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SCIENTIFIC INVESTIGATIONS

Mother Knows Best? Comparing Child Report and Parent Report of Sleep Parameters With Polysomnography

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Study Objectives: Parent report or child report is commonly used to obtain information on sleep in children. Data are lacking comparing the validity of parent-reported versus child-reported sleep parameters.

Methods: A total of 285 children (age 9 to 17 years) from the Tucson Children's Assessment of Sleep Apnea community cohort study were assessed. Parent report and child report of total sleep time (TST), sleep latency (SL), and sleep efficiency (SE) for a single night were compared to polysomnography (PSG). Intraclass correlations (ICCs) were used to evaluate agreement between child report, parent report, and PSG findings.

Results: When compared to PSG, children overestimated TST by a median of 32 minutes (interquartile range [IQR] 6 to 68), whereas parents overestimated TST by 36 minutes (IQR 13–70) (P = .006). Children overestimated SL by 4 minutes (IQR −8 to 20), whereas parents overestimated SL by 2 minutes (IQR −10 to 13) (P = .001). Children overestimated SE by 5% (IQR 0% to 11%), whereas parents overestimated SE by 6% (IQR 2% to 11%, P = .04). Both child-reported TST (ICC 0.722, $P < .001$) and parent-reported TST (ICC 0.776, $P < .001$) agreed substantially with PSG. Child-reported SL (ICC 0.467, $P < .001$) and parent-reported SL (r = .419, $P < .001$) moderately agreed with PSG. Least agreement with PSG was seen between child-reported SE (ICC 0.404, $P < .001$) and parent-reported SE (ICC 0.473, $P < .001$), but significant agreement was still present.

Conclusions: When compared to PSG, children overestimate TST to a smaller degree than their parents and overestimate SL to a larger degree than their parents, but these differences appear small. Child and parent reports appear to be equally valid for TST, SL, and SE.

Keywords: sleep, children

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BRIEF SUMMARY

Current Knowledge/Study Rationale: Parent report and child report of total sleep time and other sleep parameters is commonly used in research and clinical practice. The validity of parent report versus child report of sleep parameter compared to polysomnography has not been reported.

Study Impact: In general, parent report and child report agree equally with polysomnography. Both parents and children tend to overestimate total sleep time, sleep latency, and sleep efficiency. In cases with high disagreement between parent report and child report, child report appeared more accurate for total sleep time and sleep efficiency, whereas parent report was more accurate for sleep latency. These results suggest that parent report and child report of sleep parameters is generally equally valid, except in cases with high disagreement.

INTRODUCTION

Self-reported sleep parameters such as total sleep time (TST) and sleep efficiency (SE) are routinely used in sleep medicine research and clinical practice. Polysomnography (PSG) is the gold standard for measuring sleep parameters, but is inconvenient, expensive, and may not be reflective of habitual sleep time given the sleep disruption related to wearing PSG equipment and spending the night in a sleep laboratory. Actigraphy is commonly used in sleep research studies to measure habitual sleep and has been validated in children.[1,2] However, actigraphy may underestimate TST and wake after sleep onset.[1,3] Additionally, although actigraphy is less burdensome to patients and less expensive than PSG, actigraphy for children is not typically available outside of specialized pediatric sleep centers. Wearable accelerometer-based devices such as Fitbits have also been evaluated to measure sleep in children, but have been found to have limited accuracy.[4] Given the limitations of more objective measures of sleep parameters, self-reported sleep time is commonly used in both research studies[5,6] as well as clinical evaluation of children.

For evaluation of children with sleep complaints, both parent report and child report of sleep parameters may be used. However, parent report and child report of sleep parameters may be incongruent, and it is unknown whether parent report or child report of sleep parameters is more accurate. There are few data comparing the accuracy of parent report and child report of sleep parameters. We analyzed data from the Tucson Children's Assessment of Sleep Apnea study (TuCASA) to compare parent report and child report of sleep parameters with PSG.

METHODS

This study is a secondary analysis of phase two of the TuCASA cohort study. A detailed description of the TuCASA study has been previously described.[7] In brief, Caucasian and Hispanic children were recruited from the Tucson Unified School District, a large district representative of the Tucson population. A total of 503 children and their parents provided consent and participated in phase 1 of the study. Approximately 5 years later (mean 4.7 years), 312 children participated in phase two of the study. The TuCASA study was approved by the University of Arizona Institutional Review Board (approval # 0300000227) and the Tucson Unified School District Research Committee. Prior to undergoing study-related procedures, written informed consent was obtained from the parents and minors' assent was also obtained. Participants underwent home PSG, and both children and their parents filled out sleep questionnaires pertaining to the child's sleep on the night of PSG.

Polysomnography

A single, unattended overnight PSG was obtained with the Compumedics PS-2 system (Abbotsford, Victoria, Australia). PSG equipment was set up in the participants' home by a mixed sex team of two technicians who arrived at the home approximately 1 hour prior to the participant's bedtime. The following signals were acquired as part of the TuCASA montage: C3/A2 and C4/A1 electroencephalogram, right and left electrooculograms, a bipolar submental electromyogram, thoracic and abdominal displacement (inductive plethysmography), nasal/oral thermistor to measure airflow, nasal pressure cannula, finger pulse oximetry, electrocardiography (single bipolar lead), snoring microphone, body position (Hg gauge sensor), and ambient light levels.[7] Limb electromyography was not performed as studies were done at home and risk of tripping over limb leads was considered a safety hazard. A feasibility study of the Compumedics system was done by performing conventional PSG in a subset of participants, which showed good correlation between the two studies.[7] Scoring of sleep was performed by a single registered PSG technologist using Rechtschaffen and Kales scoring rules[8] with two exceptions. First, sleep latency (SL) was defined as latency to an epoch of any stage of sleep instead of the Rechtschaffen and Kales definition of three epochs of stage 1 or one epoch of any other sleep stages. Second, Rechtschaffen and Kales stages 3 and 4 sleep were combined into one category of NREM 3, analogous to scoring stage N3 sleep according to American Academy of Sleep Medicine (AASM) guidelines. Apneas were scored if the amplitude of the thermistor airflow decreased below at least 25% of the amplitude of baseline breathing, and lasted for more than 6 seconds or 2 breath cycles.[7,9,10] Hypopneas were designated if the amplitude of any respiratory signal decreased below 70% of the amplitude of baseline, was associated with a 3% oxygen desaturation, and the thermistor signal did not meet the criterion for apnea.[7,9] Hypopneas were not differentiated between central and obstructive. Central events were marked if no displacement was noted on both the chest and abdominal inductance channels. However, central events that occurred after movement were not included. The apnea-hypopnea index was defined as the number of apneas and hypopneas per hour of TST. TST, SL, and SE were determined from PSG. TST was defined as time from sleep onset to the end of the final sleep epoch minus time awake. SL was defined as the time from lights out to the first stage of sleep. SE was defined as TST divided by total time in bed (lights out to lights on) × 100.

Questionnaire Data

Parent and child completed surveys on their night of sleep in the morning following PSG. Specific questions were: "How long did it take you/your child to fall asleep at bedtime last night?"; "What time did you/your child first lay down to go to sleep last night?"; "What time did you/your child wake up today?"; and "How long did you/your child sleep last night?" TST was derived from the answer to the question "How long did you/your child sleep last night?" SL was derived from "How long did it take you/your child to fall asleep at bedtime last night?" Total time in bed was determined by the clock duration between reported bedtime and wake time. SE was calculated by dividing reported TST by total time in bed. Separate calculations were performed for child report and parent report of all parameters.

Statistical Analysis

Statistical analysis was performed using SPSS 25 (IBM, Armonk, New York, United States). Pearson χ^2 tests were used to compare categorical demographic differences. Wilcoxon signed-rank tests were used to compare the differences between child and parent-report of TST, SL, and SE when compared to PSG. Model 3 (two-way mixed) intraclass correlations (ICCs) were calculated to determine the agreement between parent report, child report, and PSG measurement of TST, SL, and SE. Significance was determined by values of $P < .05$. Bland-Altman plots were constructed to visualize limits of agreement between parent report/child report compared to PSG. We additionally performed a stratified analysis of adolescent compared to preadolescent child-reported sleep parameters with parent report and PSG. We also performed sensitivity analysis to account for possible exchange of information between parent and child when completing morning surveys that may have caused parent report and child report to appear more similar. Specifically, we excluded cases where parent report and child report of TST, SL, and SE were all equal. We performed an additional sensitivity analysis by excluding participants found to have sleep-disordered breathing.

We also evaluated whether parent report or child report of sleep parameters is more accurate in cases with a large discrepancy between parent report and child report. We extracted out children with the largest difference between parent report and child report to evaluate whether child report or parent report may be more accurate in cases with discordant parent report and child report. Specifically, we determined the absolute value of the difference in TST, SE, or SL between parent report and child report. Then we selected the quartile with the highest disagreement for further analysis. We again used Wilcoxon signed-rank tests to compare the differences between child report and parent report of TST, SL, and SE when compared to PSG. We additionally examined potential demographic (age, ethnicity, and sex) and sleep (PSG TST, SL, and SE) characteristics to determine if there were any differences between parent-child dyads with high and low discrepancy.

RESULTS

A total of 312 children participated in phase two of TuCASA, and 285 children had complete data and were included in analysis. Mean age of participants was 13.2 years (median 13.3, standard deviation 1.7 years, range 9.9–17.6 years). An even sex distribution was seen, with 52% boys and 48% girls. Participants were predominantly Caucasian (68%), and the remainder (32%) were Hispanic. Parent questionnaires were typically filled out by mothers (87%), with fathers completing 9% of questionnaires and other (stepparents, etc.) completing the remaining 4%. Sleep characteristics of the cohort are presented in **Table 1**. A total of 22 participants had sleep-disordered breathing, as defined by an apnea-hypopnea index ≥ 1.5 events/h.[11] Participants with sleep-disordered breathing were included in analysis.

Twenty-seven children did not fully complete the survey on how they slept the night of PSG and were excluded from analysis as child-reported sleep parameters thus could not be derived. Compared to children included in the study, excluded children were slightly older (13.8 ± 1.6 years compared to 13.2 ± 1.7, P = .04) and more likely to be Hispanic (50% Hispanic versus 32% Hispanic, P = .04). There was no sex difference between excluded and included participants (47% boys versus 52% boys, P = .60).

Children overestimated TST by a median of 32 minutes (interquartile range [IQR] 6–68), compared to parental overestimate of 36 minutes (IQR 13–70) (P = .006). Children overestimated SL by 4 (IQR −8 to 20) minutes, compared to parental overestimate of 2 minutes (IQR −10 to 13) minutes, P = .001. Children overestimated SE by 5% (IQR 0–11), compared to parental overestimate of 6% (IQR 2–11), P = .04. Results are summarized in **Table 2**.

Child-estimated TST had substantial agreement with PSG TST, ICC 0.722 (95th percentile confidence interval 0.649–0.780, P < .001). This was slightly less than parent-reported TST agreement with PSG TST, ICC 0.776, (0.717–0.822, P < .001). Child-estimated SL agreement with PSG SL was moderate, ICC 0.467 (0.327–0.578, P < .001). Parent-estimated SL agreement with PSG SL was similar, ICC 0.419 (0.266–0.540, P < .001). Child-estimated SE agreement with PSG SE was lowest of all measures, but still significant, ICC 0.404 (0.246–0.529, P < .001). Parent-estimated SE agreement with PSG SE was similar, ICC 0.473 (0.335–0.583, P < .001).

Bland-Altman plots for sleep parameters are shown in **Figure 1**. For TST, child-report limits of agreement were −109 to 167 minutes, and parent-report limits of agreement were −79 to 155 minutes. For SL, child-report limits of agreement were −75 to 88 minutes, and parent-report limits of agreement were −74 to 76 minutes. For SE, child-report limits of agreement were −19% to 28%, and parent-report limits of agreement were −14% to 25%. For TST and SE, there was a tendency for larger discrepancies to occur at lower values, with the converse occurring for SL.

Given that adolescent report of sleep parameters may be more discordant with parents than that of preadolescent children, we performed a stratified analysis of children age 9 to 12 years compared to children age 13 to 17 years. We found no statistically significant differences between adolescent and preadolescent child report of sleep parameters when compared to either parent report or PSG (**Table 3**). Comparison of child and parent agreement with PSG for sleep parameters showed that there was similar parent-PSG agreement between adolescent and preadolescent patients for SE (**Table 4**). Parent and PSG agreement of TST and SL appeared worse for preadolescents than adolescents. For TST, parent and PSG agreement had an ICC of 0.611 (0.490, 0.709) in preadolescents compared to an ICC of 0.767 (0.681, 0.830) in adolescents. For SL, parent and PSG agreement had an ICC of 0.127 (−0.239, 0.384) in preadolescents compared to an ICC of 0.499 (0.314, 0.634) for adolescents. Child and PSG agreement appeared nearly identical between preadolescents and adolescents.

Table 1—Participant sleep characteristics.

PSG total sleep time (minutes)	478 (440, 515)
PSG sleep latency (minutes)	18.5 (11, 37)
PSG sleep efficiency (%)	88.9 (84.4, 92.6)
NREM 1 sleep (%)	3.4 (2.4, 5.0)
NREM 2 sleep (%)	54.7 (50.6, 59.3)
NREM 3 (stage 3 and 4) sleep (%)	3.7 (2.6, 4.9)
REM sleep (%)	23.2 (19.8, 25.4)
Arousal index (events/h)	5.9 (4.6, 7.4)
Apnea-hypopnea index (events/h)	0.2 (0.1, 0.6)

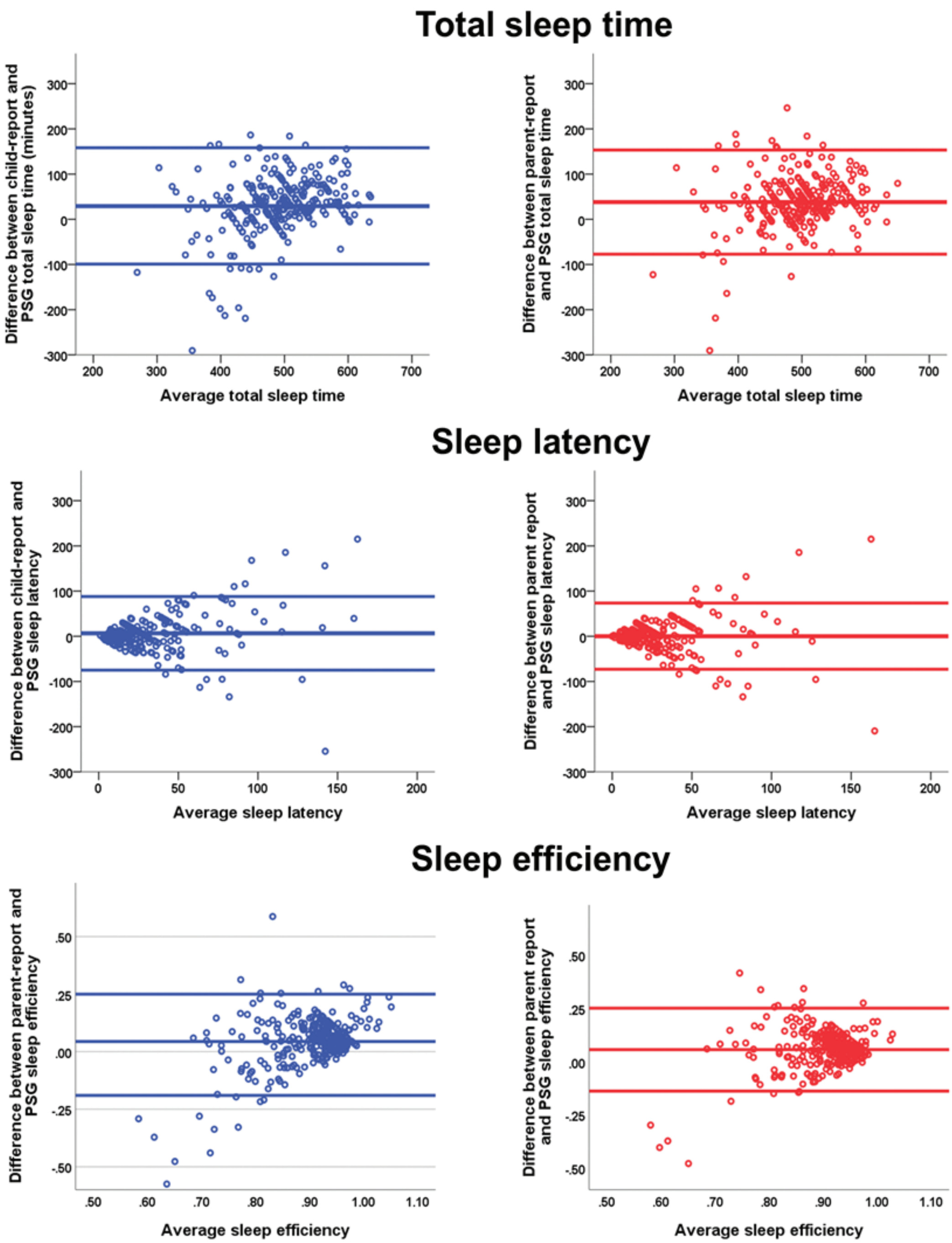
Data presented as median (interquartile range). NREM = non-rapid eye movement, PSG = polysomnography, REM = rapid eye movement.

Table 2—Comparison of parent and child estimation of sleep parameters compared with PSG.

	Child-PSG Difference	Parent-PSG Difference	P
Total sleep time (minutes)	32 (6, 68)	36 (13, 70)	.006
Sleep latency (minutes)	4 (−8, 20)	2 (−10, 13)	.001
Sleep efficiency (%)	5 (0, 11)	6 (2, 11)	.04

Data presented as median (interquartile range). PSG = polysomnography.

Figure 1—Bland-Altman plots.



Bland-Altman plots comparing parent-report (red graphs) and child report (blue graphs) of total sleep time, sleep onset, and sleep efficiency. It appears that shorter reported sleep latencies tend to be more accurate compared to PSG than longer reported latencies. Similar, reported high sleep efficiency (near 100%) appears to agree more closely with PSG. PSG = polysomnography.

We performed sensitivity analysis to account for possible exchange of information between parent and child when completing morning surveys that may have caused parent report and child report to appear more similar. Specifically, we excluded cases where parent report and child report of TST, SL, and SE were all equal. A total of 10 cases (3.5%) were found, and excluding these cases did not materially change the results. Children overestimated TST by 32 minutes compared to 35 minutes for parents (P = .002). Children overestimated SL by 4 minutes compared to 2 minutes for parents (P = .03). Finally, children overestimated SE by 5% compared to 6% for parents (P < .001). Similarly, sensitivity analysis excluding children with sleep-disordered breathing did not materially change our results.

Given the relatively similar agreement between parent report and child report with PSG in the cohort, we extracted out

Table 3—Comparison between preadolescent report and adolescent report of sleep parameters in comparison to parent report and PSG.

	Age 9–12 Years (n = 128)	Age 13+ Years (n = 157)	*P*
Parent-child TST difference	0 (0, 10)	0 (0, 15)	.96
Parent-child SL difference	0 (−10, 0)	0 (−10, 0)	.64
Parent-child SE difference	1.2% (−19.2, 10.4)	−0.8% (−16.3, 13.8)	.34
Parent-PSG TST difference	38 (17, 72)	33 (6, 68)	.25
Parent-PSG SL difference	0.5 (−10, 13)	3 (−12, 13)	.60
Parent-PSG SE difference	5.3% (2.1, 10.9)	6.5% (4.9, 10.2)	.98
Child-PSG TST difference	36 (11, 73)	32 (0, 62)	.21
Child-PSG SL difference	3 (−8, 20)	5 (−8, 21)	.49
Child-PSG SE difference	4.8% (0.8, 10.3)	6.0% (0.1, 10.4)	.82

Data presented as median (interquartile range). PSG = polysomnography, SE = sleep efficiency, SL = sleep latency, TST = total sleep time.

Table 4—Comparison between preadolescent and adolescent agreement of parent report and child report with PSG.

	Age 9–12 Years (n = 128)	*P*	Age 13+ Years (n = 157)	*P*
Parent-PSG TST agreement	0.611 (0.490, 0.709)	< .001	0.767 (0.681, 0.830)	< .001
Child-PSG TST agreement	0.704 (0.580, 0.791)	< .001	0.711 (0.604, 0.789)	< .001
Parent-PSG SL agreement	0.127 (−0.239, 0.384)	.22	0.499 (0.314, 0.634)	< .001
Child-PSG SL agreement	0.489 (0.276, 0.640)	< .001	0.444 (0.238, 0.594)	< .001
Parent-PSG SE agreement	0.012 (−0.401, 0.179)	.47	0.018 (−0.345, 0.284)	.45
Child-PSG SE agreement	0.018 (−0.392, 0.308)	.46	0.018 (−0.352, 0.286)	.46

Data presented as intraclass correlation (95% confidence interval). PSG = polysomnography, SE = sleep efficiency, SL = sleep latency, TST = total sleep time.

children with the largest difference between parent report and child report to evaluate whether child report or parent report may be more accurate in cases with discordant parent report and child report. Specifically, we determined the absolute value of the difference in TST between parent report and child report. Then we selected the quartile with the highest disagreement for further analysis. An absolute difference of 30 minutes in child-reported TST compared to parent report was the 75th percentile, and used as the cutoff. Children overestimated TST by 10 minutes (IQR −37 to 64) compared to PSG, whereas parents overestimated TST by 33 minutes (IQR −5 to 71), $P = .002$. Children overestimated SL by 15 (IQR −2 to 36) minutes while parents overestimated SL by 3 (IQR −11 to 23) minutes, $P = .008$. Children overestimated SE by 3% (IQR −6% to 9%), whereas parents overestimated SE by 6% (IQR 1% to 11%), $P = .004$. Sensitivity analysis using the quartile with highest disagreement for SE or SL was not materially different from using highest disagreement in TST. We then evaluated demographic and PSG sleep parameter differences between the high and low parent-child discrepancy groups and found no significant differences between the two groups (**Table 5**).

DISCUSSION

We found that in general, both parents and children overestimate TST, SE, and SL compared to PSG. Although we did find statistically significant differences between parent report and child report, the actual values of the differences were less than 5 minutes. These small differences are likely not relevant for most clinical and research applications. One prior study of adults used a similar methodology to compare PSG and self-report of sleep parameters.[12] The authors found that adult self-report overestimated TST by 17 minutes, similar to the overestimation of TST in our study. Additionally, one prior study used a similar methodology to compare parent-reported sleep time in children to PSG, but did not include information on child report.[13] In this study, the authors found that parents overestimated TST by 67 minutes compared to PSG. In this study, children were younger (age 6 to 11 years) and it is possible that this may have contributed to the larger difference in self-reported versus objective values. Overall, our results from this community cohort of school-age children suggest that parent report or child report may be equally valid when evaluating sleep parameters including TST, SL, and SE.

Interestingly, it appears that in cases where there is a large discrepancy between parent report and child report of sleep parameters, child report appears more accurate for TST and SE compared to parent report, whereas parent report is more accurate for SL. This may be because parents are typically awake when their school-age children go to bed, and are more aware of the child's SL. Conversely, school-age children do not typically wake up their parents overnight, and may be better reporters of TST and SE as they are more aware of their sleep in the later part of the night, when parents are typically asleep. Somewhat surprisingly, there was no difference in parent-child discrepancy between adolescents and preadolescents, and parent and PSG agreement for TST and SL were slightly worse

Table 5—Comparison of demographic and sleep characteristics of parent-child dyads with high and low discrepancy between parent report and child report of sleep parameters.

	Low Discrepancy	High Discrepancy	*P*
Female sex	47.8%	47.4%	.94
Hispanic ethnicity	32.1%	34.2%	.73
Age (years)	13.1 (11.7, 14.3)	13.8 (12.1, 14.7)	.054
Total sleep time	478 (432, 516)	475 (448, 514)	.45
Sleep latency	18 (11, 43)	21 (21, 39)	.13
Sleep efficiency	89% (85, 93)	89% (84, 92)	.12

Continuous data presented as median (interquartile range).

in preadolescents compared to adolescents. This is consistent with our prior research that has shown that parent report or child report of obstructive sleep apnea symptoms is more concordant in adolescents than preadolescents.[14]

We found that the accuracy of child report and parent report of sleep parameters was both comparable to prior studies in children comparing actigraphy to PSG.[15] Specifically, the Actiwatch 2 (Philips Respironics, Murrysville, Pennsylvania, United States) was shown to underestimate TST by 21 minutes (95% limits of agreement −128.3 to 93.7), overestimate SL by 21.4 (−34.8 to 77.6) minutes and underestimate SE by 3.4% (−24.8% to 18.0%).[15] Other actigraphic devices appear to similarly underestimate TST and SE while overestimating SL[3,4] in children. Some prior studies have shown that there are significant differences between parent and actigraphic measures of sleep.[16–18] This may be due to child and parent overestimation of TST and SE compared to PSG, whereas actigraphy underestimates TST and SE compared to PSG.

Our study does have several limitations. First, only a single night of PSG and associated self-reported data were collected; thus, we cannot establish how accurate our results would reflect habitual report compared to PSG. However, our results from a single night are consistent with prior studies suggesting a tendency toward habitual overestimation of TST and sleep efficiency.[16,17] Second, it is possible that participants may have had more accurate recall of their sleep the preceding night due to the presence of PSG equipment and increased mindfulness of their sleep as they were aware they were participating in a study. Third, our findings only apply to children age 9 years or older, although self-reported sleep habits in children as young as 6 years may be informative.[19] Fourth, we used Rechtschaffen and Kales scoring rules for PSG scoring and not current AASM scoring standards, as these were not available at the beginning of the TuCASA study. However, this is unlikely to affect our findings, as we used the current AASM definition of sleep onset, and a comparison of Rechtschaffen and Kales and AASM scoring rules in children has shown no difference in SE and a 0.9-minute difference in TST.[20] Fifth, PSG was done in the participant's home, whereas current AASM practice parameters do not recommend home sleep apnea testing for a diagnosis of obstructive sleep apnea in children.[21] However, as noted in the practice parameter,[22] the TuCASA study used a full PSG montage (except limb leads to reduce risk of trip hazard), set up by experienced technicians in the participant's home. This is much more rigorous, and distinct from almost all other studies of home sleep testing evaluated by the panel, which have used more limited type 4 PSG (cardiorespiratory monitoring). Additionally, performing PSG in the home environment would be likely to capture a more typical night of sleep for participants compared to spending the night in a sleep laboratory. Finally, the questions used in this study have not been explicitly validated, but these questions were previously used in a prior evaluation comparing parent report with PSG sleep parameters[13] and a very similar set of questions was used to evaluate self-report with PSG sleep parameters in adults.[12]

Our study has several strengths as well. First, we included a community cohort of children, not a clinical cohort of children with existing sleep problems. Second, we used ICCs to specifically measure agreement between parent report/child report and PSG, not just correlation. Additionally, given the large size of our cohort, we were able to select and evaluate cases where there was significant disagreement between parent and child.

CONCLUSIONS

Both parents and children overestimated TST, SL, and SE compared to PSG. There appears to be strong agreement between both parent report and child report compared with PSG for TST, and moderate agreement for SL and SE. In cases with high disagreement, child report may be more accurate for TST and SE, whereas parent report is more accurate for SL.

ABBREVIATIONS

ICC, intraclass correlation
IQR, interquartile range
PSG, polysomnography
SE, sleep efficiency
SL, sleep latency
TST, total sleep time
TuCASA, Tucson Children's Assessment of Sleep Apnea

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