Evidence for the Validity of a Sleep Habits Survey for Adolescents

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Study Objectives: To examine the validity of self-reported survey estimates of sleep patterns in adolescents through a comparison of retrospective survey descriptions of usual school- and weekend-night sleep habits with diary-reported sleep patterns and actigraphically estimated sleep behaviors over a subsequent week.

Design and Setting: High school students completed a Sleep Habits Survey about the previous 2 weeks and then wore an actigraph (AMI, Ardsley, NY) for 8 days while keeping a daily sleep diary. Matched-pair t-tests assessed average differences between survey and diary reports and between survey and actigraph estimates. Pearson correlations assessed the extent to which survey reports were in agreement with diary reports and actigraphy estimates.

Participants: 302 high school students (196 girls, 106 boys) in grades 9-12 from five high schools.

Results: School-night survey total sleep times and wake times did not differ from sleep amounts reported in the diary or estimated by actigraphy; survey bedtimes were slightly earlier. On weekends, survey total sleep times and wake times were longer and later, respectively, than estimated with actigraphy and reported on diaries. Moreover, school- and weekend-night survey variables were significantly correlated both with diary and actigraphy variables. Strengths of the associations were consistently greater for school-night variables than the corresponding weekend-night variables.

Conclusions: The findings support the validity of the Sleep Habits Survey estimates in comparison with diary and actigraphy. Strengths and limitations for survey measures of high school students’ usual sleep/wake patterns are discussed.

Key Words: Validity, survey, diary, actigraphy, high school students’ sleep patterns


INTRODUCTION

MANY HIGH SCHOOL STUDENTS REPORT SLEEP-WAKE SCHEDULES DURING THE ACADEMIC YEAR THAT INVOLVE LATE BEDTIMES AND SHORT SLEEP.1,2,3,4 Such estimates have typically used self-report survey questionnaires, one-time “snapshot” measures of sleep. Newer techniques provide more sustained and less subjective field assessments through daily diaries and actigraph monitoring. Yet, the coherence of adolescents’ survey reports with diary- and actigraphy-estimated sleep habits is unknown.

Self-reports or survey reports are relatively easy to utilize; however, they have limitations. Respondents tend to underestimate sleep duration and number of night wakings and overestimate sleep latency when compared with polysomnographic studies.5,6 Survey questions tend to assess information for one point in time, either retrospective or concurrent, and researchers are often uncertain whether participants are giving accurate assessments of behaviors (e.g., bedtime). Specifically, an adolescent completing a survey may report only the most recent, salient, and/or socially desirable responses. For example, a participant’s report could reflect recency, that is she or he may be more likely to report most recent as opposed to usual bedtime (e.g., usual bedtime is 11:00 p.m., but last night’s bedtime was 1:00 a.m. and the participant gave 1:00 a.m. as usual bedtime). Another liability is that study participants tend to portray themselves in a socially desirable manner.7 As a result, some high school participants might report that their usual weekend bedtime is 2:00 a.m., even if it is earlier, if they perceive that the popular teenagers go to bed at around 2:00 am on Saturday nights. Finally, expectancy effects may emerge when a researcher has preconceived ideas regarding participants’ behaviors. Consequently, researchers’ expectations regarding adolescents’ sleep needs may subtly and inadvertently influence the way in which participants complete a questionnaire or survey.

Daily sleep/wake diaries also rely on self-report; however, they are generally viewed as more accurate than participants’ global, subjective impressions obtained from a one-time survey. In comparison to surveys, daily sleep diaries depend less on memory and allow quantitative measurements of sleep length and sleep/wake schedules across a series of daily reports. Also, individuals completing sleep diaries or logs are more likely to report temporally proximal data than when completing retrospective questionnaires. Sleep diary reports tend to be correlated with objective measures of sleep, such as polysomnographic recordings.5,8 Sleep diaries also have limitations. Studies of insomniacs, for example, have shown that adults are inclined to overestimate sleep latency and underestimate total sleep time when reporting in sleep diaries.5,9,10 In addition, most people are not always aware of night wakings or when they actually fell asleep.5,10 Moreover, researchers have not compared sleep diary (daily self-reports) versus survey reports (retrospective questions) of adolescents’ sleep habits.

Another approach for assessing sleep patterns is to use more objective methodologies and thus increase precision and reliability and reduce error variance resulting from human judgment and interpretation. Actigraphy (activity-based monitoring) has been established as a valid and reliable method of assessing current sleep-wake patterns in children, adolescents, and adults.6,9,11,17 A number of studies have demonstrated the validity and the reliability of actigraphic estimations of sleep patterns in normal and clinical samples, children, adolescents, and adults based on concurrently obtained actigraphy and polysomnographic recordings in laboratory settings.6,9,12-18 Such comparisons typically yield overall agreement rates in the range of 78% to 90%.9,12-18 Good to excellent reliability of actigraph measures is obtained for measures aggregated over 5 to 7 nights, depending on the variable of interest.11

Comparison of subjective sleep/wake data to objective measures has usually focused on comparing morning report to polysomnography.10 Subjective assessments have been compared to actigraph measures col-
lected in the field less often. A few studies have evaluated the usefulness of actigraphy monitoring versus daily logs or diaries in adult insomnia patients, concluding that actigraphy has large margins of error (e.g., for sleep latency, nocturnal awakenings) in assessing sleep in adults with insomnia and, as a result, is not necessarily more informative than subjective daily diaries. By contrast, a comparison of diary and actigraphy in blind adults with different types of circadian rhythms demonstrated good correspondences for sleep onset, offset, and duration; however, the methods were poorly correlated for sleep latency and number and duration of night wakings. Such difficulties may not be a problem in non-sleep-disordered samples where actigraphy shows greater reliability vis-à-vis polysomnography. We also need to keep in mind that validation studies need to be designed so that unintentional confounds are not introduced. For example, if sleep parameters are correlated with child age, then the design or analysis must preclude age as the factor producing observed associations among different measurement devices.

The usefulness of survey data in comparison with actigraphy and daily diary measures has not been established. The purpose of the present paper is to examine whether our data provide evidence in support of the validity of self-reported survey estimates of sleep patterns in adolescents through a comparison of retrospective (2-week) survey descriptions of usual school- and weekend-night sleep habits with diary-reported sleep patterns and actigraphically estimated sleep behaviors over a subsequent week.

METHODS

Participants

A total of 302 students from five Rhode Island high schools participated in the current study over the course of 4 years during the months from late September through early December: 35 at a coeducational parochial high school (1997), 39 at an independent girls’ school (1998), 58 at an independent coeducational school (1998), 89 at a suburban public high school (1999), and 81 at an urban public high school (2000). The students in grades 9 through 12 (196 girls and 106 boys) ranged in age from 13.8 to 19.9 years (M = 16.0, SD = 1.2); all were nonboarding day students. Participants were screened only for the ability to understand and willingness to comply with the study’s minimal requirements. The E. P. Bradley Hospital Institutional Review Board for the Protection of Human Subjects (IRB) approved this study, and informed consent was obtained from parents (for participants under age 18) or students aged 18 or older. Students and their parents were compensated with gift certificates to local stores. Eighty-seven percent of the students from four of the five schools reported that they were European American, whereas students attending the urban public high school were more diverse (44% European American). On average, 75% of the students from all five schools reported that they lived with both parents; 80% of fathers and 53% of mothers were employed.

Procedure

Research assistants met with the participants twice at their high school, at the beginning and at the end of an 8-day interval. At the first visit, participants completed the Sleep Habits Survey (SHS) and other self-report measures (not presented in this report), and they were instructed in how to wear the actigraph and complete the sleep diary. The survey items queried students about usual sleeping and waking behaviors over the past 2 weeks, which is a typical interval for pointassessment sleep habits surveys. This paper examines the following SHS variables (school and weekend nights separately): (1) SHS TST: usual total sleep time (“Figure out how long you usually sleep on a school night and fill it in here.”) answered as specific hours and minutes such as 7 hours, 30 minutes; (2) SHS Bedtime: usual bedtime (“What time do you usually go to bed on school days?” answered as one specific time, such as 11:30 p.m.); and (3) SHS Wake Time: usual wake time (“What time do you usually wake up on school days?” answered as one time, such as 6:10 a.m.).

During the subsequent week, participants wore Mini Motionlogger actigraphs (Ambulatory Monitoring Inc. (AMI), Ardsley, NY) on the nondominant wrist, set for 1-minute recording bins, zero crossing mode, and a sensitivity of .05 g in a frequency range of 2 to 3 Hz, and kept daily diaries indicating total sleep times (“slept this much last night” answered as hours and minutes), bedtimes (“attempted to fall asleep at” answered as specific time), and wake times (“finally woke at”), as well as times when the actigraph was off. The following diary variables were computed for school nights and weekend nights separately: average total sleep time (Diary TST), average bedtime (Diary Bedtime), and average wake time (Diary Waketime). Diary nights were excluded if there were no comparable actigraphy nights.

At the end of the 8-day interval, the research assistant again met with the participant to check the diary for completeness and to evaluate the actigraph data in the context of the diary data. Actigraph data were analyzed according to the procedures of Acebo and colleagues11 to estimate sleep using Action-W2 software (AMI) and the validated Actigraphic Scoring Analysis (ASA) algorithm, also called the “Sadeh” algorithm. This procedure relies heavily upon the concurrent behavioral self-report obtained by the sleep diaries. For actigraphy and diary data, nights were defined as school nights if the participant went to school the following day and weekend nights were Friday and Saturday nights only. (Other non-school nights, such as vacation, days at home due to illness, or other days when school was not in session, were not included). Similar to the diary variables, based on an average of 5.2 scoreable school nights and 1.95 scoreable weekend nights, separate school- and weekend-night actigraphy variables were computed from the actigraph records as follows: sleep period (elapsed minutes from sleep onset to sleep offset), sleep onset time (clock time of the first minute of at least 3 consecutive minutes of sleep as scored by the Sadeh algorithm), and sleep offset time (clock time of the last minute of at least 5 consecutive minutes of sleep just prior to the end of the scoring interval as scored by the Sadeh algorithm). Sleep onset and sleep offset were scored within interval windows set using diary responses.

Statistical Methods

Two statistical analyses were performed to assess the agreement and divergence between survey reported sleep habits and both diary reports and actigraph records. First, matched-pair t tests assessed average differences between survey and diary reports and between survey and actigraphy estimates. Second, Pearson correlations assessed the extent to which these measures were in agreement at the individual level (e.g., survey and diary; survey and actigraphy). To examine whether agreement was similar for school nights and weekend nights, correlations were compared to each other using z (Fisher’s z transformation). An alpha level of .05 was used to determine statistical significance.

RESULTS

Means and standard deviations for survey, diary, and actigraphy sleep variables are shown in Table 1. School-night survey reported total sleep times and wake times did not differ significantly from sleep amounts reported in the diary or estimated by actigraphy. On average, estimates were within 5 minutes, and these high school students reported sleeping about 7 hours, 20 minutes on school-nights and waking up at about 6:20 a.m. Survey-reported school-night bedtimes, however, were slightly but significantly earlier (8 to 13 minutes) than diary (t = 3.59, p < .001) and actigraphy bed times (t = 5.10, p < .001). Participants also reported sleeping about 30 minutes longer on weekend nights than noted on their daily diaries (t = 4.26, p < .001) or estimated with actigraphy (t = 5.25, . Direct comparisons between diary reports and actigraph records were not done because diary reports were used to identify the portion of actigraphy records scored for nocturnal sleep.
survey-reported weekend wake times were about 55 minutes later than reported on daily diaries (t = 7.31, p < .001) and estimated with actigraphy (t = 11.87, p < .001). Survey-reported weekend bedtimes did not differ significantly from diary-report or actigraphy-estimated times.

Pearson correlations of survey versus diary and actigraphically estimated sleep variables are listed in Table 2. Overall, school- and weekend-night survey variables were significantly correlated with both diary and actigraphy variables. The strengths of the associations were consistently greater for school-night than the corresponding weekend-night variables. In addition, when age was partialled out (for the entire sample or for males and females separately), there were no changes in either the significance or the strength of the correlations. One example of this pattern is illustrated in Figure 1, showing scatter plots for survey versus diary estimates for school- and weekend-night bedtimes.

**DISCUSSION**

Our analysis supports the validity of the SHS estimates in comparison with diary and actigraphy and highlights certain strengths and limitations for survey measures of high school students’ usual sleep/wake patterns. In terms of strengths, the survey data in general corresponded quite well with subsequently collected diaries and actigraphy. Comparisons between survey reports, diary reports, and actigraph measures for school nights showed significant differences only for school-night bedtime; these differences were small (8–13 minutes). Furthermore, correlation coefficients of survey estimates with diary and actigraphy on school nights showed strong and significant correlations. In contrast, students’ survey reports of weekend total sleep time were significantly greater than diary and actigraphy estimates. Weekend wake up times from the survey also differed significantly (about 1 hour later) in comparison to actigraphy and diary-estimated times. Correlations between survey-diary and survey-actigraph sleep variables for weekends, though statistically significant, were weaker than comparable associations for school-night data. Additionally, correlations with age partialled did not reveal any changes in the findings.

Thus, high school students’ survey data for school nights were more comparable to the subsequent diary and actigraphy than for weekends. The stronger school-night associations may be accounted for by school-night sleep schedules being closely tied to and even somewhat regulated by school-start-time schedules. This linkage of school schedules and sleep schedules provides greater predictability for school-night sleep than weekend sleep, making it easier to achieve accurate estimates on school nights. By including multiple nights in the estimate, reliability of the diary and actigraph estimates for school-night sleep is also

**Table 1**—Mean (standard deviation) in Minutes of School and Weekend-Night Sleep Variables

<table>
<thead>
<tr>
<th>Sleep Variable</th>
<th>Survey</th>
<th>Diary</th>
<th>Actigraphy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sleep Time/Sleep Period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-night</td>
<td>440</td>
<td>442</td>
<td>440</td>
</tr>
<tr>
<td>Weekend-night</td>
<td>549</td>
<td>521**</td>
<td>514**</td>
</tr>
<tr>
<td>Bedtime/Sleep Onset time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-night</td>
<td>22:46</td>
<td>22:54*</td>
<td>22:59*</td>
</tr>
<tr>
<td>Weekend-night</td>
<td>00:17</td>
<td>00:08</td>
<td>00:11</td>
</tr>
<tr>
<td>Waketime/Sleep Offset time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-night</td>
<td>6:20</td>
<td>6:23</td>
<td>6:18</td>
</tr>
<tr>
<td>Weekend-night</td>
<td>9:46</td>
<td>8:46**</td>
<td>8:43**</td>
</tr>
</tbody>
</table>

1Comparison: diary and actigraphy sleep variables versus survey variables.

2Note: All Pearson correlations were significant at p < .01.

**Table 2**—Pearson Correlations of Measures for School Nights and Weekends

<table>
<thead>
<tr>
<th>Sleep Variable</th>
<th>School-night</th>
<th>Weekend-night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sleep Time/Sleep Period</td>
<td>.61a</td>
<td>.38</td>
</tr>
<tr>
<td>Survey vs. Diary</td>
<td>.53b</td>
<td>.31</td>
</tr>
<tr>
<td>Survey vs. Actigraphy</td>
<td>.76c</td>
<td>.46</td>
</tr>
<tr>
<td>Bedtime/Sleep Onset Time</td>
<td>.70d</td>
<td>.48</td>
</tr>
<tr>
<td>Survey vs. Diary</td>
<td>.71e</td>
<td>.46</td>
</tr>
<tr>
<td>Survey vs. Actigraphy</td>
<td>.77f</td>
<td>.52</td>
</tr>
</tbody>
</table>

1Note: All Pearson correlations were significant at p < .01.

2Note: To examine whether correlations were similar for school nights and weekend nights, they were compared using z (Fisher’s z transformation).

Figure 1—This figure displays scatter plots for survey versus diary estimates for school-night (A) and weekend-night (B) bedtimes. Best-fit regression lines are displayed for each scatter plot.
enhanced. By the same token, larger discrepancies between survey and diary or actigraphy sleep data for weekends may reflect greater variability of weekend sleep schedules in addition to the relative unreliability of the diary and actigraphy measures for only 2 nights of data.

The validity of survey sleep habits data for adolescents on school nights is well supported in these analyses by the similarity of group mean data for diary and actigraphy gathered about a week later, as well as by the strong correlations of the survey reports with diary and actigraphy. The usefulness of surveys for weekend estimates is less clear. Reduced correspondence of weekend survey reports with diary and actigraphy estimates may indicate poor estimates on the part of the subjects. On the other hand, the weekend survey data may better reflect high school students’ sleep patterns because they take into account more information (e.g., previous 2 weekends) than obtained for diary and actigraphy estimates. Survey queries for weekends may also represent a more difficult task, requiring adolescents to give a one-value estimate to a more variable phenomenon. Without further study, therefore, we cannot conclusively demonstrate the validity of adolescent survey estimates of weekend sleep patterns.

When considering the data presented here, the reader should keep in mind a few important issues. First, participants were asked in the survey to estimate sleep patterns for the previous 2 weeks and not to predict the following week; thus, the correspondence between the measures is likely to reflect stability of overall sleep patterns, and lack of correspondences can reflect either inaccuracies of estimates or unusual perturbations of sleep patterns during the week of observation. Second, the diary and actigraphy data are not independent measures because diary data are used in our scoring system to restrict actigraphy scoring; thus, survey data tend to show a similar level of correspondence to both sets of measures. Third, the variables from each source were defined somewhat differently. For example, the survey bedtime question was worded, “when do you usually go to bed,” whereas the diary asked, “when did you attempt to fall asleep,” and the parallel actigraphy variable was computed sleep-onset time based on the actigraphy scoring algorithm. An alternative strategy would have been to have the adolescents collect 1 or 2 weeks of actigraphy/diary data and then ask them to complete the survey at the end of those 2 weeks. This approach, however, introduces another type of reporting bias, since participants would be reporting on their sleep patterns after having monitored themselves for at least a week. Moreover, ‘real world’ surveys are generally utilized without having participants complete daily diaries. Nevertheless, the correspondence for these measures was strong. For the sleep-amount comparisons, the two self-report measures used a similar query method; however, the actigraphy variable we chose for comparison was sleep-period time (sleep onset to sleep offset) rather than actigraphically estimated total sleep time. Our decision to use sleep period in this validation analysis was based on previous literature indicating that subjects are generally poor at estimating nocturnal arousals. Actigraphy estimates of total sleep time (unpublished observation), though correlated with sleep period, were considerably lower than sleep-period estimates in this group of adolescents. Finally, as with all studies, one must question the representativeness of the sample and generalizability of the conclusions. The current survey estimates of sleep patterns are strikingly similar to a 1994 survey performed with students from other Rhode Island schools where students were mostly European American and from homes where both parents were employed.

As concerns about sleep and health in adolescents grow, the accumulation of population estimates of sleep patterns becomes more important for characterizing the scope of the problem, as well as for achieving meaningful comparisons among diverse samples. Thus, acknowledging limitations of survey reports as well as understanding their usefulness or validity is important to assessing such estimates of population parameters. Large-scale survey studies will continue to provide opportunities to accentuate meaningful findings by allowing researchers to estimate effect sizes and to examine extreme groups from larger samples. Whereas aggregated nights of actigraphically estimated sleep variables often provide a more reliable and valid assessment of sleep patterns, they are generally not feasible for such purposes. In summary, the analyses presented in this paper provide evidence supporting the validity of self-report sleep habits surveys when the goal is to describe group-level sleep patterns of large samples of adolescents.

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REFERENCES