Published in final edited form as:
Health Educ Behav. 2013 June ; 40(3): 323–330. doi:10.1177/1090198112451266.

A CROSS-CULTURAL COMPARISON OF SLEEP DURATION BETWEEN U.S. AND AUSTRALIAN ADOLESCENTS: THE EFFECT OF SCHOOL START TIME, PARENT-SET BEDTIMES, AND EXTRA-CURRICULAR LOAD

Michelle Short[1,2], **Michael Gradisar**[1], **Leon Lack**[1], **Helen Wright**[1], **Julia Dewald**[3], **Amy Wolfson**[4], and **Mary Carskadon**[5]

[1] School of Psychology, Flinders University, SA, Australia [2] Centre for Sleep Research, University of South Australia, SA, Australia [3] University of Amsterdam, Amsterdam, Netherlands [4] College of the Holy Cross, Worcester, MA, USA [5] Brown University, Providence, RI, USA

Abstract

STUDY OBJECTIVE—To test whether sleep duration on school nights differs between adolescents in Australia and the U.S. and, if so, whether this difference is explained by cultural differences in school start time, parental involvement in setting bedtimes and extra-curricular commitments.

PARTICIPANTS—385 adolescents aged 13-18 years (M=15.57,SD=0.95; 60% male) from Australia and 302 adolescents aged 13-19 years (M=16.03, SD=1.19; 35% male) from the United States.

METHODS—Adolescents completed the School Sleep Habits Survey during class time, followed by an 8-day Sleep Diary.

RESULTS—After controlling for age and sex, Australian adolescents obtained an average of 47 minutes more sleep per school night than those in the U.S. Australian adolescents were more likely to have a parent-set bedtime (17.5% vs 6.8%), have a later school start time (8:32am vs 7:45am) and spend less time per day on extra-curricular commitments (1h37m vs 2h41m) than their U.S. peers. The mediating factors of parent-set bedtimes, later school start times, and less time spent on extra-curricular activities were significantly associated with more total sleep.

CONCUSIONS—In addition to biological factors, extrinsic cultural factors significantly impact upon adolescent sleep. The present study highlights the importance of a cross-cultural, ecological approach and the impact of early school start times, lack of parental limit setting around bedtimes and extracurricular load in limiting adolescent sleep.

Corresponding Author: Michelle A. Short, Centre for Sleep Research, University of South Australia, Adelaide, South Australia, Australia michelle.short@unisa.edu.au.

Keywords

Cross-cultural; Sleep duration; Adolescent; School start time; Parent-set bedtime; Extra-curricular activities; School health

INTRODUCTION

Many factors affecting sleep vary cross-culturally, and different cultures have divergent views on the nature, purpose and importance of sleep (Biggs, Pizzorno, van den Heuvel, Kennedy, Martin & Lushington, 2010; Jenni & O'Connor, 2005; Williams, 2007). Adolescent sleep patterns vary across countries in terms of timing and duration (Gradisar, Gardner & Dohnt, 2010; Olds, Blunden, Petkov & Forchino, 2010). Adolescents who obtain inadequate sleep are more likely to lack energy, have difficulty concentrating, have worse emotional regulation, academic performance and cognitive performance, experience more depressed mood and have heightened risk of aggression, impulsivity and accidents (Bailly, Bailly-Lambin, Querlau, Beuscart & Collinet, 2004; Carskadon, Seifer, Davis & Acebo, 1991; Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998; Haynes, Bootzin, Smith, Cousins, Cameron & Stevens, 2006; Randazzo, Muehlbach, Schweitzer & Walsh, 1998; Steenari, Vuontela, Paavonen, Carlson, Fjaalberg & Aronen, 2003; Yang, Kim, Patel & Lee, 2005). Important insights into adolescent sleep may be made by utilizing a cross-cultural perspective; however, few studies have made a *direct* comparison of sleep patterns between countries, and fewer have examined specific cultural factors that may account for differences (LeBourgeios, Giannotti, Wolfson & Harsh, 2005; Tynjala, Kannas & Valimaa, 1993).

Factors such as school start times (Lui, Lui, Owens & Kaplan, 2005; O'Malley & O'Malley, 2008), extra-curricular commitments (such as homework, part-time work, sport and other activities; Carskadon, 2002; Lui et al., 2005; National Sleep Foundation, 2006), and parent limit-setting practices (LeBourgeios et al., 2005; Short, Gradisar, Wright, Lack, Dohnt & Carskadon, 2011) may explain cross-cultural differences in adolescent sleep duration. Studies consistently show earlier school start times to be associated with less sleep due to earlier rise times (Carskadon, Wolfson, Acebo, Tzischinsky & Seifer, 1998; Lui et al., 2005; O'Malley & O'Malley, 2008; Thorleifsdottir, Bjornsson, Benediktsdottir, Gislason & Kristbjarnarson, 2002; Wahlstrom, 2002). High school start times in South Australian schools (where the adolescents from the Australian sample reside) range from approximately 8:20am to 9:00am, while the Rhode Island school district (where the adolescents from the U.S. sample reside) have school start times of approximately 7:45am. Thus, it is expected that later school start times in Australian high schools will be associated with more sleep among Australian adolescents compared to those from the U.S.

The number of hours devoted to paid work, sports, homework, and other extra-curricular activities increases during adolescence, and this pattern has been associated with less sleep (Adam, Snell & Pendry, 2007, Brand, Beck, Gerber, Hatzinger & Holsboer-Trachsler, 2010; Brand, Gerber, Beck, Hatzinger, Puhse & Holsboer-Trachsler, 2010; Carskadon, 1990; Lee, 2003; NSF, 2006; Robinson, Alexander & Gradisar, 2008; Wolfson, 2002; Yang, Kim, Patel

& Lee, 2005). The present study will consider these activities together to examine the effect of extra-curricular load on adolescent sleep. It is expected that greater extra-curricular load will be associated with less total sleep. Lastly, parental involvement in regulating adolescent bedtimes may be a factor that *increases* the sleep of adolescents (Carskadon, 1990; Gangwisch, Babiss, Malaspina, Turner, Zammit & Posner, 2010; Short et al., 2011). Previous studies have reported that 5% of U.S. parents set the bedtime of their teen (Carskadon, 1990), compared to 17% of Australian parents (Short et al., 2011). Thus, it is expected that parent-set bedtimes will account for some of the cross-cultural differences in sleep between U.S. and Australian adolescents.

The primary aim of this study is to examine whether earlier school start times, greater hours spent on extra-curricular activities, and less parental involvement in setting bedtimes mediate the effect of country (Australia, U.S.) on school night sleep, as shown in Figure 1. Specifically, we expect that U.S. adolescents will have earlier school start times, spend more hours on extracurricular activities, and have less parental involvement in setting bedtimes than will Australian adolescents, and that these factors will be associated with shorter sleep duration in the U.S. adolescent group. As circadian chronotype may differ between countries (possibly due to differences in sleep timing and/or the length and intensity of exposure to daylight), circadian preference will also be assessed as a potential covariate.

METHOD

Participants

The data collection protocols for the U.S. adolescents (Wolfson, Carskadon, Acebo et al., 2003) and the Australian adolescents (Short et al., 2011) have been described previously. Data were collected from 1997 to 2000 from a non-probability sample of 302 U.S. adolescents (106 males and 196 females) aged from 13.8 years to 19.9 years (M=16.03, SD=1.19). Adolescents were in grades 9 to 12, and came from 5 high schools in Rhode Island, U.S.A: one co-educational parochial high school, one independent girl’s school, one independent co-educational school, one suburban public high school and one urban public high school. Informed consent was obtained from either a parent (for participants aged under 18 years) or from the participant, if they were over 18 years. Students and parents were reimbursed for their time with gift certificates to local stores. Seventy-five percent of adolescents lived with both parents, and 80% of fathers and 53% of mothers were employed.

In Australia, data were collected from 2008 to 2010 from 385 adolescents (228 males and 157 females) aged 13.3 years to 18.9 years (M=15.57,SD=0.95). Adolescents were in Years 9 to 11 and came from 8 schools in South Australia. Stratified random sampling was used to select one school from each of 8 strata spanning the socio-economic spectrum. School principals, adolescents, and their parent/guardian gave informed consent. Participants were reimbursed for their time with a shopping centre gift certificate. Seventy-seven percent of Australian adolescents lived with both parents and 80% of fathers and 30.4% of mothers were in full-time employment. Response rate was 84%. Ethics approval was given by the E.P. Bradley Hospital Institutional Review Board for the Protection of Human Subjects, Flinders University Social and Behavioural Research Ethics Committee, and Department of Education and Children's Services.

Measures and Procedure

As many of the mediators tested specifically related to the school week, sleep variables used were those on school nights (Sunday to Thursday nights), drawn from sleep diary data. Sleep duration was calculated as the time elapsed from sleep onset to sleep offset, excluding any wake periods during the night. Sleep diaries have shown good correspondence with the gold standard of sleep measurement, polysomnography (kappa=0.87), with high sensitivity (92.3%) and specificity (95.6%) (Rogers, Caruso & Aldrich, 1993). Actigraphic data were not reported for this sample due to concerns around the accuracy of actigraphic estimates of sleep in adolescents (Short, Gradisar, Lack, Wright & Carskadon, 2012). School start time, hours spent on extra-curricular activities, and parent-set bedtimes were assessed using items in the School Sleep Habits Survey (SSHS; Wolfson et al., 2003). School start time was determined using the item "What time do you need to arrive at school? List one time, not a range." Parent-set bedtimes were determined using the item "What is the main reason that you usually go to bed on school days? (pick one) " Eight possible responses were available, including "*My parents have set my bedtime*", "*I feel sleepy*", and "*I finish my homework*" and "*Other (please describe)*". All responses other than "*My parents have set my bedtime*" were combined in order to form a dichotomous variable. Hours spent on extra-curricular activities on school nights were calculated by summing the responses to four items relating to different extra-curricular activities. These items were: "During the last week, did you work at a job for pay?", "During the last week, did you do any organized sport or regularly scheduled physical activity?", "During the last week, did you participate in organized extra-curricular activities? [For example, committees, clubs, volunteer work, musical groups, church groups, etc.]", and *"During the last week, did you study/do homework?"* Participants indicated "*yes*" or "*no*" to these items and, if yes, gave the number of hours that they spent on that extra-curricular activity during the school week and during the weekend (separately). Only school week data were used for these analyses.

Circadian phase preference was measured using the Smith Morningness/ Eveningness Questionnaire (SMEQ; Smith, Reilly & Midkiff, 1989). The SMEQ is a 13-item self-report questionnaire. Items included "Considering your own "feeling best" rhythm, at what time would you go to bed if you were entirely free to plan your evening?" and "During the first half hour after having awakened in the morning, how tired do you feel?" Items were summed to give a total score ranging from 13 to 55, with higher scores indicating greater morningness.

Adolescents completed the School Sleep Habits Survey and Smith Morningness/ Eveningness Questionnaire during class time, followed by an 8-day Sleep Diary. Sleep diary data were used to calculate school-night sleep duration.

Statistical Analyses

Adolescents from Australia were compared to those from the United States in terms of sleep and demographic variables using between subjects t-tests or chi square analyses for non-parametric data. The mediation model was tested using the procedure outlined by Baron and Kenny (1986). To test for mediation, the preconditions involving the mediators (school start time, parent-set bedtimes, and time spent on extra-curricular activities) were tested to

determine that they were individually related to both country (Australia versus U.S.) and sleep duration. The precondition that country was significantly related to sleep duration was tested using a hierarchical regression analysis, with demographic covariates entered into Step 1 and country entered in Step 2. A second hierarchical regression analysis was performed, in which, after entering the covariates in Step 1, the mediator variables were entered into Step 2 to determine if they each explain a significant, unique amount of variance in sleep duration; then country was entered into Step 3.

RESULTS

Australian and U.S. adolescents were compared on gender, age, school night sleep duration, school night bedtime, school day rise time, school start time, parent-set bedtime, circadian phase preference, and hours spent per school day on extra-curricular activities. As seen in Table 1, significant differences were observed between groups on all variables except school night bedtime and circadian preference. Of interest, school night bedtimes were similar despite the significantly earlier wake times for the U.S. adolescents and despite the fact that the U.S. adolescents were obtaining significantly less sleep. On average, U.S. adolescents obtained a significant 55 minutes less sleep per school night and started school 47 minutes earlier. U.S. adolescents were much less likely to have their bedtime set by a parent, and spent an average of 1 hour 4 minutes more per school night on extra-curricular activities.

Significant cultural differences were observed between Australian and U.S. adolescents in regard to school start time, parent-set bedtime, and extracurricular commitments, as shown in Table 1. The relationships between school start time, parent-set bedtime and extra-curricular load and sleep duration were examined using Pearson's correlations for continuous mediator variables (school start time and extra-curricular commitments) and a point-biserial correlation for parent-set bedtime. School night sleep duration was significantly correlated with school start time, $r(628) = .29$, $p<.001$, extra-curricular commitments, $r(628) = -.23$, $p<.001$, and parent-set bedtimes, $r_{pb}(628) = .21$, $p<.001$. The relationship between country and sleep duration is tested in the first hierarchical multiple regression, discussed below, and results shown in Table 2 confirm this relationship. Thus, all pre-conditions were met.

Due to significant differences between samples in terms of age and sex, the relations between these variables and sleep duration were tested using a Pearson's correlation and point-biserial correlation, respectively. Sleep duration was significantly shorter in older adolescents, $r(628) = -.23$, $p<.001$ and among females, $r_{pb}(628) = -.19$, $p<.001$. These demographic variables were controlled by entering them into Step 1 of the hierarchical regression analyses.

Results of the first hierarchical regression, examining the relation between country (Australia, U.S.) and sleep duration, after controlling for age and sex are shown in Table 2. In Step 1, age and sex accounted for 8.1% of the variance in sleep duration ($R^2=.081$, $F(2,622)= 27.34$, $p<.001$). In Step 2, culture explained a significant 12.1% of the variance in sleep duration, after controlling for age and sex ($R^2change=.121$, $F_{change}(1,621)=94.49$, $p<.001$).

A second hierarchical multiple regression analysis was conducted to examine the variance in sleep duration explained by the mediator variables and to determine whether country continued to account for a significant amount of the variance in sleep duration after controlling for demographic and mediator variables. After controlling for age and sex, the mediator variables together explained a significant 8.6% of the variance in sleep duration in Step 2 (R^2_{change}=.086, F_{change} (3,619)=21.39, p<.001). Each mediator variable explained a significant amount of the variance in sleep duration when entered in Step 2. Beta coefficients indicated that school start time had the largest effect on sleep duration. For every hour earlier school start time, students lost an average of 29 minutes sleep per night. Having a parent-set bedtime was associated with a gain of 24 minutes of sleep per night. Extra-curricular activities had a more modest effect, with every hour spent per day on extra-curricular activities resulting in a loss of just over 4 minutes of sleep per night.

When entered in Step 3, country explained a significant 5.5% of the variance in sleep duration (R^2_{change}=.055, F_{change} (1,618)=44.00, p<.001). While the proportion of the variance in sleep duration explained by culture was reduced after controlling for the mediator variables (5.5% versus 12.1%), culture continued to explain a significant amount of the variance in sleep duration. These results are consistent with partial mediation of culture and sleep duration by school start time, parent-set bedtime, and extra-curricular load.

DISCUSSION

The current analyses sought to directly compare the school night sleep of adolescents from Australia and the United States and examine whether school start time, hours spent on extra-curricular activities, and parent-set bedtimes would mediate the relationship between culture and sleep duration on school nights. After controlling for age and sex, Australian adolescents obtained an average of 47 more minutes of sleep per school night than their U.S. counterparts. Results indicated that school start time, parent-set bedtimes, and extra-curricular load partially explain (mediate) the difference in the sleep duration between adolescents in Australia and those in the U.S.A. Each mediator explained a significant and unique amount of variance when entered in Step 2 of the hierarchical multiple regression. School start time had the largest impact upon sleep, with an hour earlier school start time associated with a loss of 29 minutes sleep per night. Thus, for U.S. adolescents, whose schools started an average of 47 minutes earlier than the Australian adolescents, this difference was associated with 23 minutes less sleep per night. These findings are consistent with previous research that has highlighted the detrimental effect of earlier school start times on adolescent sleep (Carskadon et al., 1998; O'Malley & O'Malley, 2008; Wahlstrom, 2002).

U.S. adolescents were also significantly less likely to report a parent-set bedtime (6.8%) than were Australian adolescents (17.5%). Absence of a parent-set bedtime on school nights was associated with a loss of 24 minutes of sleep per school night, consistent with previous findings (Meijer, Habekothe & Van Den Wittenboer, 2001; Short et al., 2011). Extra-curricular workload on school days showed a weaker association with sleep duration, with every extra hour spent per day associated with 4 minutes less sleep per night. U.S. adolescents spent significantly more time fulfilling extra-curricular commitments on school nights than did Australian adolescents (2h41m per day versus 1h37m per day), resulting in

an average sleep loss of just under 5 minutes per night. These results support previous research finding a detrimental effect on total sleep time of greater hours spent on homework and part-time work (Carskadon, 1990; Noland, Price, Dake & Telljohann, 2009; Wolfson, 2002; Yang et al., 2005). We extend these findings by including all facets of extra-curricular commitments, such as part-time work, homework, sport, and other activities.

Previous studies using objective measures of sleep provide support for the notion that adolescents obtain more sleep when given the chance through a longer sleep opportunity (Carskadon, Keenan & Dement, 1987; Sadeh, Gruber & Raviv, 2003). Factors such as a later school start time, parental monitoring of bedtimes, and moderation in the number of hours spent on extra-curricular activities are all likely to optimize sleep opportunity and so sleep. These factors have a cumulative effect. For adolescents who have a constellation of negative factors, such as an early school start time, no parent-set bedtime, and a heavy extra-curricular load, the impact upon their sleep and functioning is likely to be so detrimental as to present a significant negative impact. The present study also highlights that, while intrinsic biological influences (such as changes the circadian and sleep homeostatic systems) are important determinants of adolescent sleep and functioning, extrinsic factors are also influential and may moderate the effect of the biological changes to circadian timing, sleep duration, and daytime sleepiness.

Findings of the present study are consistent with Bronfenbrenner's ecological systems theory of human development, and highlight the importance of taking a comprehensive approach to adolescent sleep (Bronfenbrenner, 1994). This involved considering factors affecting adolescent sleep that spanned societal (school-start times), familial (parent-set bedtimes) and individual factors (extra-curricular load). Of course, these factors do not occur in isolation and are likely to interact in their effects. For example, public policy regarding education (particularly the availability of tertiary education opportunities) impacts upon families (the family pressure to succeed and spend long hours committed to study) which impacts upon adolescents (time spent studying and anxiety around school performance). In terms of applied ramifications, these results highlight the possible protective benefit of later school start times and the importance of protecting sleep opportunity in the morning. Any factors that demand early rise times are likely to have a negative impact on sleep duration, particularly in the light of the strong biological tendency of adolescents to delay sleep. This study provides further support that U.S. adolescents would benefit from later school start times. Later school start times have been trialed or implemented in some U.S. school districts; however this practice has yet to become widespread. Early school start times, as well as early morning sport training or study may have a negative effect on sleep and flow-on effects to daytime alertness and functioning. As discussed previously, parental help in maintaining a limit on late-night activities may similarly have a protective role.

Limitations of the Present Study

The primary limitation of this study is that it relies upon cross-sectional data. As such, causation cannot be determined. The results were, however, consistent with the hypothesized mediation. Secondly, the timing of the data collection differed by several years between the two countries. U.S. data collection occurred between 1997 and 2000 and

Australian data collection occurred between 2008 and 2010. While school night sleep may have changed among U.S. adolescents during this time, this change is likely to have resulted in less school night sleep, consistent with other studies reporting secular declines in adolescent sleep over time (Dollman, Ridley, Olds & Lowe, 2007; Iglowstein, Jenni, Molinari & Largo, 2003). Thus, the difference between the two groups is likely to have only heightened across this time. Thirdly, there are many different aspects of culture that may affect sleep. Factors such as sleep hygiene may further help to explain the difference in sleep duration between the Australian and U.S. adolescents, similar to the findings of LeBourgeios and colleagues (2005) when comparing U.S and Italian adolescents. Amongst teens, the aspects of sleep hygiene that may be especially pertinent are in regard to engaging in stimulating activities before attempting to initiate sleep. In particular, the use of electronic media and mobile phones, both before bed and whilst in bed, may affect sleep onset latencies and sleep duration (Cain & Gradisar, 2010; Johnson, Cohen, Casen, First & Brook, 2004). The present study may have benefited from the inclusion of a measure of sleep hygiene, as well as a measure of technology use, to examine this empirically. Differences in the length and intensity of exposure to daylight may also partially explain differences in sleep patterns between countries. Lastly, adolescents came from within one state of each country; therefore, there may be differences between each sample and the adolescents from other states that limit the generalizability of these findings.

Finally, while we have seen that a number of differences distinguish adolescents in the U.S. and those in Australia (parent-set bedtimes, school start time and extra-curricular load), the two countries are likely to be similar in many ways. For example, the U.S. and Australia are in the World Bank's most affluent range. Adolescents in less-developed lower income nations are under-represented in sleep research, and future research would benefit from broadening the cultures and countries on which we have normative sleep data and comparing more divergent cultures cross-culturally.

Concluding Remarks

The present study has shown how cultural differences in school start times, parent-set bedtimes, and extra-curricular load partially explains the increased sleep duration in Australian adolescents compared to those in the U.S. While biologically-driven pubertal changes result in a greater propensity toward phase delay and later bedtimes and wake times, this propensity can be moderated by socio-cultural norms and practices. Considering the important effects of insufficient sleep, the protection of adolescent sleep needs to be considered across multiple domains.

REFERENCES

Adam EK, Snell EK, Pendry P. Sleep timing and quantity in ecological and family context: A nationally representative time-diary study. Journal of Family Psychology. 2007; 21:4–19. [PubMed: 17371105]

Bailly D, Bailly-Lambin I, Querlau D, Beuscart R, Collinet C. Sleep in adolescents and its disorders. A survey in schools. Encephale. 2004; 30:352–359. [PubMed: 15538310]

Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. Journal of Personality and Social Psychology. 1986; 51:1173–1182. [PubMed: 3806354]

Biggs SN, Pizzorno VA, van den Heuvel CJ, Kennedy JD, Martin AJ, Lushington K. Differences in parental attitudes towards sleep and associations with sleep-wake patterns in Caucasian and Southeast Asian school-aged children in Australia. Behavioral Sleep Medicine. 2010; 8:207–218. [PubMed: 20924834]

Brand S, Beck J, Gerber M, Hatzinger M, Holsboer-Trachsler E. 'Football is good for your sleep': Favorable sleep patterns and psychological functioning of adolescent male intense football players compared to controls. Journal of Health Psychology. 2009; 14:1144–1155. [PubMed: 19858334]

Brand S, Gerber M, Beck J, Hatzinger M, Puhse U, Holsboer-Trachsler E. High exercise levels are related to favorable sleep patterns and psychological functioning in adolescents: A comparison of athletes and controls. Journal of Adolescent Health. 2010; 46:133–141. [PubMed: 20113919]

Bronfenbrenner, U. International Encyclopedia of Education. 2nd. ed.. Vol. 3. Elsevier; Oxford: 1994. Ecological models of human development..

Cain N, Gradisar M. Electronic media use and sleep in school-aged children and adolescents: A review. Sleep Medicine. 2010; 11:735–742. [PubMed: 20673649]

Carskadon MA. Adolescent sleepiness: Increased risk in a high-risk population. Alcohol, Drugs and Driving. 1990; 5:317–328.

Carskadon MA. Patterns of sleep and sleepiness in adolescents. Pediatrician. 1990; 17:5–12. [PubMed: 2315238]

Carskadon, MA. Factors influencing sleep patterns of adolescents.. In: Carskadon, MA., editor. Adolescent sleep patterns: biological, social and psychological influences. Cambridge University Press; New York: 2002. p. 4-26.

Carskadon, MA.; Keenan, S.; Dement, WC. Nighttime sleep and daytime sleep tendency in preadolescents.. In: Guilleminault, C., editor. Sleep and its disorders in children. Raven Press; New York: 1987. p. 43-52.

Carskadon MA, Seifer R, Davis SS, Acebo C. Sleep, sleepiness and mood in college-bound high school seniors. Sleep Research. 1991; 70:175.

Carskadon MA, Wolfson AR, Acebo C, Tzischinsky O, Seifer R. Adolescent sleep patterns, circadian timing, and sleepiness at a transition to early school days. Sleep. 1998; 21:871–881. [PubMed: 9871949]

Dollman J, Ridley K, Olds T, Lowe E. Trends in the duration of school-day sleep among 10- to 15-year-old South Australians between 1985 and 2004. Acta Paediatrica. 2007; 96:1011–1014. [PubMed: 17524028]

Gangwisch JE, Babiss LA, Malaspina D, Turner JB, Zammit GK, Posner K. Earlier parental set bedtimes as a protective factor against depression and suicidal ideation. Sleep. 2010; 33:97–106. [PubMed: 20120626]

Gradisar M, Gardner G, Dohnt H. Recent worldwide sleep patterns and problems during adolescence: A review and meta-analysis of age, region, and sleep. Sleep Medicine. 2010; 12:110–118. [PubMed: 21257344]

Haynes PL, Bootzin RR, Smith L, Cousins J, Cameron M, Stevens S. Sleep and aggression in substance-abusing adolescents: Results from an integrative behavioral sleep-treatment pilot program. Sleep. 2006; 29:512–520. [PubMed: 16676785]

Iglowstein I, Jenni OG, Molinari L, Largo RH. Sleep duration from infancy to adolescence: reference values and generational trends. Pediatrics. 2003; 111:302–307. [PubMed: 12563055]

Jenni OG, O'Connor BB. Children's sleep: An interplay between biology and culture. Pediatrics. 2005; 115:204–216. [PubMed: 15866854]

Johnson JG, Cohen P, Casen S, First MB, Brook JS. Association between television viewing and sleep problems during adolescence and early adulthood. Archives of Pediatric and Adolescent Medicine. 2004; 158:562–568.

LeBourgeios MK, Giannotti F, Wolfson AR, Harsh J. The relationship between reported sleep quality and sleep hygiene in Italian and American adolescents. Pediatrics. 2005; 115:257–265. [PubMed: 15866860]

Lee M. Korean adolescents' "Examination Hell" and their use of free time. New Directions for Child and Adolescent Development. 2003; 99:9–21. [PubMed: 12741200]

Lui X, Lui L, Owens JA, Kaplan DL. Sleep patterns and sleep problems among schoolchildren in the United States and China. Pediatrics. 2005; 115:241–249. [PubMed: 15866858]

Meijer AM, Habekothe RT, Van Den Wittenboer GLH. Mental health, parental rules and sleep in pre-adolescents. Journal of Sleep Research. 2001; 10:297–302. [PubMed: 11903859]

National Sleep Foundation. Sleep in America Poll. National Sleep Foundation; Washington: 2006.

Noland H, Price JH, Dake J, Telljohann SK. Adolescents' sleep behaviours and perceptions of sleep. Journal of School Health. 2009; 79:224–230. [PubMed: 19341441]

Olds T, Blunden S, Petkov J, Forchino F. The relationships between sex, age, geography and time in bed in adolescents: A meta-analysis of data from 23 countries. Sleep Medicine Reviews. 2010; 14:371–378. [PubMed: 20207558]

O'Malley, EB.; O'Malley, MB. School start time and it's impact on learning and behavior.. In: Ivanenko, A., editor. Sleep and psychiatric disorders in children and adolescents. Informa Healthcare; New York: 2008.

Randozzo AC, Muehlbach MJ, Schweitzer PK, Walsh JK. Cognitive function following acute sleep restriction in children ages 10-14. Sleep. 1998; 21:861–868. [PubMed: 9871948]

Robinson JA, Alexander DJ, Gradisar MS. Preparing for Year 12 examinations: Predictors of psychological distress and sleep. Australian Journal of Psychology. 2008; 61:59–68.

Rogers AE, Caruso CC, Aldrich MS. Reliability of sleep diaries for assessment of sleep/wake patterns. Nursing Research. 1993; 42:368–371. [PubMed: 8247821]

Sadeh A, Gruber R, Raviv A. The Effects of Sleep Restriction and Extension on School-Age Children: What a Difference an Hour Makes. Child Development. 2003; 74:444–455. [PubMed: 12705565]

Short MA, Gradisar M, Wright H, Lack LC, Dohnt H, Carskadon MA. Time for Bed: Parent-set bedtimes associated with improved sleep and daytime functioning in adolescents. Sleep. 2011; 34:797–800. [PubMed: 21629368]

Short MA, Gradisar M, Wright H, Lack LC, Dohnt H, Carskadon MA. The discrepancy between actigraphic and sleep diary measures of sleep in adolescents. Sleep Medicine. 2012; 13:378–384. [PubMed: 22437142]

Smith CS, Reilly C, Midkiff K. Evaluation of three circadian rhythm questionnaires with suggestions for an improved measure of morningness. Journal of Applied Psychology. 1989; 74:728–738. [PubMed: 2793773]

Steenari M-R, Vuontela V, Paavonen J, Carlson S, Fjaalberg M, Aronen E. Working memory and sleep in 6- to 13-year-old schoolchildren. Journal of the American Academy of Child and Adolescent Psychiatry. 2003; 42:85–92. [PubMed: 12500080]

Thorleifsdottir B, Bjornsson JK, Benediktsdottir B, Gislason T, Kristbjarnarson H. Sleep and sleep habits from childhood to young adulthood over a 10-year period. Journal of Psychosomatic Research. 2002; 53:529–537. [PubMed: 12127168]

Tynjala J, Kannas L, Valimaa R. How young Europeans sleep. Health Education Research. 1993; 8:69–80. [PubMed: 11067187]

Wahlstrom K. Changing times: Findings from the first longitudinal study of later high school start times. NASSP Bulletin. 2002; 86:633.

Williams SJ. The social etiquette of sleep: Some sociological reflections and observations. Sociology. 2007; 41:313–328.

Wolfson, A. Bridging the gap between research and practice: What will adolescents' sleep/wake patterns look like in the 21st century?. In: Carskadon, MA., editor. Adolescent Sleep Patterns: Biological, Social and Psychological Influences. Cambridge University Press; Cambridge: 2002.

Wolfson AR, Carskadon MA, Acebo C, Seifer R, Fallone G, Labyak SE, et al. Evidence for the validity of a sleep habits survey for adolescents. Sleep. 2003; 26:213–216. [PubMed: 12683482]

Yang C-K, Kim JK, Patel SR, Lee J-H. Age-related changes in sleep/wake patterns among Korean teenagers. Pediatrics. 2005; 115:250–256. [PubMed: 15866859]

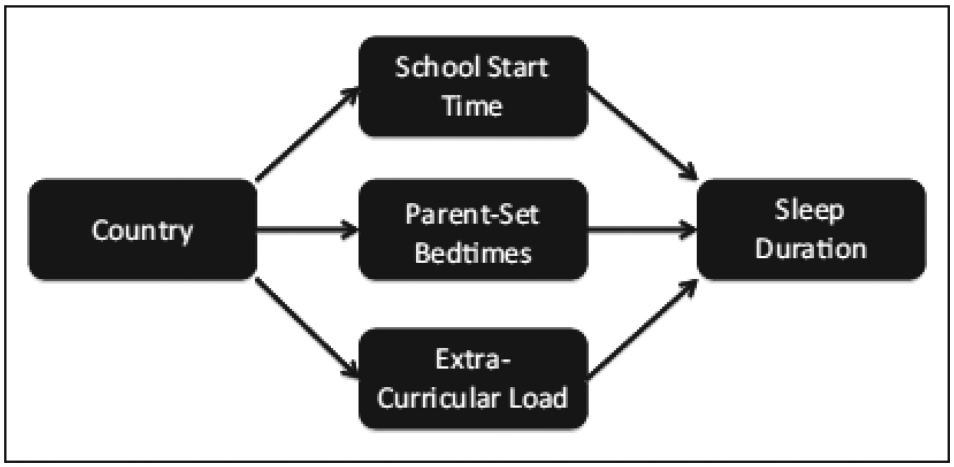

Figure 1.
Model showing the mediation of the relationship between country and sleep duration by school start time, parent-set bedtimes, and extracurricular workload

Table 1

Comparison between Australian and U.S. adolescents on different sample characteristics.

	Australian		U.S.		Statistics
	Mean	**SD**	**Mean**	**SD**	
Sex (%male)	59.2		35.1		$X^2 = 39.42^{***}$
Age, mean years	15.57	0.95	16.03	1.19	$t = 5.38^{***}$
Circadian Preference	33.25	6.66	33.94	3.71	$t = 1.73$, *ns*
Bedtime, mean	10:28pm	0.90hrs	10:36pm	0.93hrs	$t = -1.77$, *ns*
Sleep duration, mean	8h17m	58m	7h22m	57m	$t = 12.06^{***}$
Wake time, mean	7:10am		6:23am		$t = 15.54^{***}$
School start, mean	8:32am	0.28hrs	7:45am	0.37hrs	$t = 30.57^{***}$
Parent-set bedtime (%yes)	17.5		6.8		$X^2 = 18.45^{***}$
Extra-curricular load (hrs)[#]	8.12	6.86	13.40	9.36	$t = 7.99^{***}$
Part-time work	1.51	3.22	3.25	6.51	$t = 4.38^{***}$
Sport	2.27	3.11	2.17	3.69	$t = -0.39$,ns
Other Activities	0.51	1.27	1.54	2.76	$t = 6.16^{***}$
Homework	4.17	4.58	6.52	5.94	$t = 5.79^{***}$

$^{***}p<.001$

[#]Average hours spent across one school week

Table 2

Summary of hierarchical regression analysis examining the effect of country on school night sleep duration after controlling for sex and age.

Variable	*B*	*SE B*	*Beta*	*p*
Step 1				
Sex	−21.49	4.88	−.17	<.001
Age	−12.63	2.25	−.22	<.001
Step 2				
Sex	−10.69	4.68	−.08	.02
Age	−8.46	2.14	−.15	<.001
Country	46.81	4.82	.37	<.001

Table 3

Summary of Hierarchical Regression Analysis examining the mediation of country and sleep duration by school start time, parent-set bedtimes and extra-curricular load, after controlling for age and sex

Variable	*B*	SE *B*	*Beta*	*p*
Step 2				
Sex	−11.91	4.81	−.09	.01
Age	−8.83	2.21	−.15	<.001
Parent-set bedtime	−23.64	7.07	−.13	.001
School start time	28.54	5.09	.22	<.001
Extra-curricular load	−.85	.29	−.11	.004
Step 3				
Sex	−8.37	4.68	−.07	*ns*
Age	−6.96	2.15	−.12	.001
Parent-set bedtime	−19.50	6.87	−.10	.005
School start time	−13.30	8.00	−.10	*ns*
Extra-curricular load	−.53	.29	−.07	*ns*
Country	53.39	8.05	.42	<.001