their minds (Arora et al., 2014). The visual content exposure or cognitive processes (decision making, problem solving, and memory) that occur from computer or video gaming may increase cognitive alertness (Arora et al., 2014; Weaver et al., 2010). Arora and colleagues (2014) suggest that a combination of mental excitation and delayed melatonin release from the artificial light emission may exacerbate the delayed circadian shift commonly experienced by adolescents. Future studies examining computer and video game use effects on sleep may find it beneficial to include measures of morningness/eveningness or melatonin levels.

Mobile phone. Mobile phone use of more than two hours was associated with delayed bed time and sleep onset of around 30 minutes and reduced time spent in bed and sleep duration of nearly an hour compared to non-users. This is consistent with a recent study by Arora and colleagues (2014) who observed increased risk for difficulty falling asleep and significant reductions in weekday sleep duration with bedtime mobile phone users. Other studies have found similar results where mobile phones in the bedroom, use during the day, and in the hour before going to sleep is associated with increased risk of insufficient sleep duration (Harada et al., 2002; Hysing et al., 2015; Kubiszewski et al., 2014). These results indicate the importance of including questions on mobile phone use in future research and clinical assessments of problematic sleep.

In a letter to the editor, Van den Bulck (2003) wrote that the threat of mobile technology to healthy sleep patterns is potentially more important than the threat posed by entertainment media. The latter may appear to affect time to bed, while the mobile phone seems to lead to interrupted sleep. While the current study found an association between mobile phone use and sleep, mobile phone use did not interrupt the sleep of this age group preceding adolescents. However, this phenomenon is something to be wary of as age increases.

Tablets and MP3 players. Young adolescents who used tablets and/or MP3 players for longer than two hour durations had later sleep onsets, fragmented sleep with shorter longest sleep periods and longer night wakings, and they scored 5% less in sleep efficiency compared to non-users. Consistent with the current findings, previous studies have reported that the use of tablets and MP3 players in the bedroom and before bed is associated with increased risk for insufficient sleep (Hysing et al., 2015; Kubiszewski et al., 2014). Two studies have found that tablet use was not associated with delayed SOL or shorter sleep duration in older adolescents and adults (Heath et al., 2014; Fossum et al., 2014). Older individuals may be less sensitive to EMDs impact on the physiological regulation needed to obtain behavioural quietude before sleep onset. The current study's findings suggest that young adolescents who spent longer durations of time on tablets or MP3 players experienced greater difficulties in intiating and maintain sleep, highlighting the importance of including tablets and MP3 players in future research. These results may reflect the marked increase in use of these devices in the daily lives of New Zealand youth, and highlight the need for parental vigilance over the length of time spent on these devices.

Portable device activities. The current study found no association between particular activities on portable devices (messaging, listening to music, and video gaming) with sleep/wake patterns. In contrast, Arora et al., (2014) reported that young adolescents who played video games, listened to music, or used the internet for social networking before bedtime had increased risk for difficulty falling asleep and switching off, and reductions in sleep duration. The greatest impact was observed with frequent users of social networking sites who reported almost one hour less of sleep (Arora et al.,). The current study only considered the multifunctionality of portable devices (tablets, MP3 players, and mobile phones) and did not include computers, laptops, game consoles, and TV’s in this. It should be noted that computers and other devices have multiple uses, allowing multiple tasks to be simultaneously undertaken. Hysing and colleagues (2015) recommend that findings concerning the relationship between EMD and sleep/wake patterns need to be carefully interpreted due to the multifunctionality of most electronic media platforms.

Overall screen time. Overall screen time was associated with later bedtimes and longer sleep onset latencies, and sleep onset times suggesting that longer durations of screen time during the day and evening may result in difficulties getting to bed and falling asleep. Overall screen time was also associated with shorter sleep duration, lower sleep efficiency, and more night wakings. Taken together, young adolescents overall EMU was associated with insufficient and disrupted sleep patterns. Numerous studies have reported screen time to be associated with later bedtimes (King, Delfabbro, Zwanns, & Kaptsis, 2014; Kubiszewski et al., 2014), longer SOL (Hysing et al., 2015), and reduced sleep duration (Chahal et al., 2013; Drescher et al., 2011; King et al., 2014; Hysing et al., 2015; Olds et al., 2006).

Drescher and colleagues (2011) found differential results depending on age group, where overall screen time was associated with shorter TST 10-13 year-olds, but not older adolescents aged 13-17 years. This finding suggests that screen time has a greater impact on sleep/wake patterns during the young adolescent period. It may be that young adolescents are at increased risk for more negative effects of electronic media use compared to their older counterparts. Future longitudinal and experimental research may help to shed light on the possibility of sensitive periods of development to the use of EMDs.

Summary and implications. Consistently, literature on children and adolescents electronic media use report greater access to numerous devices within the household. The commonality of EMDs is concerning given the current studies research findings linking EMU and multiple negative outcomes for sleep behaviours. Interestingly, television viewing was associated with the least sleep/wake variables out of all the EMDs examined. This may reflect that the act of watching television may be operationally dissimilar to the act of playing a video game or sending a text message. Television viewing may be a more passive activity requiring less direct attention and be associated with relaxation compared to other EMDs that require more interaction and engagement (Gradisar & Short, 2013). In New Zealand, television viewing is primarily a joint activity where only 27% of children watch TV by themselves, compared to the internet where 73% used it by themselves (BSA 2015). It may be that with less parental supervision, computers and portable media devices are used during more sensitive periods of time with possibly more harmful content, resulting in a greater impact on sleep. Taken together, normative values for children’s sleep/wake behaviours and EMU may guide parents, teachers, and health professionals to assist young adolescents with establishing good bedtime routines and healthy sleep hygiene habits.

6.4. Implications of the Findings

A number of research implications can be identified from the current study's contributions to our knowledge of young adolescent sleep/wake patterns, and associations between sleep behaviours, school time well-being, and electronic media access and use.

Young adolescents are a relatively understudied group with in New Zealand literature, and the current study suggests that even minor sleep disruptions in a non-clinical sample are associated with increased hyperactivity/inattention and decreased pro-social behaviours and appropriate classroom behaviours and participation. This begins to underscore the importance of good sleep in normal development during young adolescence.

Soffer-Dudek et al., (2011) states that while a combination of early affective changes during puberty and the slow emergence of reliable cognitive control may create a period of vulnerability for young adolescents, this also creates unique opportunities. This is a crucial time for learning and developing social and emotional skills. Current theory on the role of sleep proposes that sleep provides a time for the consolidation and maintenance of new and socially relevant information (Astill et al., 2012). For example, sleep has been implicated in the accurate recognition of facial emotions and expressions, which plays an important part in social cognition and skills (Killgore et al., 2008). Soffer-Dudek et al., (2011) assert that this provides an opportunity for early intervention to improve developmental trajectory. In particular, the current studies results suggest EMU plays an important role in acquirement of adequate sleep. The silver lining of this finding is that electronic media use is a modifiable behaviour and can be changed.

Overall sleep is an important aspect of child well-being and should not be overlooked when children present to medical professionals with behavioural problems at school. Interventions to treat sleep problems could make up an important component of wider behavioural interventions to help young adolescence in the regulation and maintenance of healthy behaviours. Improving sleep hygiene through education and better management of electronic devices could enhance the health and well-being of child and adolescent populations (Arora et al., 2014; Moseley & Gradisar, 2009).

6.5. Strengths of the Current Study

This investigation builds on existing literature by examining normal sleep in a New Zealand community sample of young adolescents and possible associations with well-being and electronic media use. Particular strengths include the use of a sleep-diary measure; focus on the schooling context and including measures of classroom behaviour and participation; and inclusion of multiple EMDs and an overall screen time variable measured across the school week.

Sleep diary. The use of a sleep diary is a main strength of the current study. It enabled a wide range of sleep/wake behaviours to be measured and analysed over the course of an entire school week, allowing for wealth of information on self-reported sleep patterns and possible sleep problems. Sleep diaries are often reliant on parental reports and recent findings illustrate the importance of adolescent-derived estimates of sleep patterns (Short, Gradisar, Lack, Wright, & Chatburn., 2013). The current's studies reliance on self-reported sleep behaviours may have resulted in greater accuracy in measures of bedtime and sleep initiation behaviours compared to parental reports, because they may over or underestimate sleep times due to a lack of knowledge (Horne & Biggs, 2013). In addition, the adherence to Short and colleagues (2013) recommendations for measurement of sleep behaviours over the course of a school week is a strength of the current study, as it provides information on multiple sleep behaviours that have been handled correctly (i.e., the measurement of the school week and TST). It is hoped that future studies on child and adolescent sleep will follow Short and colleagues (2013) recommendations to allow for greater accuracy and comparability in the literature on paediatric sleep. This will provide research that can greater inform health professionals working with youth and their sleeping difficulties.

Schooling context and academic performance. It has been identified that the consequences of inadequate sleep may first become evident at school (Aronen et al., 2000), as school is a challenging environment for young people, where the appropriate regulation of behaviours is important to fit in. The current study's use of teacher rated measures for socio-emotional and behavioural adjustment is a strength, as teachers have been shown to be reliant informants of child and adolescent daytime behavioural functioning (Paavonen et al., 2003; Aronen et al., 2000). In terms of academic performance, while the current study not only employed measures on academic achievement, it included measures of classroom behaviours and participation that are necessary for adequate engagement in the classroom context and for future academic achievement (Dotterer & Lowe, 2011). This identifies that when students are faced with a night of inadequate sleep it may be challenging to direct their energy appropriately, and respond adaptively and flexibly to changing instructions set by their teacher.

Multiple electronic media devices and screen time. A strength of the current study is the inclusion of multiple EMD and the duration of use over the school week. This provides a broader understanding into the duration of use of multiple EMDs and associations with sleep/wake behaviours. A particular strength is the inclusion of portable devices, such as mobile phones and tablets, which previously have gained little attention within sleep research. The current study's use of individual EMDs with multiple sleep variables was able to detect a delay in young adolescents sleep phase associated with computer use. Identifying patterns of sleep behaviours, such as this, is informative to possible mechanisms behind this association, such as delayed melatonin release or increased arousal. An additional strength was the inclusion of overall screen time, which provides an understanding into the collective effects of EMU (Gradisar & Short, 2013).

Taken together, in documenting associations between sleep/wake patterns, school time well-being, and EMU this strengthens the assertion that EMU may contribute to insufficient sleep, and insufficient sleep may contribute to behavioural difficulties at school. This could be further strengthened when considered across diverse samples and varying contexts, alongside statistical analyses that allow for links to be made between sleep, well-being, and EMU.

6.6. Limitations of the Current Study

There are several limitations to be aware of when interpreting the current study's findings. This includes the cross-sectional and homogeneous nature of the current study; retention rate and small sample size; and possible measurement error with respect to night wakings, LSP, and EMU.

Research design. The cross-sectional nature of the current study does not allow for any conclusive statements on possible cause and effect in the association between sleep/wake patterns, well-being, and electronic media use. While some findings from longitudinal studies suggest that sleep is more likely to predict well-being, rather than well-being predict sleep (Kelly & El-Sheikh, 2014), other findings suggests the causal relations between sleep problems and well-being appear to be bi-directional (Dahl & Lewin, 2002). On the one hand, insufficient sleep may be a result of child psychopathy and significant stressors in an adolescent's life, and on the other hand, psychopathology or not coping with daily life challenges could result from or be exacerbated by insufficient sleep. A number of studies have found that problem behaviours are marginally responsible for changes in sleep patterns (Friedrickson et al., 2004; Gregory & O'Connor, 2002; Kelly & El-Sheikh, 2014; Meijer et al., 2010). These results suggest that there may be reciprocal relations between sleep and well-being, and this could also be the case for EMU. While it may be the case where young adolescents' use of EMDs affects the time they go to bed and the amount of sleep obtained, it may also be the case where individuals who struggle to initiate and maintain sleep chose to use EMDs as a way to pass time (Eggermont & Van den Bulck, 2006). El-Sheikh et al. (2010) state that establishing directionality of effects is a very important consideration for future research, as directionality of effects may be different during various developmental periods.

Homogeneous sample. A main limitation in interpreting the current study's findings is the homogeneous nature of the sample in regards to ethnicity and SES. Both of which have been implicated in the relationship between sleep and well-being (Gellis, 2011; El-Sheikh et al., 2010; 2013). Participants' parents mainly identified as New Zealand European, highly educated, and from higher SES backgrounds, resulting in the sample not being representative of the South Island New Zealand population. In particular, there was an underrepresentation of Maori and Pacific Island participants and individuals within lower SES brackets. Therefor generalising the present findings to the broader New Zealand young adolescent population must be tentative. One New Zealand study on students aged 14-18 years found cultural differences in terms of sleep length, whereby New Zealand European students obtained the most sleep on weekdays (8:36 hours), followed by Maori (8:29 hours), Pacific Island (8:26 hours), and lastly Asian students (8:18 hours; Dorofaeff & Denny, 2006). Gellis (2011) proposes that sleep related problems are likely to do with a variety of factors including an individual's SES and ethnic background, and it has been suggested by Buckhalt & Staton (2011) that it is likely that the impact of sleep problems is not uniform across children and adolescents due to these individual differences. An additional factor to consider is that the distribution across EMD may not be equal across social groups. For example, the New

Zealand BSA report found tablet availability to differ for different socio-demographic groups (BSA, 2015). For example, tablets are more likely to be in higher income households and fewer tablets are found in Pacific Island homes, homes with younger parents, and lower income homes (BSA, 2015). The current study's finding on the access and use of EMDs may not be typical of the wider New Zealand population.

Retention rate and sample size. The present study has a small sample size of 148 participants and had a 50% attrition rate. The use of one off sleep questionnaires in previous studies has allowed for minimal attrition rates and greater numbers of participants to be included in the overall sample. In comparison, the current study's requirement of recording sleep/wake patterns and EMU every day over the course of an entire school week may be a large expectation of young adolescents with busy lives. Attrition from the study could affect generalizability, as non-participants have been shown to have more emotional and behavioural problems in comparison to participants (Stormark, Heiervang, Heimann, Lundervold, & Gillberg, 2008). There may be a possibility that sleep and associated problems are underrepresented in the current study.

Measurement of night waking. Whilst, the sleep diary is a primary strength in the current study, it is not a perfect measure. Diary measures are dependent on the accuracy and reliability of the person completing them, and thus also have a number of limitations (Horne & Biggs, 2013). Research comparing sleep diaries with actigraphy have shown the use of sleep diaries result in an overestimation of sleep duration through an underappreciation of night wakings (Tremaine et al., 2010). This suggests caution in the interpretation of self-reported episodes of night waking and subsequently the measurement of the LSP. It may be that participants in the current study have underreported the number and duration of night waking experiences. Horne and Biggs (2013) suggest that a combination of actigraphy and sleep diary measures is required for gathering the most accurate information regarding sleep/wake patterns. Despite this, sleep diaries provide a useful methodology to collect valuable information regarding the profile of sleep/wake patterns in children and adolescents, and although objective data would be informative, sleep diaries and questionnaires remain the most widely used and cost effective measures in community samples (Horne & Biggs 2013).

Measurement of EMU. Results for young adolescents' EMU were based on self-report diaries, and there is limited research to validate measures of self-reporting of EMU among children and adolescents (Hale & Guan, 2015). The current study's method of recording EMU in 30 minute time slots may create an inflated estimation. For example, while an participant may have sent three text messages and ticked the corresponding 30 minute box, they may have only spent 5 minutes on their phone. One study with adults showed that participants are more likely to over report than under report the frequency of mobile communications (Kobayashi & Boase, 2012). This study used a smart phone Application that records logs of calls, text messages and Gmail activity to compare to self-report questionnaires. There are a number of Apps available for recording the amount of time spent on electronic communication devices. However, self-reports remain the most cost-effective and manageable method of conducting research such as this.

6.7. Directions for Future Research

Although the current study has provided novel findings with respect to associations between young adolescent sleep/wake behaviours, well-being, and EMU, further research is required to gain a greater understanding of these associations within a New Zealand context. Furthermore, additional factors must be considered to better inform current theory on the role sleep plays throughout development.

A greater representation of the New Zealand population is needed in future studies on sleep/wake patterns. Other New Zealand studies examining children's sleep have had similar difficulties in obtaining a representative sample of the population (Nixon et al., 2008). Similar to the current study's findings, El-Sheikh et al (2010) found that sleep problems were unrelated to internalising symptoms. However, this was only for children from high SES backgrounds. Sleep problems were positively related to internalising symptoms for children from lower SES families. The negative effects of sleep problems in terms of socio-emotional behavioural problems and academic achievement have been found to be more pronounced for ethnic minorities and children from lower SES homes, which may be due to chronic stress from living in adverse conditions (Buckhault et al., 2009; El-Sheikh et al., 2010). There are no studies examining the role of ethnicity and SES in the association between sleep and well-being from New Zealand that the author is aware of, with most studies conducted in Britain and the USA. This demonstrates the importance of future New Zealand studies taking into consideration the broader sociocultural milieu when examining children and adolescents well-being outcomes from insufficient sleep. In summary, the current study may have failed to find an association between sleep and internalising problems and academic achievement because the homogeneous profile of participants may be protective of poor outcomes of insufficient sleep. Future studies should endeavour to have a representative sample across the New Zealand population to best be able to explore the association between these variables, and whether SES and ethnicity play a role in New Zealand children and adolescents experience of inadequate sleep.

A number of additional factors have been identified to be of importance to our understanding of the development of sleep and are of use to future research studies examining the relationship between sleep, well-being, and EMU. These include measures of weekend sleep, pubertal status, subjective feelings of sleepiness, parental rules around sleep behaviours, and a broader range of variables that encompass the concept of sleep hygiene.

Weekend sleep. In addition to findings of young adolescents gaining insufficient sleep during weekdays, research often finds that those with reduced sleep durations may try to compensate for this during weekends (Canet, 2010; cite more). Additional data on weekday and weekend sleep variability would be informative to our understanding of the common phenomenon of sleep phase delay seen through the development of adolescence (Carskadon, 2002). Weekend sleep is thought to be representative of adolescents sleep needs and true circadian rhythm. Furthermore, inconsistent sleep schedules between weekdays and weekends have been associated with behavioural difficulties of hyperactivity, internalising problems, and lower grades (Biggs, Lushington, Van den Heuvel, Martin, & Kennedy, 2011; Wolfson & Carskadon, 1998).

Pubertal status. Pubertal status has been linked to longer sleep onset latency and has been implicated in the sleep phase drift thought to begin during the young adolescent period (Carskadon et al, 2004). Later sleep times coupled with later melatonin onset occur for adolescents at a more mature pubertal stage, suggesting that the onset of the ‘biological night’ is later for more mature adolescents (Andrade et al., 1993; Carskadon et al, 1997). Sadeh and colleagues (2000) suggest that the ongoing and gradual process of sleep phase “drift” may occur earlier than previously hypothesised. This may be due to the marked secular shift in age at which children, especially girls, enter puberty (Parent et al., 2003). Puberty has also been implicated in the expression of psychosocial problems due to reduced sleep (Johnson et al., 2000). A future study could incorporate an evaluation of young adolescent’s development, such as Tanner’s stages (Rico, et al., 1993), to gain greater understanding of how biological changes taking place may interact with pre-sleep behaviours, sleep and well-being.

Sleepiness. It would be informative to include a measure of daytime tiredness or sleepiness, as these constructs have been shown to have a stronger relationship with socio-emotional and behavioural functioning, and academic achievement that sleep parameters of sleep duration or quality (Dewald et al., 2009). Self-reported ratings of sleepiness inform our understanding of sleep need, and whether children obtaining less than the recommended amount of sleep experience daytime effects of sleepiness.

Parental rules. Parent set bedtimes have been shown to be related to improved sleep behaviours and less daytime fatigue in adolescents (Short et al., 2011). In 6-11 year-old children, Buxton and colleagues (2015) found that children of parents who enforce rules on EMU slept on average one hour longer than children without rules (Buxton et al., 2015). This may be an important consideration for future studies, given that young adolescence is time of increased autonomy around bedtime.

Sleep hygiene. Multiple factors have been identified as detrimental to child and adolescent sleep patterns including the family environment, social, academic, and sport demands, caffeine, and the use of electronic media (Bartel et al, 2015; Buxton et al., 2015). These external factors are described as being under the umbrella term of “sleep hygiene” and are classified as a set of behaviours that have the propensity to be incompatible with the development and maintenance of healthy sleep patterns (Bartel et al., 2015). Broader reports of sleep hygiene with the inclusion of EMU will provide an in depth understanding of young New Zealand adolescents’ daily demands and activities that may be incompatible with sleep.

6.8. Concluding Remarks

The purpose of this project was to present New Zealand data on the sleep patterns of young adolescents, and to begin to describe the frequency of sleep behaviours that may be problematic for young adolescents during their intermediate schooling years. Alongside this, the relationships between sleep behaviours and school time well-being and the use of electronic media devices were described to provide insight into possible factors that may be impacting on the sleep of New Zealand youth and how insufficient sleep may be associated with problematic behaviours at school. As far as the researcher is aware, this is the first study in New Zealand to provide normative sleep diary data on young adolescents sleep across school days. It has also provided unique New Zealand data on the relationship between young adolescents sleep, well-being, and EMU.

Stable sleep patterns were identified, that were mostly consistent with international data on young adolescents sleep. Young adolescents aged 11-12 were found on average to obtain the recommended 9 hours of sleep. However, a large number of participants were obtaining less than the recommended duration of sleep. It is therefore important to consider why this may be. The duration of screen time was associated with later bedtimes, shorter sleep onset latencies, sleep onset times, alongside shorter total sleep times. It could be hypothesised that young adolescents aren’t reaching their ideal sleep time due to daytime use of electronic media. A number of mechanisms have been described to explain how electronic media devices may result in troubles of getting to bed, and initiating and maintain sleep, such as displacing time and increasing arousal.

School time problems from insufficient sleep were identified and the pattern of results from the current study suggest that young adolescents who are sleep deprived demonstrate problem behaviours that are imperative for initiating and maintaining friendships with peers, and class time and school engagement. While previous research has investigated similar outcomes as the current study, no studies have found this pattern of results. With more understanding of sleep requirements of this age group preceding adolescents, strategies may be implemented by parents, schools, health professionals, and young adolescents to improve sleep hygiene and habits, and subsequently well-being during this important period of transition.

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Appendix A

Dear [principal],

I'm a Masters student from the University of Canterbury, and I'm currently working under the supervision of Dr Jacki Henderson with the Canterbury Child Development Research Group. We are wanting to conduct a study on Year 7 children's sleep patterns and technology use. This involves us working with schools and we are interested in involving [school] Intermediate in this research.

The research involves looking at children's technology use and sleep patterns over a typical school week and one weekend. Most of this information will be recorded by the children themselves into a Sleep and Activity diary. Further information sought includes children's daily functioning. This includes their emotional and behavioural functioning, and their academic performance. This information will be recorded in short questionnaires by parents and the Year 7 teacher, respectively. Through this we will gain information such as attention levels, how well they do in a class room environment, and if they complete homework.

Part of this would include myself visiting the schools involved and talking to the year 7 classes to outline how to fill out the Sleep and Activity diary step by step, and answering any questions children may have. Children will receive a movie voucher on completion of the sleep diary.

I would really appreciate if I could organize a time to meet with yourself, or deputy Principal, to discuss this research, if it is something [school] Intermediate would be interested in. We currently have one Intermediate school from Christchurch involved in the study, and are now seeking Dunedin schools. Ultimately I would love to create a working relationship with [school] so that I can complete my research on a topic of great importance for New Zealand children.

I look forward to your reply

Best regards,

Beth Milne

Appendix B

Department of Psychology
Christchurch Child Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
28/10/14

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Turning in or Tuning in: A study into the sleep and technology use of children

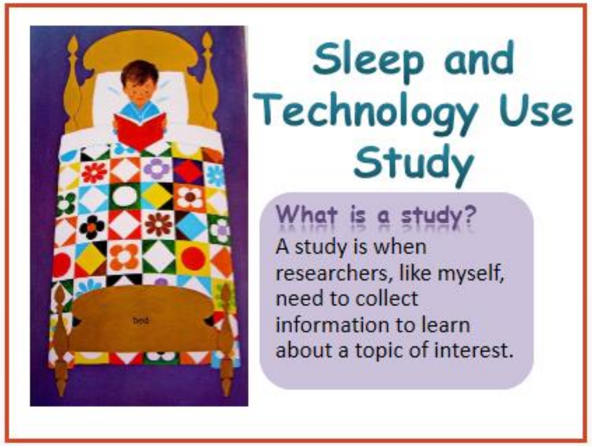
Information for Parents

My name is Elizabeth Milne. I am a postgraduate student in the Psychology Department at the University of Canterbury. I am going to be conducting a research study on the relationship between Year 7 children's technology use, sleep patterns, and their daily functioning. On Monday the 3rd of October children who indicate they would like to take part in the study will be given a "sleep pack" to bring home and talk with their parent/caregiver about what is involved in participating in the study. Participation in the study will involve children filling out a Sleep and Activity Diary for 7 days which should take around 5 minute each day, and a parent/caregiver to complete 3 short questionnaires. This study has been approved by the University of Canterbury Human Ethics Committee.

If you and your child decide to participate I would be really grateful if you can first complete the parent/caregiver consent forms to take part in the study, and then encourage and check that your child fills out their Sleep and Activity Diary in the morning and/or before they go to bed. This research topic is of great importance to assist in our understanding on how our young children are responding to the increase in technology use.

If you or your child decides not to take part in the study, please return the sleep pack to your child's teacher. When your child has completed their Sleep Diary could they please take it back to school with the other forms in the envelope and return it to their teacher on Monday the 10th of November. If you have any questions concerning the study please contact me at elizabeth.milne@pg.canterbury.ac.nz or on 364 2987 ex.3620.

Appendix C



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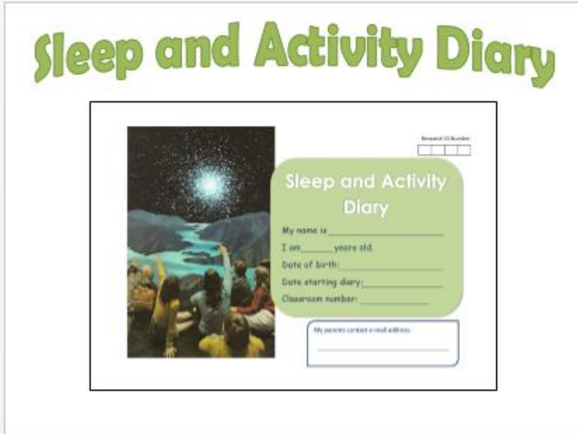


5

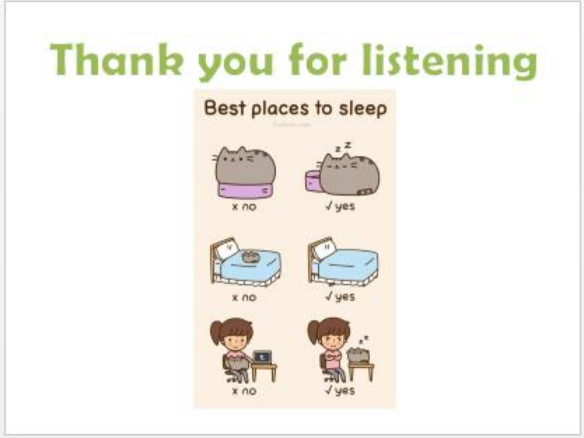
6


Night time sleep
Night 1: Night time sleep
Day:
9.00
10.00
text
15mins
Text
friend
I'LL RISE,
BUT I WON'T SHINE

7


What are the benefits of being in this study?
This study will help us understand more about sleep.
And most importantly, Timezone is kindly giving you 3 FREE game tokens if you remember to fill in your sleep dairy every day and hand it in fully completed!

8


Thank you for listening
Best places to sleep
x no
√ yes
x no
√ yes
x no
√ yes

9

Appendix D

Department of Psychology
Christchurch Child Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
10/10/14

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Information sheet for Parents

My name is Elizabeth Ann Milne. I am a student at the University of Canterbury and currently studying towards my Master's in Science, majoring in Psychology. As part of my degree I have chosen to work within the Christchurch Child Developmental Research Group to study technology use, sleep patterns, and development in Intermediate school children.

What is the purpose of the study?

The purpose of this research is to better understand the relationship between children's use of technology, sleep patterns, and daytime functioning. This research will give us an opportunity to assess New Zealand children's sleep patterns when the use of electronic media is rapidly increasing.

If you and your child agree to participate in the study your child will need to fill out each day for 7 days a Sleep and Activity Diary. They may like to begin filling out their diary on Monday afternoon and finish on the following Monday. Your child will record their sleep behaviours, i.e. time in bed, night waking, and what they did while awake (e.g. did they try to go back to sleep or watch TV?). I have visited your child's school and explained the study, describing how to use the Sleep and Activity Diary step by step and answering any questions of theirs.

My research study will also asses children's daily functioning and academic performance. This will be assessed in questionnaires that the parent and child's teacher complete. In terms of academic functioning, we will gain information such as attention and skill levels, and how well they do in a classroom environment.

What do I have to do?

Your involvement in this project will be to fill out three questionnaires. These include (1) a survey about your household technology; (2) Strengths and Difficulties Questionnaire which is a general measure of adjustment in children; (3) and Behaviour Assessment System for Children to assess children's behaviour and self-perceptions. Filling out these questionnaires should take about 20 minutes.

I would be very grateful if you could please encourage your child to complete their Sleep and Activity Diary in the morning and/or before they go to bed. This should take 5 minutes each day. Your child will receive a Timezone 'Certificate of Excellence' and 3 free game tokens for helping in this research study. Your child will get this after they have returned the forms and sleep diary in the envelope provided to their form room teacher.

There are no foreseeable risks in the performance of these tasks for you or your children.

You may receive a copy of the project results by contacting the researcher at the conclusion of the project. Furthermore, I will offer to present the study's findings at a school meeting, where the Board of Trustees, staff, and parents will be invited. Children's classrooms may also receive a poster of the results on technology use and sleep patterns.

Participation is voluntary and you have the right to withdraw at any stage without penalty. If you withdraw, I will remove information relating to you and your child. However, data removal becomes impossible once all questionnaires and sleep diaries have been put together, as they then become anonymous.

The results of project may be published, but you may be assured of the complete anonymity of data gathered in this investigation: your identity or your child's identity will not be made public. To ensure anonymity, all data will be stored at The University of Canterbury, and only I and my supervisors Dr Jacki Henderson and Professor Neville Blampied will have access to the data. A thesis is a public document and will be available through the UC Library.

This project is being carried out as a requirement for a Masters in Science by Elizabeth Ann Milne under the supervision of Dr Jacki Henderson and Professor Neville Blampied, who can be contacted at jacki.henderson@canterbury.ac.nz or on 364 2987 ex. 3679 and neville.blampied@canterbury.ac.nz or on 364 2199. They will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree for your child to participate, please sign your consent form. If you do not wish to participate, please return all forms in the envelope to your child's teacher.

Thank you for your time,

Elizabeth Ann Milne

Appendix E

Department of Psychology
Christchurch Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
10/10/14

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Information Sheet for Children

Hi, my name is Elizabeth Ann Milne. I am a student at the University of Canterbury, and I'm currently studying children's technology use, sleep, and their development.

What is a study?

A study is when researchers, like myself, need to collect information to learn about a topic of interest. I want to learn about technology use at home, and your sleep patterns. I would like to have 300 students in my study.

Today we use more technology than ever before. My family got their first computer when I was 12 years old, and we only ever had the one! Now most families have multiple communication devices, like laptops, iPads, and mobile phones.

One household computer compared too...

Lots of computers, often each person has their own

My family also got a mobile phone that *we all* had to share, and it couldn't even text! We could only make phone calls from it.

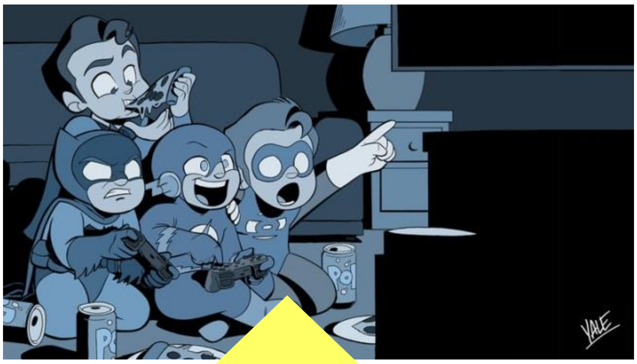
A handheld phone compared too...

A mobile that you can call and text, get internet access, play games, take photos and videos, listen to music, and more.

We would like to invite you to be a part of a study on your everyday technology use and sleep patterns. For example, do you have your own computer, and do you use it before bed?

What will you have to do?

If you take part in the study you will fill out a sleep and activity diary of your sleeping and waking times. This will be filled out over 7 days. You will also tell us how much technology you use each day.



Who will see the information you give us?

The only people who will be able to see your sleep diary will be the people working on the study

What are the benefits of being in this study?

This study will help us understand more about sleep,

And most importantly, Timezone is kindly giving you 3 FREE game tokens if you remember to fill in your sleep dairy every day and hand it in fully completed!

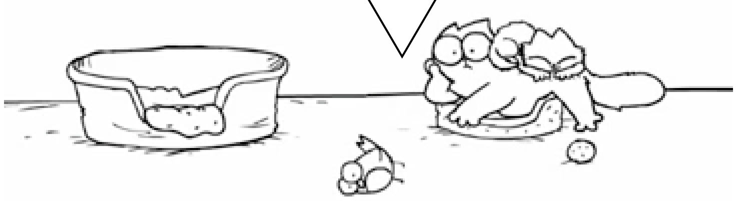
You will also receive a summary of the results at the end of the study.

Do I have to be in the study?

You don't have to be in the study if you don't want to be. If you choose not to be in the study just let your parents, teacher, or I know. Most importantly, if you say *yes* to begin with and then change your mind later on, you can still pull out of the study.

Questions

If you have any questions you can talk to your parents or me. I will be visiting your school, where I can take all your questions. If you think of a question during the study you or your parents can contact me.



Appendix F

Department of Psychology
Christchurch Child Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
10/10/14

UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND

Information sheet for teachers

My name is Elizabeth Ann Milne. I am a student at the University of Canterbury and currently studying towards my Master's in Science, majoring in Psychology. As part of my degree I have chosen to work within the Christchurch Child Developmental Research Group to study the technology use, sleep patterns, and development in Intermediate school children.

What is the purpose of the study?

The purpose of this research is to better understand the relationship between children's use of technology, sleep patterns, and daytime functioning. This research will give us an opportunity to assess New Zealand children's sleep patterns as the use of electronic media rapidly increases.

Children will fill out each day in a 7 day Sleep and Activity Diary, which begins on a Monday night and finishes on the following Monday. Children will record their sleep behaviours, i.e. time in bed, night waking, and what they did while awake (e.g. did they try to go back to sleep or watch TV?). I will be visiting schools to explain the study to children. This will involve me outlining how to use the Sleep and Activity Diary step by step and answering any questions children may have.

My research study will also asses children's daily functioning and academic performance. Parents will fill out questionnaires on their child's daily functioning. We would appreciate your assistance and participation in filling out a brief measure on academic performance and school time behaviour on each of your pupils involved in the research study.

What do I have to do?

Your involvement in this project will be to fill out a brief questionnaire per child. Through this we will gain information such as attention and skill levels, and how well the child does in a class room environment. Each questionnaire will take 5-10 minutes to complete per child. You will also receive compensation for your help and involvement in this research study.

We would also appreciate to organize a time that suits your classroom schedule to visit the school. This will be a short 15 minute visit to introduce the study to the children and can be conducted in a Year 7 assembly or by visiting classrooms. The children will be taken through how to fill out the sleep diary via a projection, power-point presentation, or a verbal introduction, depending on the facilities available. At the end of the introduction children will be sent home with a package to take home to their parents. This will include the information sheets for the parents/guardians and children, the parents' consent and child's assent form, the sleep and activity diary, and 3 questionnaires' for the parents. These packages will be returned by the children to you. We would appreciate it if you could deliver these to the office or Principal. An appropriate date of return will be outlined in the information sheet.

We will then pick them up and once all packages have been collected and checked that all items are included, incentives of Timezone game tokens will be handed out by myself to the children. You will receive a brief questionnaire on the child's academic performance and school time behaviour once we have received the parents' consent and child's assent forms. As an acknowledgement of your commitment and help, you will receive a Westfield voucher priced in accordance to your workload.

There are no foreseeable risks in the performance of these tasks for you or your students.

You may receive a copy of the project results by contacting the researcher at the conclusion of the project. Furthermore, I will offer to present the study's findings at a school meeting, where the Board of Trustees, staff, and parents will be invited. Children's classrooms may also receive a poster of the results on technology use and sleep patterns.

The results of project may be published, but you may be assured of the complete anonymity of data gathered in this investigation: your identity will not be made public. To ensure anonymity, all data will be stored at The University of Canterbury, and only I and my supervisors Dr Jacki Henderson and Professor Neville Blampied will have access to the data. A thesis is a public document and will be available through the UC Library.

This project is being carried out as a requirement for a Masters in Science by Elizabeth Ann Milne under the supervision of Dr Jacki Henderson and Professor Neville Blampied, who can be contacted at jacki.henderson@canterbury.ac.nz or on 364 2987 ex. 3679 and neville.blampied@canterbury.ac.nz or on 364 2199.They will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

Once you have completed the questionnaires I would appreciate it if you could return these to the school office.

Thank you for your time,

Elizabeth Ann Milne

Department of Psychology
Christchurch Child Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
29/10/14

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Consent Form for Parents

I have been given a full explanation of this project and have had the opportunity to ask questions. I understand what is required of me if I agree to take part in the research.

I understand that participation is voluntary and I may withdraw at any time without penalty. If I withdraw from participation this will include any information I have provided to be withdrawn should this remain achievable.

I understand that any information or opinions I provide will be kept confidential to the researcher, Dr Jacki Henderson, and Professor Neville Blampied, and that any published or reported results will not identify the participants or their school. I understand that a thesis is a public document and will be available through the UC Library.

I understand that all data collected for the study will be kept in locked and secure facilities and/or in password protected electronic form. Data may be stored up to ten years.
I understand that I am able to receive a report on the findings of the study by contacting the researcher at the conclusion of the project.

I understand that I can contact the researcher Elizabeth Ann Milne at elizabeth.milne@pg.canterbury.ac.nz on 364 2987 ex. 3620, or supervisors Dr Jacki Henderson at jacki.henderson@canterbury.ac.nz on 364 2987 ex. 3679, and Professor Neville Blampied at neville.blampied@canterbury.ac.nz on 364 2199 for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

By signing below, I agree to participate in the research project.

I……………………………………………………(full name) hereby consent for my child

……………………………………………………..(full name) to take part in this study

Signature……………………………………………Date………………………………

Contact Details:

Phone No: ______________________________ Email: ______________________________

Tick box if you would like to receive a summary of the results ☐

If you don’t agree for you or your child to participate please return all forms in their envelope to your child’s teacher.

Appendix H

Department of Psychology
Christchurch Child Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
21/11/14

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Assent Form for Children

Sign the form only if you:

- ✓ Have understood what you will be doing in this study,
- ✓ Have had all your questions answered,
- ✓ Have talked to your parent(s) or legal guardian(s) about this project, and
- ✓ Agree to take part in this research.

Print your name here: ____________________

Signature: ____________________

Date: ______ / ______ / ______
Day Month Year

Tick box if you would like to see the results of the study ☐

Elizabeth Ann Milne

Appendix I

Department of Psychology
Christchurch Child Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
15/12/14

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Turning in or Tuning in: A study into the sleep and technology use of children

I would just like to thank all Year 7 children and their parents/caregivers who participated in my research study. I've had a great turnout rate, especially with children filling out their Sleep and Activity diaries consistently over 7 days, which is no easy feat! I look forward to letting you all know the results.

If you still have a sleep pack at home, half used or not filled in, could you please hand the sleep pack back to the school office by the end of term. It would be of great help to return the packs to me so I can make use of them again. If your child's school is now closed for the year please send the packs back to:

Elizabeth Milne
Room 226-Psychology Office
Psychology Department
University of Canterbury
20 Kirkwood Ave
Ilam
Christchurch

I would also like to say thank you to all Year 7 teachers, Patrice Connor and Tony Hunter for facilitating this research. I wish everyone a merry Christmas and a happy New Year! If you have any questions concerning the study please contact me at elizabeth.milne@pg.canterbury.ac.nz or on 364 2987 ex.3620.

Kind Regards,

Elizabeth Milne

Appendix J

Research ID Number

Sleep and Activity Diary

My name is ____________________

I am______ years old.

Date of birth: ____________________

Date starting diary: ____________________

Classroom number: ______________

My parents contact e-mail address:

____

EXAMPLE: Technology Diary from afternoon to bedtime. Day: Monday

Please tick ✓ or colour in what technology devices you used in the table below. Each box equals **30 minutes or half an hour** time slots.

You may not fill in all the slots because of sports or school activities. If you use any technology for homework please tick the **For Homework** column.

Which of these devices did you use and when?														
Time	IPOD			IPAD/TABLET			IPHONE/Android			TV	Game Console	PC Computer	For Homework	
	Skype/ Messaging	Music	Gaming	Skype/ Messaging	Music	Gaming	Skype/ Messaging	Music	Gaming					Scoring
3.00-3.30														
3.30-4.00			SPORTS PRACTICE											
4.00-4.30												✓	✓	
4.30-5.00														
5.00-5.30														
5.30-6.00	✓	✓	✓							✓				
6.00-6.30	✓	✓	✓				✓			✓				
6.30-7.00														
7.00-7.30			TEA TIME											
7.30-8.00										✓				
8.00-8.30										✓				
8.30-9.00														
9.00-9.30														
9.30-10.00														
10.00-late														

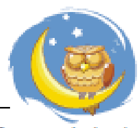
DAY 1: Technology Diary from afternoon to bedtime. Day: ____________________

Please tick ✓ or colour in what technology devices you used in the table below. Each box equals 30 minutes or half an hour time slots.

You may not fill in all the slots because of sports or school activities. If you use any technology for homework please tick the **For Homework** column.

Which of these devices did you use and when?														
Time	IPOD			IPAD/TABLET			IPHONE/Android			TV	Game Console	PC Computer	For Homework	
	Skype/ Messaging	Music	Gaming	Skype/ Messaging	Music	Gaming	Skype/ Messaging	Music	Gaming					Scoring
3.00-3.30														
3.30-4.00														
4.00-4.30														
4.30-5.00														
5.00-5.30														
5.30-6.00														
6.00-6.30														
6.30-7.00														
7.00-7.30														
7.30-8.00														
8.00-8.30														
8.30-9.00														
9.00-9.30														
9.30-10.00														
10.00-late														

Night 1: Night time sleep



Day: ____________________

Time you went to bed: ____________________

What did you do in Bed before going to sleep? E.g. read a book, message a friend. ____________________

What time did you turn out your bedroom light? ____________________

Time it took to fall asleep: please circle answer

0-10 mins	10-20 mins	20-30 mins	30-60 mins	60 mins or longer How long?

Did you have trouble falling asleep? ☐ YES ☐ NO

Did you wake up during the night? ☐ YES ☐ NO

If YES please fill out the table below:

	Woke up once	2nd time awake	3rd time awake	Coding
What time did you wake up?				#Wakings
Did anything wake you up?				
How long were you awake for?				Duration
What did you do when you work up?				

Time awake in the morning? ____________________

Did something wake you? YES ☐ NO ☐

What time did you get out of bed for the day? ____________________

Researcher use only	
SO:	
SOL:	LSRP:
TA:	#NW:
TAW:	DRTN:
Total TIB:	T/A DN:
TST:	

Final Questions on Sleep and Technology Use

Do you think you are a good sleeper? ☐YES ☐NO

If you could change anything about your sleep patterns what would that be?

____

____

____

You have reached the end of the Sleep and Activity Diary!

Thank you for filling it out!

Please hand it in to your teacher with all of your parent's forms and receive your TimeZone voucher!

Appendix K

Department of Psychology
Christchurch Child Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
10/10/14

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Teacher Questionnaire

Students Name: ______________________________ Date: ________________

For how long have you been teaching this student? Months [ ]

ACADEMIC ABILITY

Overall, how would you rate this child's progress in the following academic areas in comparison with other children of the same age?

	More than 1-year delayed	Below average	Average	Above average	More than 1-year ahead
Mathematics	1	2	3	4	5
English Language Spoken	1	2	3	4	5
English Language Written	1	2	3	4	5
Art	1	2	3	4	5
Physical Education	1	2	3	4	5
Health	1	2	3	4	5
Technology	1	2	3	4	5

Overall, how would you rate this child's progress in the following skill areas in comparison with other children of the same age?

	More than 1-year delay	Below average	Average	Above average	More than 1-year ahead
Communication skills	1	2	3	4	5
Numeracy skills	1	2	3	4	5
Information skills	1	2	3	4	5
Problem-solving skills	1	2	3	4	5
Self-management skills	1	2	3	4	5
Social and co-operative skills	1	2	3	4	5
Work and study skills	1	2	3	4	5

What level of the NZ curriculum (i.e. National Standards) do you anticipate that this student will reach by the end of **YEAR 7** in the following school subjects?

	Level 2 or lower	Level 3	Level 4	Level 5	Level 6 or higher
Mathematics	1	2	3	4	5
English	1	2	3	4	5
Science	1	2	3	4	5
Social Sciences	1	2	3	4	5
Learning Languages	1	2	3	4	5
The Arts	1	2	3	4	5
Health and Physical Education	1	2	3	4	5
Technology	1	2	3	4	5

Please indicate whether the following behaviours are characteristic of the child by circling either:

1= Never
2, 3, or 4 = Sometimes (base your judgement on how frequently the behaviour occurs)
5 = Frequently

	Never	Sometimes			Frequently
Makes appropriate transitions between different activities	1	2	3	4	5
Completes school work without being reminded	1	2	3	4	5
Listens and carries our directions from teachers	1	2	3	4	5
Completes school assignments or other tasks independently	1	2	3	4	5
Completes school assignments on time	1	2	3	4	5
Asks for help in an appropriate manner	1	2	3	4	5
Produces work of acceptable quality for his/her level	1	2	3	4	5

SCHOOL PARTICIPATION

Please rate the student on how well they participate in the following classroom behaviours compared to other children of the same age:

	Not at all	Only a little	Quite a lot	A great deal
Puts in effort in class	1	2	3	4
Shows persistence	1	2	3	4
Concentrates on task or on topic	1	2	3	4
Pays attention	1	2	3	4
Asks questions	1	2	3	4
Contributes to class discussion	1	2	3	4

Appendix L

Department of Psychology
Christchurch Child Development Research Group
64 3 364 2987 ex. 3620
elizabeth.milne@pg.canterbury.ac.nz
10/10/14

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Parent Questionnaire on Demographic information

Name:_______________________________________

Age: ☐ 20-30 ☐31-40 ☐41-50 ☐51-60 ☐61-70 ☐71-80

Please tick the appropriate boxes concerning you.

Gender:☐Female
☐Male
☐Other

Which ethnic group do you belong to?
☐ New Zealand European
☐Māori
☐Samoan
☐Cook Island Maori
☐Tongan
☐Niuean
☐Chinese
☐Indian
☐Other such as DUTCH, JAPANESE, TOKELAUAN. Please state: ______________________

What is your highest form of education?
☐No Qualifications
☐Sixth Form School Certificate/Year 13 NCEA Level 3
☐University Degree in ________________________
☐Other Tertiary Qualification in _____________________________________
☐Higher Degree (e.g. Masters or PhD) ________________________________

What is your current employment? ____

Is this paid employment? YES☐ NO☐

Can you please describe your role i.e. Manager of what company or stay at home mother?

____

____

P.T.O

How many parents/caregivers living in the household? ____________________________________

What is your current relationship status?

☐Single

☐Defacto relationship

☐Married

☐Civil union

☐Separated

☐Divorced or Dissolved

☐Widowed or surviving civil union partner

How many children do you have? _____________

How old is each child? ______________________

Child's name who is participating in study: ____

Age of child: _____________

Gender of child: ☐Male

☐Female

☐Other

Does this child share a room with another sibling? Yes/No

Does this child share a room with anyone other than a sibling? Yes/No

If yes, how many other people in the room? __________________

How many children in the room? __________________

Appendix M

Parent Questionnaire on Technology

The aim of this questionnaire is to find out about your household availability to technology devices.

What technology devices do you have collectively in your household? Please tick the appropriate box and record how many of each device is in your home.

Device	Number:	
☐ Television		
☐ Computer		
☐ Laptop (work or personal)		
☐ iPod		
☐ Land line telephone		
☐ Mobile phone		How many are smart phones?
☐ Tablet (e.g. an iPad)		
☐ Stereo/Radio		

What technology devices does your child have access to? Please record how many of each device

Device	Number:	
☐ Television		
☐ Computer		
☐ Laptop		
☐ iPod		
☐ Land line telephone		
☐ Mobile phone		How many are smart phones?
☐ Tablet (e.g. an iPad)		
☐ Stereo/Radio		

What technology devices does your child own? Please record how many of each device

Device	Number:	
☐ Television		
☐ Computer		
☐ Laptop		
☐ iPod		
☐ Land line telephone		
☐ Mobile phone		Is this a smart phone? Yes/No
☐ Tablet (e.g. an iPad)		
☐ Stereo/Radio		

What technology devices are in your child's bedroom?

☐ Television	☐ Mobile phone	Is this a smart phone? Yes/No
☐ Computer	☐ Tablet (e.g. an iPad)	
☐ Laptop	☐ Stereo/Radio	
☐ iPod		
☐ Land line telephone		

Appendix N

Adjusted Mean Difference for Continuous Sleep Outcomes by Time Spent Using Electronic Media Devices : One of three tables

Specific Electronic Media Devices	Bed Time		Sleep Onset		Sleep Onset Latency	
	Mean Difference [95% CI]	*P* Value	Mean Difference [95% CI]	*P* Value	Mean Difference [95% CI]	*P* Value
IPod or IPad/Tablet						
None	Reference		Reference		Reference	
<2 Hr	1.76 [-11.85, 15.36]	.80	5.45 [-7.45, 18.35]	.41	0.24 [-0.19, 0.67]	.27
>2 Hr	6.8 [-20.90, 34.52]	.63	24.59 [-1.67, 50.84]	.07	0.66 [-0.21, 1.53]	.14
Mobile Phone						
None	Reference		Reference		Reference	
<2 Hr	.024 [-13.77, 13.82]	.99	1.66 [-11.42, 14.73]	.80	0.18 [-0.25, 0.62]	.40
>2 Hr	44.13 [17.27, 70.98]	.001	32.11 [6.66, 57.56]	.01	-0.10 [-0.94, 0.74]	.82
Television						
None	Reference		Reference		Reference	
<2 Hr	-0.84 [-22.15, 20.46]	.93	4.14 [-16.06, 24.33]	.69	-0.004 [-0.67, 0.66]	.99
>2 Hr	7.6 [-18.79, 34]	.57	18.54 [-6.47, 43.55]	.15	0.58 [-0.25, 1.40]	.17
Computer/Game Console						
None	Reference		Reference		Reference	
<2 Hr	4.96 [-8.49, 18.41]	.47	17.06 [4.31, 29.81]	.009	0.31 [-0.12, 0.73]	.15
>2 Hr	30.04 [-2.16, 62.24]	.07	56.22 [25.70, 86.74]	.000	0.64 [-0.36, 1.66]	.21

Adjusted Mean Difference for Continuous Sleep Outcomes by Time Spent Using Electronic Media Devices: Two of Three

Specific Electronic Media Devices	Wake up Time		Total time in bed		Total Sleep Time	
	Mean Difference [95% CI]	*P* Value	Mean Difference [95% CI]	*P* Value	Mean Difference [95% CI]	*P* Value
IPod or IPad/Tablet						
None	Reference		Reference		Reference	
<2 Hr	8.53 [-2.18, 19.24]	.12	5.38 [-10.33, 21.08]	.50	0.88 [-13.72, 15.48]	.91
>2 Hr	2.54 [-19.25, 24.34]	.82	2 [-29.97, 33.97]	.90	-31.66 [-61.38, -1.94]	.04
Mobile Phone						
None	Reference		Reference		Reference	
<2 Hr	-0.92 [-11.77, 9.94]	.87	-0.72 [-16.64, 15.20]	.92	-1.27 [-16.07, 13.53]	.87
>2 Hr	-14.64 [-35.77, 6.48]	.17	-55.91 [-86.90, -24.93]	.000	-44.43 [-73.24, -15.63]	.003
Television						
None	Reference		Reference		Reference	
<2 Hr	20.15 [3.39, 36.92]	.02	7.66 [-16.93, 32.25]	.54	10.54 [-12.32, 33.39]	.36
>2 Hr	25.77 [5.01, 46.53]	.02	1.79 [-28.67, 32.24]	.91	-5.91 [-34.22, 22.41]	.68
Computer/Game Console						
None	Reference		Reference		Reference	
<2 Hr	7.11 [-3.47, 17.69]	.18	4.33 [-11.19, 19.85]	.58	-7.45 [-21.87, 6.98]	.31
>2 Hr	37.84 [12.50, 63.17]	.004	5.7 [-31.45, 42.88]	.76	-12.54 [-47.09, 22]	.47

Adjusted Mean Difference for Continuous Sleep Outcomes by Time Spent Using Electronic Media Devices: Three of Three

Specific Electronic Media Devices	Longest Sleep Period		Sleep Efficiency		Night Wake Duration	
	Mean Difference [95% CI]	*P* Value	Mean Difference [95% CI]	*P* Value	Mean Difference [95% CI]	*P* Value
IPod or IPad/Tablet						
None	Reference		Reference		Reference	
<2 Hr	-7.42 [-29.69, 14.86]	.51	-.007 [-.02, .01]	.41	-0.51 [-3.32, 2.29]	.72
>2 Hr	-75.47 [-120.80, -30.13]	.001	-.05 [-.02, .01]	.003	6.32 [0.62, 12.02]	.03
Mobile Phone						
None	Reference		Reference		Reference	
<2 Hr	9.47 [-13.11, 32.05]	.41	.000 [-.02, .02]	.99	-0.58 [-3.42, 2.26]	.69
>2 Hr	-10.55 [-54.49, 33.40]	.64	.009 [-.02, .04]	.58	-3.22 [-8.74, 2.31]	.25
Television						
None	Reference		Reference		Reference	
<2 Hr	12.52 [-22.35, 47.39]	.48	.005 [-.02, .03]	.70	1.37 [-3.02, 5.76]	.54
>2 Hr	-16.99 [-60.18, 26.20]	.44	-.01 [-.05, -.02]	.43	6.58 [1.15, 12.02]	.02
Computer/Game Console						
None	Reference		Reference		Reference	
<2 Hr	-12.65 [-34.66, 9.36]	.26	-.02 [-.04, -.002]	.03	2.88 [0.11, 5.65]	.04
>2 Hr	-8.05 [-60.75, 44.66]	.76	-.03 (-.07, .01)	.15	2.73 [-3.90, 9.36]	.42