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ORIGINAL PAPER

Screening for Sleep Reduction in Adolescents Through Self-report: Development and Validation of the Sleep Reduction Screening Questionnaire (SRSQ)

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Abstract
Background Sleep reduction, resulting from insufficient or poor sleep, is a common phenomenon in adolescents. Due to its severe negative psychological and behavioral daytime consequences, it is important to have a short reliable and valid measure to assess symptoms of sleep reduction.
Objective This study aims to validate the Sleep Reduction Screening Questionnaire (SRSQ) that can be used to screen for symptoms of sleep reduction in adolescents.
Methods Various samples from the general and clinical populations were included in the study. The SRSQ is a nine-item questionnaire that is based on the longer, four dimensional Chronic Sleep Reduction Questionnaire (Meijer in J Sleep Res 17:395–405,

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doi:10.1111/j.1365-2869.2008.00677.x, 2008). Items were selected on the basis of principal components analysis, item-total correlations, and substantive consideration. The SRSQ was validated by calculating correlations with self-reported and objective sleep and self-reported daytime functioning. Cut-off scores were determined so that the SRSQ can be used as a screening instrument.

Results Internal consistencies of the SRSQ were good (Cronbach's alpha = .79 in the general population). Correlations with self-reported sleep, daytime functioning and objective sleep variables were satisfactory and in the expected directions. The SRSQ discriminates well between clinical and non-clinical cases. When accounting for prevalence of sleep reduction symptoms in the general population, the area under the curve was .91, sensitivity was .80 and specificity was .87.

Conclusions The SRSQ appears to be a short reliable and valid questionnaire. Due to the limited number of items and the availability of cut-off scores, it is a practical tool for clinical and research purposes.

Keywords Sleep · Adolescent · Sleep reduction · Screening instrument

Introduction

Sleep reduction, resulting from insufficient or poor sleep, is a common phenomenon in adolescents (Loessl et al. 2008; Meijer 2008; Roberts et al. 2008) that can have severe negative psychological and behavioral daytime consequences, such as behavioral problems, poor emotional wellbeing, impaired cognitive and school performance (Curcio et al. 2006; Dewald et al. 2010; Fallone et al. 2002; Mitru et al. 2002; Moore et al. 2009; Wolfson and Carskadon 2003). Considering the negative impact of sleep reduction on adolescents' mental health, it is valuable to have a well-developed and brief (Morin 2003) screening instrument for sleep reduction symptoms that shows good psychometric qualities (Spruyt and Gozal 2011).

Spruyt and Gozal (2011) reviewed available sleep questionnaires but found that the majority focuses on children's sleep and parent report. Moreover, most questionnaires refer to sleeping behaviors (e.g., Adolescent Sleep Hygiene Scale), sleep patterns (e.g., School Sleep Habits Survey), or sleep disorders (e.g., Sleep Disorders Inventory for Students–Adolescents) and therefore directly address bed times, sleep onset, sleep duration, etc. However, as it is known that adolescents differ in their individual sleep need (Mercer et al. 1998), which can be defined as the time somebody needs to sleep in order to function optimally throughout the day, examination of daytime consequences rather than of sleep directly gives a more representative picture of whether an adolescent is sleeping enough according to his or her individual sleep need.

Meijer (2008) developed the Chronic Sleep Reduction Questionnaire (CSRQ), which measures daytime symptoms of insufficient or poor sleep, taking individual sleep need into account (i.e. the amount of sleep somebody needs to function optimally during the day). The CSRQ clusters the symptoms into four subscales: Shortness of sleep, sleepiness, loss of energy, and irritation. The CSRQ appears to be a reliable questionnaire (Meijer 2008) and Dutch and English versions have been validated against actigraphy data (Dewald et al. 2012). Dewald et al. (2012) reported relationships with sleep variables that were similar for the first three subscales but different for the subscale Irritation, suggesting that irritation is

not a universal symptom that can be observed in all adolescents with sleep reduction. This idea is supported by research showing that emotional consequences of sleep reduction vary across individuals (Dahl 1999). It might also be that irritation is generally a characteristic of longer lasting or chronic sleep reduction (De Bruin et al. 2013). However, a short period of sleep reduction may already cause deteriorated daytime functioning (Van Dongen et al. 2003). As high correlations between the other three subscales of the CSRQ suggest a single underlying dimension, we aim to develop a short screening instrument based on the CSRQ for general symptoms of sleep reduction, regardless of the period during which the problems exist.

In the present paper we report about the development of a new questionnaire, the Sleep Reduction Screening Questionnaire (SRSQ), which is based on the CSRQ. Similar to the CSRQ, the SRSQ accounts for individual sleep need by measuring daytime symptoms rather than sleep directly. Yet the SRSQ primarily functions as a short screening instrument that covers a broader range of sleep problems than other questionnaires, relying on adolescent self-report to gauge perceived symptoms of sleep reduction, rather than focusing on a specific sleep disorder. In this way, the SRSQ can be used as a general indicator of sleep reduction that is severe enough to warrant further clinical diagnosis and treatment. Although highly needed, to date no such instrument exists for an adolescent population.

We will investigate the validity of the SRSQ by calculating correlations with self-reported and objective sleep data (actigraphy) as well as with self-reported daytime functioning, and we will compare the results with those of the longer CSRQ. We will also investigate whether the SRSQ can discriminate between clinical and non-clinical cases that are assumed to differ to the extent to which they experience symptoms of sleep reduction. For the clinical cases, samples of adolescents with insomnia and Delayed Sleep Phase Disorder will be used, as these are common sleep disorders in adolescence (Gradisar et al. 2011; Moore and Meltzer 2008; Stores 1996).

Summarizing, we aim to develop a screening instrument for the assessment of symptoms of sleep reduction in adolescents. In order to be suitable for general use by therapists in clinical practice, by researchers, and by professionals working with adolescents, e.g., in schools, the measurement instrument must be short but still sufficiently reliable and valid. In addition, the measurement instrument must be both sensitive and specific in the identification of sleep reduction. By selecting items from a larger set, on the basis of both statistical properties and substantive consideration, we expect to develop a short, reliable, and valid measurement instrument. By comparing its psychometric qualities in general and clinical samples, we also expect to determine a cut-off score so that the instrument can be used as a screening instrument to identify adolescents who should be treated for general sleep reduction symptoms.

Methods

Procedure

The SRSQ is developed on the basis of data collected with the longer, four dimensional CSRQ. Both clinical and general samples are included in the present study. These samples are described below and are summarized in Table 1. The study was conducted with the approval of the University of Amsterdam Review Board, the Medical Research Ethics Committee of the Academic Medical Centre of the University of Amsterdam, the Social and Behavioral Research Ethics Committee of Flinders University, and the Department of

Table 1 Sample descriptives

Sample	N	% boys	Mean age	Analysis
General population	951	41.3	14.7	Principal component analysis, correlations with self-reported daytime functioning and subjective sleep variables, ROC analysis and cut-off scores
General population Dutch sample[a]	166	28	15.2	Correlations with actigraphy
General population Australian sample[a]	236	65	15.5	Correlations with actigraphy
Delayed sleep phase Disorder	144	56.3	15.5	ROC analysis and cut-off scores
Insomnia	66	19.7	15.0	ROC analysis and cut-off scores

[a] Dewald et al. (2012)

Education and Children's Services (South Australia) Ethics Committee. Informed consent was obtained from all participants.

Samples

Samples from the General Population

951 adolescents from the general population completed online questionnaires on symptoms of chronic sleep reduction, sleep quality, daytime sleepiness, sleep disorders (insomnia, circadian rhythm sleep disorders), depression, attention problems and school performance. Adolescents were recruited from four different schools in and around Amsterdam. These data were used for the development and validation of the SRSQ.

To calculate the correlations with actigraphy data, we used data from 166 Dutch and 236 Australian adolescents that have been described elsewhere (Dewald et al. 2012).

To check whether the SRSQ retained its psychometric properties when administered separately from the larger CSRQ, we administered the SRSQ twice to 113 adolescents in an Amsterdam high school.

Clinical Samples

We included the following two clinical samples:

Delayed Sleep Phase Disorder (DSPD) 144 adolescents who were referred to the Centre for Sleep-Wake Disorders and Chronobiology of Hospital Gelderse Vallei in Ede, the Netherlands, were diagnosed with Delayed Sleep Phase Disorder by a neurologist. Diagnosis was based on a clinical interview and Dim Light Melatonin Onset (DLMO) (mean DLMO was 22:33 h). All adolescents completed the CSRQ before they started melatonin treatment.

Insomnia 66 adolescents who received cognitive behavioral therapy for their sleep onset and maintenance problems, completed the CSRQ prior to treatment. Adolescents were

admitted to treatment after a clinical interview indicating insomnia (sleep onset and/or maintenance problems).

Measurements

Chronic Sleep Reduction

The CSRQ (Meijer 2008) was administered to measure chronic sleep reduction symptoms. This 20-item questionnaire consists of the following four subscales: shortness of sleep (6 items; e.g., 'I am a person who does not get enough sleep'), Sleepiness (4 items; e.g., 'Do you feel sleepy during the day?'), Loss of Energy (5 items; e.g., 'I am active during the day') and Irritation (5 items; e.g., 'Others think that I am easily irritated'), and refers to the previous 2 weeks (see Table 2 for a full list of items). Each question has three ordinal response categories, with higher scores indicating more symptoms of chronic sleep reduction. The total CSRQ scale consists of the sum of the four subscales, with a Cronbach's alpha of .84 (Meijer 2008). In the present study Cronbach's alpha was .86.

Sleep Quality

Sleep quality was assessed by a sleep quality questionnaire (Meijer and Van den Wittenboer 2004). This questionnaire consists of seven items with three-point response scales measuring problems with falling asleep, maintaining sleep, reinitiating sleep and waking up (e.g., 'I felt well rested when I woke up this morning'). Meijer and Van den Wittenboer (2004) reported a Cronbach's alpha of .67. Cronbach's alpha in the present study was .74.

Daytime Sleepiness

Daytime sleepiness was measured using a pediatric modification of the Epworth Sleepiness Scale (ESS) (Johns 1991). In this eight-item questionnaire, adolescents rate on a four-point Likert scale how likely they are to doze in different situations (e.g., 'Sitting and reading'; 'Watching TV'). Various modifications have been used in pediatric populations (Anderson et al. 2009; Gibson et al. 2006). For this study, the last item 'in a car while stopped for a few minutes in traffic' was replaced with 'doing homework or taking a test'. This change was adapted from previous research, which reported a Cronbach's alpha of .74 (Anderson et al. 2009). Cronbach's alpha in the present study was also .74.

Insomnia

Insomnia was assessed with the insomnia subscale of the Holland Sleep Disorder Questionnaire (HSDQ) (Kerkhof et al. 2013), measuring different sleep disorders. It consists of eight items (e.g., 'The quality of my sleep is poor and I do not feel rested when waking up'), which have to be rated on a five-point Likert Scale. Cronbach's alpha reported by Kerkhof et al. (2013) was .78. In the present study Cronbach's alpha was .88.

Circadian Rhythm Sleep Disorder (CRSD)

CRSD was measured with the CRSD subscale of the HSDQ (Kerkhof et al. 2013). This subscale consists of six items (e.g., 'I usually fall asleep in the morning hours. In the

morning I have trouble to wake up on time. I sleep in during the weekend'), which have to be rated on a five-point Likert Scale. Cronbach's alpha was .81 in the study of Kerkhof et al. (2013). Cronbach's alpha in the present study was .78.

Depression

Depression was assessed with the Dutch version of the Children's Depression Inventory (CDI) (Kovacs 2002), which is based on the Beck Depression Inventory (BDI) (Beck et al. 1961) for adults. Most CDI items cover similar content and symptom areas; however, some additional items have been added to the CDI in order to cover areas of school, aggression and other social-peer relations. The CDI includes 27 items, each consisting of three statements that are graded in severity (e.g., 'I am sad once in a while'; 'I am sad many times'; 'I am sad all the time'). The higher the assigned value (ranging from 0 to 2), the more severe the symptom. The total score can range from 0 to 54. Cronbach's alpha of the Dutch CDI version was .80 (Kovacs 2002). Cronbach's alpha in the present study was .85.

Attention Problems

Attention problems were measured with the attention problems subscale of the Youth Self-Report (YSR) (Verhulst et al. 1997). This scale consists of nine items (e.g., 'I find it difficult to concentrate and to keep paying attention') which have to be rated on three-point Likert Scales. Cronbach's alphas ranging from .57 to .68 have been found for different age groups in healthy children. Cronbach's alpha in the present study was .74.

School Performance

Participants were asked about the grades that they mostly received at school ('Which grade do you usually receive at school?'). Answers consist of five categories, ranging from '4 or lower' (reflecting a clear 'fail' in the Netherlands) to '9/10' (the highest grades that can be achieved in the Netherlands).

Actigraphy

Actigraphy involves use of a wristwatch-like portable device that can record movements over an extended period of time (e.g., a few weeks). Actigraphy is known to be a reliable and valid measure to study sleep in a natural environment (Kushida et al. 2001; Morgenthaler et al. 2007). In the present study we used AW4 actiwatches (Cambridge Neurotechnology Ltd., Cambridge, UK) and calculated the following sleep parameters from five consecutive school nights (Sunday to Thursday night): (a) sleep onset latency: Time between bedtime and sleep onset, (b) sleep duration: Time between sleep onset and sleep offset, (c) total sleep time: Number of minutes that adolescents actually slept (i.e. the time between sleep onset and sleep offset minus wake after sleep onset) and (d) sleep efficiency [i.e. 100 × (total sleep time/time in bed)]: Percentage of uninterrupted night sleep [see Dewald et al. (2012) for more information on the data collection and analysis].

Statistical Analyses

Development of the SRSQ

To develop the SRSQ, we used the data from the general population (N = 951). Items were selected from the original CSRQ, taking both content and statistics into account. Statistical information came from principal components analysis (PCA) and corrected item-total correlations. To warrant the content validity of the SRSQ, we aimed to include equal numbers of items for the different aspects of sleep reduction symptoms.

Validation of the SRSQ

To test whether the psychometric properties of the short SRSQ were still as good as those of the longer CSRQ, we first calculated internal consistencies (Cronbach's alphas). Correlations with different aspects of self-reported sleep (e.g. sleep quality) and self-reported daytime functioning (e.g., depression) are reported to give an indication of the validity. Furthermore, we calculated correlations with actigraphy data of five consecutive school nights (Sunday to Thursday night).

To determine cut-off scores for sleep reduction, we conducted a receiver operating characteristic (ROC) analysis. The ROC curve depicts the relationship between proportions of true positives (the 'sensitivity' of the questionnaire, i.e. the probability of a positive test result if the clinical diagnosis is positive) and proportions of false positives (i.e. the probability of a positive test result if the clinical diagnosis is negative, expressed as '1-specificity') for all possible thresholds. The area under the curve (AUC) indicates the probability that a person is correctly classified by the questionnaire (i.e. as belonging to the clinical or general population group). Depending on the purpose of the measurement, one may be interested in a cut-off score with optimal sensitivity, optimal specificity, or one that maximizes Youden's criterion and is the best compromise between sensitivity and specificity (Youden 1950). AUC, sensitivity, specificity, and cut-offs are estimated through the normal density function (Fluss et al. 2005) so that we can take the prevalence of sleep reduction symptoms in the general population into account.

Sleep reduction symptoms can be caused by insomnia, DSPD, and a range of other problems. Prevalence estimates of these disorders vary. For adolescent DSPD, Moore and Meltzer (2008) report a prevalence of 5–10 %, and Gradisar et al. (2011) report a prevalence of 7–16 %. For insomnia a distinction in reported prevalences can be made between insomnia *diagnosis* [4–5 % (Ohayon et al. 2000; Roberts et al. 2008)] and current insomnia symptoms (9.4 % (Johnson et al. 2006); 25–27 % (Ohayon et al. 2000; Roberts et al. 2008)). From these varying prevalences, we chose 15 % as a conservative estimate of general prevalence of sleep reduction symptoms.

Results

Development of the SRSQ

In a PCA of the correlations between the 20 CSRQ items in the sample from the general population (N = 951), the five irritation items (9, 10, 14, 19, 20; see Table 2) had high loadings on a single, separate component. The idea that the symptom irritation differs from the other sleep reduction symptoms was supported by low corrected item-total correlations

(the five Irritation items were among the lowest eight). Therefore, the Irritation items were removed. A PCA of the remaining items did not show a clear structure. We therefore based further selection on substantive considerations and corrected item-total correlations.

Table 2 CSRQ and SRSQ items

Items CSRQ	Item	Subscale	Corrected item-total correlations CRSQ	Corrected item-total correlations SRSQ
1[a]	Do you have trouble getting up in the morning?	Shortness of sleep	.52	.52
2	Do you feel well rested at school?	Loss of energy	.62	
3[a]	Do you feel sleepy during the day?	Sleepiness	.58	.55
4	Do you often yawn throughout the day?	Sleepiness	.48	
5[a]	Are you immediately wide awake when you wake up?	Shortness of sleep	.37	.36
6	I oversleep in the morning (e.g. continuing to sleep even though I need to get up)	Shortness of sleep	.36	
7	At noon I feel as energetic as in the morning	Shortness of sleep	.26	
8[a]	When I am at school for a while I have trouble keeping my eyes open	Sleepiness	.54	.52
9	Do other people think that you react angrily when they ask you for something or say something to you?	Irritation	.42	
10	When I do not get enough sleep it is more likely that I start an argument	Irritation	.28	
11[a]	Do you have enough energy during the day to do everything?	Loss of energy	.46	.44
12[a]	I am active during the day	Loss of energy	.47	.45
13[a]	I have to struggle to stay awake in class	Sleepiness	.52	.51
14	Do other people say that you seem annoyed?	Irritation	.32	
15[a]	I don't feel like going to school because I feel too tired	Loss of energy	.59	.57
16	I feel very alert at school	Loss of energy	.63	
17[a]	I am a person who does not get enough sleep	Shortness of sleep	.51	.48
18	I would like to sleep longer	Shortness of sleep	.43	
19	Others think that I am easily irritated	Irritation	.30	
20	Do you think that you behave unkindly towards your friends or parents without a reason?	Irritation	.42	

Sample of 951 adolescents from the general population

[a] Items included in the SRSQ

We removed Item 7 from the questionnaire because it had the lowest item-total correlation. As the second response option was rarely chosen (1.3 %), item 18 was also removed. Four of the remaining thirteen items belonged to the subscale shortness of sleep (items 1, 5, 6, and 17), four to Sleepiness (3, 4, 8 and 13) and five to loss of energy (2, 11, 12, 15 and 16). In order to warrant the content validity of the SRSQ, we aimed at covering the three aspects of sleep reduction with equal numbers of items.

Shortness of sleep items 5 and 6 had the lowest item-total correlations. As we preferred the wording of item 5, we removed item 6. Item 4 was removed because it had the lowest item-total correlation of the sleepiness items and also seems less representative of sleepiness. Finally, items 2 and 16 from the subscale loss of energy were removed because their contents overlap with aspects of sleepiness. As a result, the final questionnaire contained 9 items, covering three aspects of sleep reduction symptoms with three items each (see Table 2). The SRSQ yields a single score, with a minimum score of 9 and a maximum score of 27.

Validation of the SRSQ

Cronbach's alpha for the SRSQ was .79 in the general population (N = 951), .78 in the DSPD group and .77 in the insomnia group. Furthermore, Cronbach's alpha was .76 in the Dutch (N = 166) and .84 in the Australian sample. These reliabilities are considered satisfactorily high, in comparison to the much longer 20-item CSRQ. That is, correcting the .86 Cronbach's alpha of the 20-item CRSQ for test length would yield a reliability of .73, which is lower than the .79 Cronbach's alpha of the 9-item SRSQ.

Correlations for the SRSQ with self-reported sleep and daytime functioning were calculated for the general population (N = 951) (see Table 3). The results show that the SRSQ was correlated with self-reported sleep and daytime functioning variables in the expected directions, and that the correlations were as high as the correlations of the 20-item CSRQ version.

We found similar, even slightly stronger relationships between the SRSQ and objectively measured sleep variables than the ones that have been reported by Dewald et al. (2012) for the full CSRQ (see Table 4). All relationships were in the expected directions, indicating that adolescents who scored high on the SRSQ also had longer sleep onset latencies and slept shorter than adolescents that scored low on the SRSQ. Sleep efficiency was not significantly related to either the CSRQ or the SRSQ. Means and standard deviations of the actigraphy data are reported in the publication by Dewald et al. (2012).

Cut-off scores for the identification of adolescents with sleep reduction were determined using the sample from the general population (N = 951) and the two clinical groups, under the assumption that adolescents from the clinical groups experience more sleep reduction symptoms than adolescents from the general population. We matched cases from the general population with clinical cases according to sex and age, to make the groups comparable. As the two clinical groups did not differ on the pre-treatment CSRQ scores, we combined them into a single clinical group in the analyses. We took an equally large sample from the general population. After case–control matching, the sample from the general population consisted of 210 adolescents (44.8 % boys, mean age = 15.4 years, mean SRSQ = 15.04 ± 3.75) and the clinical group consisted also of 210 adolescents (44.8 % boys, mean age = 15.4 years, mean SRSQ = 20.39 ± 3.73).

ROC analyses were conducted to determine cut-off scores. For the SRSQ, we found a ROC curve with an AUC of .91 (95 % confidence interval .86–.95). This AUC is comparable to the AUC for the longer CSRQ (AUC = .91, 95 % CI .87–.95). For the SRSQ, the optimal cut-off according to Youden's criterion, which gives equal weight to sensitivity

Table 3 Correlations between symptoms of chronic sleep reduction (SRSQ and CSRQ), self-reported sleep and daytime functioning (N = 951)

	SRSQ	20-item CSRQ
Self-reported sleep		
Sleep quality	−.55	−.58
Daytime sleepiness	.43	.42
Insomnia	.68	.71
Circadian rhythm sleep disorder	.55	.56
Self-reported daytime functioning		
Depression	.52	.57
Attention problems	.48	.51
School performance	−.17	−.17

All p-values $\leq$ .001

Table 4 Correlations between symptoms of chronic sleep reduction (SRSQ and CSRQ) and actigraphy data in Dutch and Australian samples

	SRSQ (p value)	CSRQ (p value)
Dutch sample (N = 166)		
Total sleep time[a]	−.16 (.05)	−.12 (.14)
Sleep onset latency	.24 (≤.01)	.22 (≤.01)
Sleep duration[b]	−.23 (≤.01)	−.19 (≤.01)
Sleep efficiency[c]	−.03 (.68)	−.01 (.93)
Australian sample (N = 236)		
Total sleep time[a]	−.08 (.20)	−.09 (.17)
Sleep onset latency	.35 (≤.001)	.34 (≤.001)
Sleep duration[b]	−.20 (≤.01)	−.18 (≤.01)
Sleep efficiency[c]	.05 (.46)	.01 (.92)

Correlations for the CSRQ have been previously reported (Dewald et al. 2012)

[a] Total sleep time: minutes of actually obtained sleep

[b] Sleep duration: time between sleep onset and sleep offset

[c] Sleep efficiency: total sleep time/time in bed × 100

and specificity, was 17.3. With this cut-off, 79.9 % of the clinical cases and 86.7 % of the healthy population were correctly identified. A 17.3 cut-off means that a respondent who consistently chooses the middle response option would qualify as a clinical case. The same is of course true for any respondent with an average score of 2 across items. For optimal sensitivity, a cut-off of 14.1 was found (correctly identifying 95.4 % of the clinical cases and 50.0 % of the healthy population), and for optimal specificity, a cut-off of 20.4 was found (correctly identifying only 50.0 % of the clinical cases but 98.7 % of the healthy population).

The results reported above are derived from data of adolescents who completed the full CSRQ. Separate administration of the SRSQ among 113 adolescents in a high school in Amsterdam showed good reliabilities as well. Cronbach's alpha was .82 (N = 113) on the first measurement occasion and .81 (N = 77) 2 weeks later. Test–retest reliability was also very good (r = .88).

Discussion

The aim of the present study was to develop and validate a short questionnaire that can be used as a screening tool for sleep reduction symptoms. Our results demonstrate that the SRSQ is a reliable and valid questionnaire.

Internal consistencies of the SRSQ were good and, taking the number of items into account, comparable to the internal consistencies of the original version of the questionnaire. Similar correlations with self-reported daytime functioning and sleep variables were found for the SRSQ and the 20-item CSRQ, indicating that the SRSQ is as valid as the original questionnaire. The good psychometric properties of the SRSQ, which hardly differ from the longer CSRQ, represent an advantage of this screening instrument.

We hardly found any significant correlation with TST. This supports the idea that sleep time per se does not adequately reflect somebody's degree of sleep reduction. As some people may function well with less sleep than usual whereas other people need more sleep for optimal functioning, it is important to take somebody's individual sleep need into account (Dewald-Kaufmann et al. 2013). In addition, research has shown that not only short sleepers, but also long sleepers can have sleep complaints (Grandner and Kripke 2004), further supporting the idea that sleep duration in itself is not always informative. With reference to sleep efficiency, which generally is considered to be an indicator of sleep quality, we did not find an association with symptoms of sleep reduction either. Interestingly, relationships with self-reported sleep variables (sleep quality and daytime sleepiness) were stronger than the relationships with the objective sleep variables. This finding may be due to common method bias, that is, correlations between subjective measures may be inflated because of the shared method of self-report.

The SRSQ discriminates well between clinical and non-clinical cases. However, as symptoms of sleep reduction do not refer to a sleep disorder as being defined by the DSM-IV (American Psychiatric Association 1994) or ICSD-2 (American Academy of Sleep Medicine 2005), the SRSQ is not primarily intended for diagnosing sleep disorders. Moreover, sleep reduction symptoms might also be caused by non-sleep disorders, such as depression or somatic illnesses. Still, scores above the cut-off do indicate the presence of (sleep-related) problems, requiring further diagnosis to identify the cause of sleep reduction (e.g., sleep disorders, poor sleep hygiene, somatic or psychiatric disorders), and to determine subsequent treatment.

The validation results of the SRSQ are partly based on Dutch samples. However, a multi-group factor analysis has shown the English and Dutch versions of the CSRQ to be equivalent (Dewald et al. 2012), which is also supported by the similar correlations with actigraphy data in the Dutch and Australian samples. We can therefore assume that all validity results apply to both the Dutch and English language versions of the SRSQ. Still, more precise cut-off scores for the English language version remain to be determined in future research.

To summarize, the SRSQ appears to be a short, valid and reliable measure to assess sleep reduction symptoms in adolescents. It is related to relevant measures of sleep and daytime functioning and can discriminate very well between clinical and non-clinical cases. With its limited number of items, the SRSQ is quickly and easily applicable, and the availability of cut-off scores for sleep reduction makes it a practical tool for clinical and research purposes.

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Conflict of interest The authors declare that they have no conflicts of interest.

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