ORIGINAL RESEARCH

Sleep duration and subjective psychological well-being in adolescence: a longitudinal study in Switzerland and Norway

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Background: Adolescents' sleep duration and subjective psychological well-being are related. However, few studies have examined the relationship between sleep duration and subjective psychological well-being longitudinally across adolescence – a time of profound biological and psychosocial change. The aim of this longitudinal study was to investigate whether shorter sleep duration in adolescents is predictive of lower subjective psychological well-being 6 months and 12 months later or whether lower subjective psychological well-being is predictive of shorter sleep duration.

Methods: Adolescents (age range, 10.02–15.99 years; mean age, 13.05±1.49 years; 51.8%, female) from German-speaking Switzerland (n=886) and Norway (n=715) reported their sleep duration and subjective psychological well-being on school days using self-rating questionnaires at baseline (T1), 6 months (T2), and 12 months from baseline (T3).

Results: Cross-sectional and longitudinal analyses revealed that sleep duration decreased with age. Longer sleep duration was concurrently associated with better subjective psychological well-being. Crossed-lagged autoregressive longitudinal panel analysis showed that sleep duration prospectively predicted subjective psychological well-being while there was no evidence for the reverse relationship.

Conclusion: Sleep duration is predictive of subjective psychological well-being. The findings offer further support for the importance of healthy sleep patterns during adolescence.

Keywords: adolescence, sleep duration, psychological well-being, international, longitudinal study

Introduction

Complaints about poor sleep and daytime sleepiness are common among adolescents,[1,2] and acute[3] and chronic[4] sleep disturbances have been related to poor psychological functioning, such as impaired cognitive performance,[5,6] depression,[7–12] and poor physical health.[13–16] Short sleep duration, insomnia, as well as interrupted sleep due to sleep apnea, nocturnal enuresis, and periodic limb movement in children and adolescents adversely affects learning, academic performance,[17–23] emotional processing,[24–26] and – relatedly – psychological functioning.[27–30] In a cross-sectional survey with a large population of college students (n=1,125; 17–24 years old), over 60% of respondents were categorized as poor-quality sleepers with shorter sleep duration.[19] Poor sleep quality and sleepiness were independently associated with poor school achievement in children and adolescents.[20] Remarkably, over 25% of adolescents report sleep disturbances.[7,31–34] Cross-sectional[19,35] and longitudinal studies, eg,[36,37] have shown

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that acute and chronic sleep disturbances persist over time, which may compromise adolescents' mental and physical health in the long run.

Although older adolescents of 15–16 years still require approximately 9 hours of sleep on average per night as do younger adolescents of around 10–11 years,[38–40] a wealth of studies shows that average sleep duration decreases significantly across adolescence.[22,41–44] Several factors may be responsible for this decrease, including: physical maturation; psychological factors; social factors, such as decreasing supervision by parents and increasing importance of peer relations; and issues related to education and training, involving pressure related to academic achievement, homework, vocational issues, and extracurricular activities.[27,28,38,39,45]

Taken together, the pattern of published evidence suggests that sufficient sleep during adolescence is related to adolescents' psychological well-being. Although there are numerous studies of the relationship between sleep and poor mental health, longitudinal studies focusing on the relationship between sleep duration and positive aspects of functioning, such as psychological well-being, are scarce.[46] An exception is a 3-year longitudinal study of 2,259 students aged 11–14 years that showed that depressive symptoms and low self-esteem were predicted by short sleep.[47] Positive psychological well-being involves both cognitive and affective aspects.[48] Cognitive aspects include evaluations of whether one's life is on the right track and whether one has a positive attitude toward one's future. Affective aspects include whether one experiences positive emotions and joy in life as well as an absence of negative affect and symptoms of mental distress.[48]

The present study extends upon previous research in two respects. First, we studied interrelations between sleep schedules and subjective psychological well-being (SPW) across three time points of measurement testing for both directions of prediction. The measurement points were each separated by 6 months (data were collected in May, November, and again in May). Second, we tested whether associations between sleep duration and SPW are different between age groups. We therefore divided the sample into three age categories: 10–11 year olds; 12–13 year olds; and 14–15 year olds. Sleep duration and SPW were assessed in two large samples of adolescents from Switzerland and Norway. Although both countries are examples of Western cultures, they, for instance, differ markedly with regard to day length in May and November, which may be associated with sleep patterns and SPW.[32]

Methods

Participants

In total, 2,703 adolescents provided data on at least one measurement time point. A total of 1,601 adolescents (age range at T1, 10.02–15.99 years; mean age, 13.05–1.49 years; 51.8% females) from two different European countries (Switzerland, n=886; Norway, n=715), and from a socioeconomically diverse sample provided complete data across all three measurement waves (T1, n=2,330; T2, n=2,094; T3, n=2,061. As data were assessed during school lessons with school classes, it is possible that, for instance, some participants provided no data at T1 but at a later assessment time). Comparing adolescents with complete data with the ones with incomplete data revealed that participants with complete data were younger ($F[1; 2,520]=29.1$; $P<0.001$), more often female ($\chi^2[1]=10.23$; $P=0.001$), had higher levels of SPW at T1 ($F[1; 2,363]=23.55$; $P<0.001$), and at T2 ($F[1; 2,139]=17.80$; $P<0.001$), as well as longer sleep duration at T1 ($F[1; 2,340]=116.04$; $P<0.001$). The two nations did not differ with regard to the probability of having complete data ($\chi^2[1]=0.22$; $P=0.88$). Furthermore, the two national groups differed with respect to age ($F[1; 2520]=37.65$; $P<0.001$); the Swiss sample mean age was 13.34±1.54 years; the Norwegian sample mean age was 12.97±1.50 years). Sex distribution was not significant ($\chi^2[1]=0.16$; $P=0.69$). The grades sampled were from fourth to ninth; these school years are compulsory in both countries. Socioeconomic status was: 31%, upper class; 37%, middle class; and 32%, working class. The majority of adolescents lived with both parents (n=2,132; 80%), 18% (n=480) with their mothers only, and just 2% (n=53) with their fathers only.

Procedure

Participants were recruited by advertisements in the local schools in the canton of Bern, located in the German-speaking part of Switzerland, and in Bergen (Norway). The first wave of the investigation took place in early summer (May, T1), followed by further waves after 6 months in early winter (November, T2), and again 6 months later in early summer (May, T3). Each assessment took place in the classroom during a school lesson. All participants and their parents gave informed consent regarding study participation. The study followed the ethical principles required by the home institution of the study (the University of Bern, Switzerland) and laid down in the Declaration of Helsinki and was financially supported by the Swiss National Science

Materials

Self-assessment of SPW; Bern well-being questionnaire for adolescents

The present study used five items from the Bern well-being questionnaire for adolescents (BFW/J)-subscale. One item was: "Positive attitude towards life", such as "My future looks good", and "I enjoy life more than most of the other people". Four items from the BFW/J-subscale included: "Joy in life", such as "Did it occur in the past few weeks that you were pleased because you had achieved something?" or "Did it occur in the past few weeks that you were pleased because other people liked you?" Answers were given on four-point rating scales with 1= "not at all" and 4= "completely". To increase reliability, the nine items were combined to build a score of subjective psychological well-being. Cronbach's alpha of this score was 0.77 at T1, 0.81 at T2, and 0.82 at T3, which represents good internal consistency.

Sleep duration on weekdays

Sleep duration on weekdays was assessed with two items asking for time in bed before school days and time of getting up on school days. The participants had to fill in the respective clock times. Sleep duration was calculated by the difference between bed and getting up time.

Statistical analysis

To assess relationships between sleep duration and SPW in different age groups, we divided participants into three age groups representing very early adolescence: (ages 10–11 years; mean age, 11.20±0.50 years); late early adolescence (ages 12–13 years; mean age, 12.96±0.56 years); and early middle adolescence (ages 14–15 years; mean age, 14.94±0.54 years).

To compare differences in SPW and sleep duration between countries, age groups, and across the three waves, two analyses of variance (ANOVAs) for repeated measures were computed with the factors country (Switzerland versus Norway), age group ("10 to 11 year olds" versus "12 to 13 year olds" versus "14 to 15 year olds"), and assessment time (T1, baseline; T2, 6 months from T1; and T3, 12 months from T1). Additionally, Pearson's correlations between sleep duration and SPW were computed separately for the three age groups and the three assessment times. To test longitudinal relations between sleep duration and SPW controlling for the initial levels of these constructs, a crossed-lagged autoregressive longitudinal panel model was employed. This model specifies autoregressive paths (each construct is regressed on its level at the preceding measurement wave), crossed-lagged paths (each construct is regressed on the other construct's level at the preceding measurement wave), as well as correlations between the two constructs (or their residuals) on the concurrent measurement wave. This model was estimated separately for the three age groups applying multi-group comparison and the χ^2 difference test. For paths that were not significantly different between the three age groups as indicated by the χ^2 difference test, the paths were set equal across groups.

An alpha of $P<0.05$ was accepted as a nominal level of significance. All statistical computations were performed with IBM SPSS® (IBM Corporation, Armonk, NY, USA) and AMOS® 19 for Windows (Amos Development Corporation, Spring House, PA, USA). Missing values were not imputed for analyses conducted with SPSS® (ANOVA for repeated measures, correlations), while analyses conducted with the AMOS® applied estimation of missing values by the full information maximum likelihood method.

Results

Descriptive statistics for the course of sleep duration and SPW across adolescence

There were no significant differences between males and females in SPW ($F[df=1]=3.65$; $P=0.06$) or sleep duration ($F[df=1]=0.66$; $P=0.42$). Repeated measures ANOVA revealed that sleep duration decreased with age in cross-sectional analysis (ie, analyses comparing the age groups; [$F\{2; 1,584\}=532.23$; $P<0.001$]) and longitudinal analysis (analysis of the trend across the measurement points; [$F\{2; 1,583\}=276.07$; $P<0.0010$]). Sleep duration was shorter in Norway than in Switzerland ($F[1; 1,584]=39.94$; $P<0.001$). Age-group X measurement time, country X measurement time, country X age group interactions, and the three-way interaction country X age-group X measurement time were not significant ($P>0.10$). Table 1 provides descriptive statistics for sleep duration by countries (Switzerland and Norway), age groups ("10–11 year olds", "12–13 year olds", and "14–15 year olds"), and across the three measurement points (T1, T2, and T3). The decline in sleep duration across adolescence is reflected by a decline from 10.00 hours and 9.82 hours among the 10–11 year olds at T1 in Switzerland and Norway, respectively, while the 14–15 year olds slept 8.36 hours and 8.01 hours at T3 in Switzerland and Norway. Inspection of effect sizes of the decline in sleep

Table I Description of sleep duration and subjective psychological well-being, separated by: CH and N; age groups (I, 10–11 year olds; II, 12–13 year olds; III, 14–15 year olds); and the three measurement time points (T1, T2, and T3)

Age	Country	T1		T2		T3		Between T1 and T2		Between T2 and T3		Over T1 and T3	
		M (min)	SD	M (min)	SD	M (min)	SD	t (df)	P/d	t (df)	P/d	t (df)	P/d
Sleep duration													
I	CH	600	38	591	45	574	39	2.82 (211)	0.005/0.22	8.81 (248)	0.000/0.41	8.66 (201)	0.000/0.68
	N	589	45	583	44	571	37	3.05 (281)	0.003/0.13	6.37 (283)	0.000/0.31	8.20 (284)	0.000/0.45
II	CH	563	43	551	45	537	65	4.96 (360)	0.000/0.25	8.36 (440)	0.000/0.25	6.41 (370)	0.000/0.45
	N	550	48	541	44	522	51	4.58 (368)	0.000/0.19	8.70 (321)	0.000/0.39	12.01 (331)	0.000/0.56
III	CH	518	43	516	42	502	42	3.83 (364)	0.001/0.04	7.82 (375)	0.000/0.35	9.47 (359)	0.000/0.38
	N	502	51	497	50	481	52	2.51 (191)	0.013/0.10	5.01 (171)	0.000/0.33	5.23 (175)	0.000/0.42
		$F_{(2, 2,178)}=534.64$; P<0.001		$F_{(2, 2,072)}=439.69$; P<0.001		$F_{(2, 2,024)}=347.36$; P<0.001							
Subjective psychological well-being													
I	CH	3.40	0.44	3.35	0.46	3.34	0.45	1.22 (212)	0.23/0.11	0.02 (256)	0.99/0.03	2.08 (215)	0.04/0.15
	N	3.44	0.43	3.35	0.47	3.27	0.50	3.22 (295)	0.00/0.20	3.78 (296)	0.00/0.17	6.21 (296)	0.00/0.36
II	CH	3.31	0.49	3.28	0.48	3.24	0.52	1.22 (363)	0.22/0.06	2.02 (457)	0.04/0.07	2.60 (378)	0.01/0.13
	N	3.29	0.48	3.20	0.51	3.09	0.52	4.64 (383)	0.00/0.18	5.60 (335)	0.00/0.20	8.19 (342)	0.00/0.39
III	CH	3.23	0.48	3.25	0.53	3.22	0.56	1.05 (371)	0.30/0.05	1.14 (386)	0.26/0.05	0.16 (366)	0.87/0.01
	N	3.19	0.48	3.12	0.54	3.06	0.54	1.49 (193)	0.14/0.13	0.57 (173)	0.57/0.11	2.50 (175)	0.01/0.25
		$F_{(2, 2,198)}=32.47$; P<0.001		$F_{(2, 2,103)}=13.73$; P<0.001		$F_{(2, 2,066)}=12.43$; P<0.001							

Notes: Cohen's d=0.2–0.49, little effect; d=0.5–0.79, middle effect; d>0.8, large effect. Subjective psychological well-being was measured with the Bern well-being questionnaire for adolescents (BFW/J)-subscales: "Positive attitude towards life" and "Joy in life". Rating scales with higher mean values reflect greater psychological well-being.
Abbreviations: M, mean; SD, standard deviation; CH, Switzerland; N, Norway; T1, baseline in May; T2, November (6 months after T1); T3, (12 months after T1, again in May); I, mean age, 11.2 years; II, mean age, 13.0 years; III, mean age, 14.9 years; min, minutes.

duration in both countries and all age groups indicated a considerably stronger decrease (ie, double the size or more) in the period from November–May than in the period from May–November (with the exception of the 12–13 year olds in Switzerland).

SPW also decreased with age in cross-sectional ($F[2; 1,652]=18.87$; $P<0.001$) and longitudinal analyses ($F[2; 1,652]=39.44$; $P<0.001$). SPW was lower in Norway than in Switzerland ($F[1; 1,652]=10.93$; $P<0.001$). Moreover, the age-group X measurement time interaction was significant ($F[2; 1,652]=3.90$; $P=0.02$; indicating a stronger decline among the 12–13 year olds than in the younger and older age groups), as was the country X measurement time interaction ($F[2; 1,651]=8.47$; $P<0.001$; indicating a stronger decline among Norwegian adolescents) while the country X age-group interaction and the three-way interaction were not significant ($P>0.10$).

Analysis of relationship between sleep duration and SPW

Table 2 gives the zero-order correlations between sleep duration and SPW in the three age groups. Concurrent correlations between sleep duration and SPW were significantly positive indicating higher levels of SPW among adolescents with longer sleep duration with the exception of concurrent correlations among the 10–11 year olds at T1 and among the 14–15 year olds at T3.

The longitudinal path analysis is displayed in Figure 1. The paths could be set equal across the three age groups (indicating similarity of the path coefficients in the three age groups) with the exception of the path from sleep duration at T2 on sleep duration at T3, which could only be set equal between the younger two age groups (fit indices

for the model allowing this path to vary between the oldest age group and the two younger groups: $\chi^2[23]=28.01$; $P=0.22$, root mean square error of approximation $=0.007$; fit indices for comparison with the model which additionally sets this path equal across all age groups: $\chi^2[1]=23.35$; $P<0.001$). Generally, the stabilities of sleep duration and SPW from T1 to T2 to T3 were high to very high. Among the crossed lagged paths (the paths between the constructs of sleep duration and SPW across time points), only the path from sleep duration at T1 to SPW at T2 was significant indicating a positive relation between sleep duration at T1 and SPW at T2. This path was of equal strength in the three age groups; however, it represents a quite small effect size.

Discussion

Regarding the relationship between sleep duration and SPW, our findings echo evidence from numerous studies that have confirmed an association between adolescents' sleep duration and subjective psychological well-being.[19,35,49–52] Our findings indicate that sleep duration is a longitudinal predictor of SPW. The findings show that affect regulation is compromised by short sleep.[24] However, the size of the effect was weak when SPW at baseline was controlled. Moreover, the effect was not consistent across all measurement time points.

By contrast, our findings do not indicate that SPW is a longitudinal predictor of sleep duration. The pattern of results extends upon previous findings in showing that the relationship between sleep duration and SPW across one year is very similar in the three age groups of very early adolescents (10–11 year olds), late early adolescents (12–13 year olds), and early middle adolescents (14–15 year olds).

Table 2 Correlations between sleep duration and subjective psychological well-being, separated by the three age groups (I, 10–11 year olds; II, 12–13 year olds; III, 14–15 year olds) and three measurement time points (T1, T2, and T3)

SPW		Cronbach's alpha	Sleep duration		
			T1	T2	T3
I	T1	0.73	0.05	0.07	0.04
	T2	0.78	0.12**	0.11*	0.09*
	T3	0.82	0.11*	0.10*	0.10*
II	T1	0.78	0.14**	0.09*	0.10**
	T2	0.80	0.12**	0.14**	0.08*
	T3	0.82	0.12**	0.09**	0.12**
III	T1	0.79	0.20**	0.10*	0.10*
	T2	0.85	0.19**	0.13**	0.16**
	T3	0.84	0.12**	0.09*	0.06

Notes: *$P<0.05$. **$P<0.01$. Higher means reflect a more positive SPW.
Abbreviations: T1, baseline in May; T2, in November (6 months after T1); T3, May (12 months after T1); I, mean age, 11.2 years; II, mean age, 13.0 years; III, mean age, 14.9 years; SPW, subjective psychological well-being.
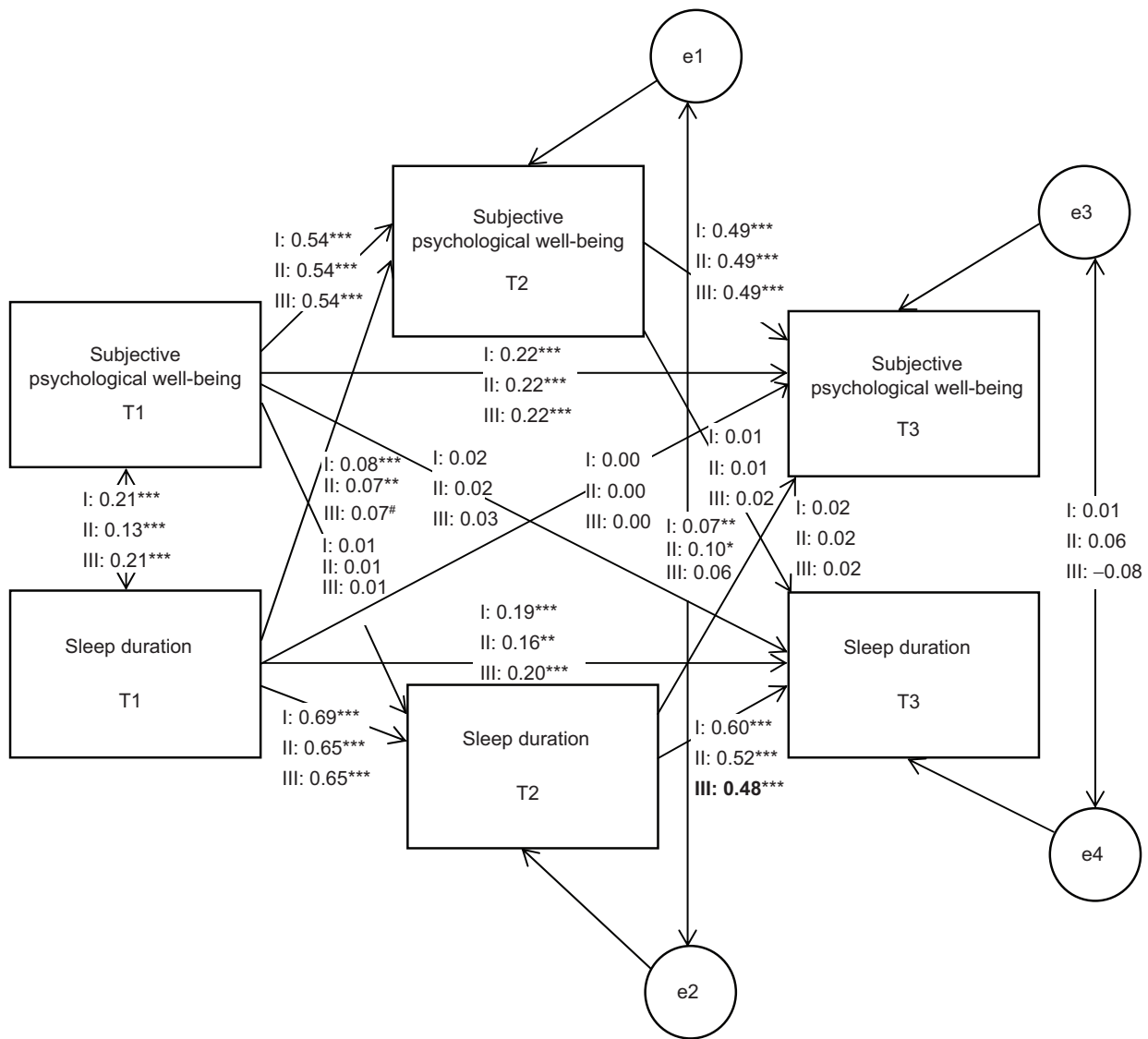
Figure 1 Longitudinal path model.
Notes: Standardized estimates are displayed. Bold letters indicate that this path is significantly different for the respective age group. Fit indices for the displayed model set all paths equal across age groups, except for the path between sleep duration at T2 and sleep duration at T3 for the oldest age group: χ^2=28.01; df=23; P=0.215; RMSEA =0.007. Model comparison of the displayed model with the model setting all paths equal across age groups: χ^2=23.35; df=1; P<0.001. $^{\#}P$=0.08; $^{*}P$<0.05; $^{**}P$<0.01; $^{***}P$<0.001.
Abbreviations: RMSEA, root mean square error of approximation; I, 10–11 year olds; II, 12–13 year olds; III, 14–15 year olds; e, error term.

Regarding changes in sleep duration and SPW across adolescence our findings are consistent with the existing literature by showing that adolescents' sleep duration decreases with age.[43,53] Interestingly, the reduction in sleep duration was smaller between May (a month with already relatively long day length in the northern hemisphere) and November (a month with relatively short day length in the northern hemisphere) than between November and the following May. This difference might reflect a stronger need for sleep in November than in May possibly due to shorter day length. Sleep duration is associated with seasonal changes in day length;[54–59] however, we did not find stronger seasonality of

sleep duration in Norway than in Switzerland as one might have expected due to the more dramatic seasonal differences in day length in northern countries. While subjective psychological well-being decreased more from May–November than from November–May, this pattern was less pronounced and also inconsistent across subgroups.

Taken together, our findings add to the knowledge that the adolescents' sleep duration plays an important role for their subjective psychological well-being and may inform school counselors on the importance of adequate sleep duration for the adolescents' well-being. We note that, while the 10–13 year old adolescents on average still had the recommended sleep

duration of 9 hours on weekday nights,[40,60] sleep duration was on average shorter for the 14–15 year olds although they still require the same amount of sleep as their younger peers.[40] We believe that both adolescents' and parents' education in sleep hygiene should be promoted, especially for older adolescents, because of their rapid changes in physiology and behavior,[61] including physical maturation, psychological factors, social factors (eg, parental monitoring decreases from younger adolescence to young adulthood, involvement in peer groups increase with a consequent increase in leisure activities), issues related to vocational development, and extracurricular issues. There is also evidence that favourable parental style as well as parental monitoring of adolescents' bedtimes and stricter household rules with regard to screen time were related to longer sleep and/or better sleep quality,[62,63] which may in turn play a role for adolescent's psychological well-being.[24,63–65]

Limitations

The strength of this study is the large sample size that allowed to study three different age groups separately, and its longitudinal design. There are also limitations that preclude overgeneralization of the findings. First, objective measurements (eg, actigraphy) would add to the study, allowing comparisons with subjective measurements. Second, we did not include subjective sleep quality to our analyses. Sleep duration is not necessarily associated with subjective sleep quality, and sleep quality and psychological functioning are associated.[66] In a related vein, we did not assess other possibly important sleep variables such as sleep debt or circadian preference that would have allowed a more comprehensive picture of adolescents' sleep habits and circadian rhythms. Third, SPW could have been defined and measured differently. More specifically, future research might include additional dimensions of SPW, such as optimism,[67] satisfaction with life,[68] and mental toughness.[69] Fourth, as no measure of depressive disorder was assessed, it was not possible to test whether the associations also hold if participants with clinically relevant depression were excluded. Finally, applying an intervention design to improve sleep would allow to investigate the causal relationship between sleep duration and psychological functioning.

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Disclosure

The authors report no conflicts of interest in this work.

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