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School Start Times, Sleep, and Youth Outcomes: A Meta-analysis

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Abstract

OBJECTIVES: To review and meta-analyze existing evidence regarding the impact of school start times (SSTs) on youth sleep and developmental outcomes considering the moderating effects of youth and school characteristics. Scopus, ScienceDirect, JSTOR, Pubmed, PsychInfo, ERIC, Proquest, EBSCO, and Google Scholar were used through 2019 to select studies measuring (1) school start time and (2) sleep or other developmental outcomes. Data from 28 studies and 1 774 509 participants were extracted and analyzed using random-effects models with robust variance estimation.

RESULTS: Later SSTs were associated with better overall developmental outcomes, longer sleep duration, and less negative mood. Specifically, new SSTs between 8:30 and 8:59 were associated with better outcomes than 8:00 to 8:29 start times. Later SSTs were more strongly associated with lower levels of sleepiness for high school (versus middle school) youth, and youth in private (versus public) schools reported better sleep and later wake times with later SSTs. Although this meta-analysis suggests an overall benefit of later SSTs, there was limited research to test outcomes such as sleep hygiene, naps, and behavioral and physical health outcomes.

CONCLUSIONS: There is converging evidence that later SSTs are associated with better overall developmental outcomes, longer sleep duration, and less negative mood. More research needs to consider student and school characteristics to obtain reliable estimates related to possible differences by sex, race, school size, percent free/reduced lunch, and percent minority.

Sleep is a biological imperative shaped by physiologic needs and social and environmental factors.[1] The importance of sleep for youth development, socioemotional functioning,

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academic achievement, and health is well documented.[2,3] Aside from targeting individual habits and sleep-hygiene behaviors,[4] there is a growing interest in understanding and changing structural influences on youth sleep and related outcomes.[5] In particular, parents and educators are considering how school-related factors, such as what time schools begin, may be matched or mismatched to the circadian rhythms of young people.[6,7] Youth spend most of their waking hours in educational settings.[8] They also spend a large portion of their lives from childhood (entering kindergarten around age 5) to young adulthood (graduating high school around age 18) in formal educational spaces. In the intermediary periods, youth encounter developmental milestones, perhaps the most notable of which is puberty. Puberty is associated with changes in sleep and circadian rhythms.[9,10] Changes in circadian rhythms are associated with "sleep phase delay",[11] and adolescents tire later at night. However, as youth move from elementary to middle and high school, the start of school is not similarly delayed; in fact, school often starts earlier, effectively moving in the opposite direction of youth's biological rhythms.[12] Although the biological need for sleep may decline in the intervening years between childhood (7–12 hours may be appropriate) and adolescence (7–11 hours may be appropriate),[13] the opportunity for sleep is truncated by later bedtimes and earlier or similar school start times at a magnitude much larger than the decline in need for sleep. As a result, communities and schools are beginning to reconsider school start times (SSTs) with many districts and states (eg, California) enacting legislation to delay the start of school to match the delay in adolescent sleep phase.[7,12,14] Although there is a growing evidence base to support these new policies,[7,12,15–20] there has been less systematic analysis of the optimal start time for young people depending on individual characteristics, such as age and school level (ie, elementary, middle, and high school), sex, and socioeconomic status, as well as consideration of school characteristics, such as regional differences (ie, urban, suburban, or rural) and private versus public schools.

The current meta-analysis contributes to the science on SST and pediatric development through the investigation of 4 aims. The first aim is to investigate the associations between SST with sleep and developmental outcomes. The subsequent aims consider possible moderators. For example, the second aim investigates if the association between SST and sleep and development are moderated by initial SST (ie, which start times would benefit most from a delay?). Third, the analysis investigates if associations are moderated by new SST (ie, which new start times are associated optimal youth outcomes?). Finally, the meta-analysis considers whether associations are moderated by youth and school characteristics, such as age, year in school, sex, ethnicity/race, private versus public schools, and urban, rural, or suburban communities.

Literature Search

Literature searches were conducted Scopus, ScienceDirect, JSTOR, Pubmed, PsychInfo, ERIC, Proquest, EBSCO, and Google Scholar, using a combination of keywords associated with school start time ("school start time" or "school starting times"), sleep ("sleep", "sleep duration", or "sleep pattern"), and developmental outcomes ("achievement", "academic performance", "mental health", "well-being", or "health") across samples with different ages and stages of development (ie, elementary, middle, or high school). The searches included studies through the end of 2019 and produced 1263 records. One hundred and nineteen

duplicate records were removed, and the remaining 1144 abstracts were reviewed and screened. Of these, only articles meeting all of the following inclusion criteria were retained: (1) measured school start time; (2) measured sleep or other developmental outcomes; (3) published in English; and (4) could not be excluded based on available information in the abstract. The research team requested unpublished data from authors who have published on pediatric sleep, school start time, sleep, and developmental outcomes via e-mail and ResearchGate ($n = 10$); however, no records were added through this approach. Taken together, the literature searches and screening resulted in 80 reports retained for further examination.

The full texts of these 80 reports were screened for the following exclusion criteria: (1) did not include school start time ($n = 9$); (2) did not include empirical data ($n = 21$, including 17 meta-analysis and review articles); (3) did not include appropriate statistics (eg, qualitative research, $n = 1$); and (4) duplicate reports ($n = 3$); as a result, 34 were excluded (46 reports were retained). The research team also reviewed the reference lists of 17 meta-analysis and systematic review articles, producing 125 records. After screening and cross-checking, 114 reports were excluded and 11 articles were retained, yielding a total of 57 (46 + 11) reports. Approximately half of these 57 articles ($n = 28$) were coded by 2 to 3 coders. Coding discrepancies were discussed and resolved to achieve intercoder agreement (interrater reliability rs = 0.99–1.00 for continuous variables and κs = 0.83–1.00 for categorical or string variables). Once reliability was achieved, the remaining 29 articles were independently coded by 1 of the 3 trained coders.

The 57 reports were coded, and the primary investigator contacted authors ($n = 53$) to obtain missing information (eg, group comparison statistics, sample descriptives, and demographic information) for effect size computation (eg, correlations between school start time and sleep) or moderation analysis (eg, participants' race or ethnicity). Only 21 requests were met; 13 authors indicated they were not able to provide requested statistics or raw data, and 19 authors did not respond despite several attempts. The coders coded 39 reports with complete data, whereas 29 reports had sufficient statistical information for inclusion (see Supplemental Table 9 for additional information about included studies). Two reports analyzed the same research data; therefore, 28 studies were included in the final analyses (see Fig 1 PRISMA flowchart[21]): 27 peer-reviewed articles and 1 research report. A detailed data-extraction manual can be found in the Supplemental Information. Additional information about studies for which there was insufficient information for inclusion is shown in Supplemental Table 10.

Measuring School Start Times

Many studies ($n = 18$) measured specific school start times (eg, 7:45 AM, "What time do you need to arrive at school?"[17]), whereas others ($n = 10$) used school start time ranges (eg, 7:30–7:45 AM[22]). Approximately 36% of studies ($n = 10$) included data pre- and postdata examining developmental outcomes before and after a change in school start time (eg, delaying start time from 7:50 to 8:45 AM in the Seattle School District[23]), whereas remaining studies ($n = 18$) compared SSTs across countries (Australia versus United States[17]), districts

(eg, Altoona versus Chippewa Falls in Wisconsin[24]), or schools (eg, "early-starting schools" versus "late-starting schools"[25]).

The following terminology is used to synthesize across analytic approaches: "initial SST" refers to the SST before the implementation of an SST delay, whereas "new SST" refers to the SST after the implementation of an SST delay. Two additional terms allow for the inclusion of studies that did not implement a change in SST but analyzed schools with different start times. These terms include "earlier SSTs", which are discussed in contrast to "later SSTs" as a descriptive comparison of SST timing irrespective of any changes implemented in the SSTs.

First, the current study investigated the direct effects of school start times (ie, new, later school start times) on outcomes without considering initial or later start time. Next, initial and later SST were considered as moderators of the direct effect. To conduct the moderation analyses, all SSTs were coded into 5 groups: (1) before 7:30 AM, (2) between 7:30 and 7:59 AM, (3) between 8:00 and 8:29 AM, (4) between 8:30 and 8:59 AM, and (5) after 9:00 AM to account for differences in how SSTs were reported; for example, some studies reported SSTs as specific times whereas others reported a range of times. However, although SSTs were coded categorically in the moderation analyses, they were treated as a continuous variable when estimating direct effects on developmental outcomes.

MEASURING DEVELOPMENTAL OUTCOMES

To investigate the broad impact of SSTs, this study focused on a range of developmental outcomes: (1) sleep ($n = 25$), (2) socioemotional health (both positive and negative; $n = 8$), (3) academics (eg, grades; $n = 9$), (4) cognitive development (eg, sustained attention; $n = 3$), (5) behavioral health (eg, substance use; $n = 3$), and (6) physical health ($n = 3$). Sleep indicators consisted of duration ($n = 23$), quality ($n = 10$), bedtime ($n = 17$), wake time ($n = 15$), sleepiness ($n = 13$), chronotype ($n = 7$), hygiene ($n = 2$), and social/jet lag and naps ($n = 3$). Sleep indicators were assessed using self-reports ($n = 18$), actigraphy ($n = 2$), a combination of self-reports and actigraphy ($n = 3$), a combination of actigraphy and laboratory assessment ($n = 1$), and a combination of self-reports and other method (ie, "school records"; $n = 1$). Other outcomes were assessed using self-reports ($n = 6$), school records ($n = 4$), parent reports ($n = 1$), cognitive tests ($n = 1$), biomarkers ($n = 1$), a combination of self-reports and parent reports ($n = 1$), a combination of self-reports and school records ($n = 1$), a combination of self-reports, teacher reports, and cognitive tests ($n = 1$), a combination of self-reports, teacher reports, and school records ($n = 1$), and a combination of self-reports and health center records ($n = 1$).

Measuring Effect Sizes of School Start Time on Youth Developmental Outcomes

Studies reported the effect of SST on youth developmental outcomes using a range of statistics, including correlations and mean comparisons. Correlation coefficients were transformed to Fisher's z using the following equation:[26]

$$Z = \frac{1}{2}\ln\left(\frac{1 + r}{1 - r}\right)$$

When studies reported mean differences in youth outcomes by SSTs, effect sizes were converted to Cohen's d using the online utility developed by Lenhard and Lenhard.[27] Cohen's d was then transformed into correlation coefficients using the following equation:[2826]

$$r = \frac{d}{\sqrt{d^2 + a}},\ a = \frac{(n_1 + n_2)^2}{n_1 n_2}$$

where n_1 and n_2 were group sizes. When studies reported odds ratios for the effect of SST on youth outcomes, the odds ratios were converted to Cohen's d using the following equation:[26]

$$d = \log OddsRatio \times \frac{\sqrt{3}}{\pi}$$

and were then transformed to correlation coefficients. When unadjusted effect sizes were not available, we converted regression coefficients into semipartial correlations using the following equation (Aloe and Becker, 2012[28]):

$$r_{sp} = \frac{t\sqrt{\left(1 - R^2\right)}}{\sqrt{(n - p - 1)}}$$

where t is the t test of the target regression coefficient, R^2 is the total amount of variance in adjustment explained by the regression model, n is the sample size, and p is the number of predictors.

To standardize interpretation, all effect sizes were coded such that positive effect sizes represent later SSTs having a stronger association with better youth outcomes. For example, if a study reported a negative correlation between SST and depressive symptoms, the correlation coefficient was reverse coded to capture a positive association between later SST and better socioemotional well-being. As another example, if a study reported a mean difference in sleep duration between 2 groups with different SSTs, Cohen's d was computed to compare sleep duration in the latter SST group to the earlier SST group.

Risk of Bias and Strength of Evidence

Risk of bias was evaluated for all synthesized studies using an adapted version of the Newcastle-Ottawa Scale for assessing the quality of nonrandomized studies in meta-analyses.[29] The third and fourth authors coded the representativeness of the sample (r = 0.93), inclusion of intervention cohorts (r = 0.93), assessment of school start times (r = 0.98), whether analyses controlled for baseline measure of outcome (r = 1.00), control confounding variables (r = 0.91), assessment of outcome (r = 0.98), and adequacy of follow-up of cohorts (r = 0.90). A detailed coding manual is reported in Supplemental Table 11. The rating resulted in a sum score per study (possible ranges = 0–21, with higher scores indicating better quality). Next, the quality of each study was coded as high (sum scores of 17–21), moderate (sum scores of 10–16), low (sum scores of 5–9), or poor (sum scores

of 0–4). The strength of evidence was coded for each outcome domain following prior meta-analyses.[30] The first and second authors coded risk of bias (r = 0.94), imprecision (r = 1.00), inconsistency (r = 1.00), indirectness (r = 1.00), publication/reporting bias (r = 0.88). A detailed coding manual is reported in Supplemental Table 12. The coding resulted in a sum score for each study that ranged between 5 and 12. The sum scores were averaged within each outcome domain. Next, strength of evidence for each outcome was coded where scores of 5 to 6 were coded as high, 7 to 10 as moderate, and 11 to 12 as low.

ANALYSIS PLAN

All analyses were conducted in a meta-regression framework using the robumeta R package.[31] Random-effects models were used to allow true effect sizes to vary among studies.[26] Robust variance estimations[31] were used to handle nonindependence in effect sizes (eg, effect sizes drawn from the same study or project). Correlated effects weights were used based on the most prevalent source of dependence in the data (ie, multiple measures from the same participants[32]). The average correlation between dependent effect sizes (ρ; ranging between 0 and 1) was specified at the default value (0.80).[31] Previous research demonstrates robustness in estimates of effect sizes across reasonable values of ρ.[33] Finally, small sample adjustments were implemented to provide unbiased estimates with small numbers of studies (eg, <40) and skewed covariates.[34] Simulation research shows that after incorporating the small sample adjustments, the RVEs of effect sizes are robust when the degree of freedom is >4.[34] As such, estimates that had <4 degrees of freedom were excluded from analysis.

Intercept-only meta-regression models were conducted to examine the effect of SSTs on youth outcomes overall and for each domain separately. The estimated mean effect sizes were then converted to correlations, and Cohen's[35] criteria were used to evaluate the effect sizes. The significance of SST effects was determined by the 95% confidence intervals (CIs) and P values. Heterogeneity was evaluated using 2 indices: the between-study variance in study-average effect sizes (τ^2), and the ratio of true heterogeneity to total variance across the observed effect sizes (I^2).

Next, univariate meta-regression models examined how the association between SST and youth developmental outcomes was moderated by school start time, youth characteristics (age, sex, and race or ethnicity), and school characteristics (school level, sector, size, SES, racial or ethnic composition, urbanicity, region, and country). Categorical moderators were dummy coded, and the reference group was rotated to obtain all possible pairwise comparisons. Next, subgroup analyses were conducted for each categorical moderator to obtain the mean effect size for each group. Meta-regression analyses investigate whether there are statistically significant differences by groups (ie, are the groups statistically different from each other) based on the moderating variable. In contrast, subgroup analyses complement the moderation analyses by providing estimates for the individual effect size by subgroup (ie, the specific subgroup effect size estimate).

Multiple sensitivity analyses were conducted to examine robustness. First, the overall association between SST and youth developmental outcomes was investigated by (1)

controlling for participant age and (2) focusing on studies that reported youth-level data. Next, sensitivity analyses examined the moderating effects of SST separately at each school level (ie, elementary, middle, or high school). Two sets of sensitivity analyses were investigated for the moderating effects of youth and school characteristics: (1) controlling for age in all meta-regression analyses and (2) addressing potential heterogeneity across countries by focusing on US studies only for youth race or ethnicity, school sector, and urbanicity.

Finally, publication biases were investigated using funnel plots with Egger's tests[36] and trim-and-fill analyses.[37] Because RVE is not available for assessing publication bias,[38] effect sizes were aggregated within each project, and publication bias using traditional meta-analytic methods (assuming effect sizes are independent) in random effects models were examined using the Metafor R package.[39]

RESULTS

Overall Effects of School Start Time

First, the average effect of SST was estimated across SST, youth characteristics, and school characteristics. This was done in 2 steps: (1) estimating the effect between SST and an aggregate indicator of overall development and (2) estimating the effect of SST for each indicator (ie, sleep, socioemotional, academic, behavioral, physical, and cognitive) separately. For socioemotional well-being, additional analyses examined positive and negative outcomes separately. Each sleep indicator (duration, quality, bedtime, wake time, hygiene, chronotype, social/jet lag and naps, and sleepiness) was analyzed separately. Table 1 presents the effect size, confidence interval, and heterogeneity estimates. Figure 2 presents a forest plot for all effect sizes. Supplemental Figs 4–13 present forest plots for each developmental indicator.

For aggregated developmental outcomes, there was a small SST effect (Table 1, top row) such that later SSTs were associated with better outcomes (mean effect size = 0.061; SE = 0.022, 95% CI = 0.015–0.107; $P = .01$). For sleep outcomes (Table 1, second row), there was no significant effect for aggregated sleep or for individual sleep indicators with 1 exception: later SSTs were associated with longer sleep duration, with a small effect size (mean effect size = 0.109; SE = 0.043; 95% CI = 0.019–0.199; $P = .02$). Studies on sleep hygiene and social/jet lag and naps were not sufficiently powered to produce reliable results (degrees of freedom [df] < 4). For socioemotional outcomes, positive and negative socioemotional well-being were investigated separately, and there was a small effect between later SSTs and lower levels of negative socioemotional well-being (higher scores indicate lower levels of negative socioemotional well-being; mean effect size = 0.060; SE = 0.023; 95% CI = 0.001–0.119; $P = .04$). There were no significant associations between SST and academic outcomes. Because of limited degrees of freedom ($df < 4$), there were not sufficient data to examine the association between SST and positive socioemotional well-being, and other developmental domains (ie, behavioral, physical, or cognitive).

Sensitivity Analyses

Two sets of sensitivity analyses were conducted. The first set controlled for participant age and centered age at 15 years (ie, the mean age across studies; range was 9–21 years old), so that the intercept of each meta-regression model would estimate the mean effect size across studies. Results are shown in the top portion of Supplemental Table 13. Covarying age necessitated removing 2 studies that did not report participant age; this resulted in insufficient data to examine negative socioemotional outcomes, academic outcomes, or sleep chronotype. For outcomes that had sufficient degrees of freedom for analysis, an identical pattern of significance was observed as the primary findings reported above. The second set of sensitivity analyses examined the overall effects of SST on developmental outcomes, including only studies that report youth-level data. Results are shown in the bottom portion of Supplemental Table 13. Again, an identical pattern of significance was observed, supporting the robustness of the primary findings reported above.

Moderation by Initial School Start Time

To investigate whether associations between SST and outcomes were dependent upon initial SSTs, and to identify which start time categories may benefit most from later SSTs, moderation analyses were conducted on initial SST. Because previous research suggests potential nonlinear effects of SST,[12] the 5 SST categories were dummy coded and tested as moderators in a meta-regression. The reference groups were rotated to obtain all possible comparisons. Subgroup analyses provided estimates of the effect sizes for the association between SST and youth outcomes for each SST category.

Several significant moderating effects emerged for initial SST, and the meta-regression results are shown in Table 2. For the aggregated developmental outcome indicator, later SST was associated with better outcomes for youth whose initial SST was 7:30 to 7:59 AM (compared with youth with SSTs before 7:30 AM). For sleep outcomes, later SST was associated with better overall sleep for youth whose initial SST was 7:30 to 7:59 AM (compared with youth with SSTs before 7:30 AM). No significant moderating effects were observed for other outcomes. Subgroup analyses (Table 4) observed that later SSTs were significantly associated with better aggregated outcomes, better aggregated sleep indicators, and longer sleep duration for youth whose initial SST was between 7:30 and 7:59 AM, but not youth in other SST categories.

Sensitivity Analyses

Sensitivity analyses examined the moderating effects of SST separately at each school level (elementary, middle, and high schools). Because of limited study numbers, however, analyses were only sufficiently powered for high school studies. Among high school studies, later SST was associated with better youth outcomes when initial SST was 7:30 to 7:59 AM. Focusing on the moderating effects of initial SST (Supplemental Table 14), we observed 2 significant findings. Later SSTs were associated with better overall sleep and earlier bedtime for youth whose initial SST was 7:30 to 7:59 AM (compared with youth with initial SSTs of 8:30–8:59 AM).

Moderation by New School Start Time

To investigate whether associations between SST and outcomes were dependent upon new SSTs, moderation analyses investigated the impact of the new SST after the implementation of a later, delayed SST. The 5 SST categories were dummy coded and tested as moderators in a meta-regression. The reference groups were rotated to obtain all possible comparisons. Subgroup analyses provided the effect size estimates for the association between SST and youth outcomes for each SST category.

Significant moderating effects emerged for sleep outcomes and estimates from the meta-reg ression results are presented in Table 3. Later SSTs were associated with better sleep quality for youth whose new SST was 8:30 to 8:59 AM (compared with those whose new SST was 8:00–8:29 AM). No significant moderating effects were observed for other outcomes. Subgroup analyses showed that later SSTs were significantly associated with better overall outcomes, better overall sleep, and longer sleep duration among youth whose new SST was 8:30 to 8:59 AM but not for other new SSTs (Table 5).

Sensitivity Analyses

Sensitivity analyses examined the moderating effects of SST separately at each school level (elementary, middle, and high schools). Because of limited study numbers, however, analyses were only sufficiently powered for high school studies. Among high school studies, later SST was associated with better youth outcomes only when new SST was 8:30 to 8:59 AM.

Moderation by Youth and School Characteristics

The final set of analyses examined the extent to which the association between SST and youth outcomes varied by youth (age, sex, and race or ethnicity) and school characteristics (school level, sector, size, socioeconomic status [SES], racial or ethnic composition, urbanicity, region, and country). Meta-regression analyses were conducted for each moderator separately. Each moderator (school level, sector, urbanicity, region, and country) was dummy coded, and the reference group was rotated to obtain all possible comparisons. To obtain effect size estimates, subgroup analyses examined the association between SST and youth outcomes within each moderator category.

Youth Characteristics—No significant moderating effect emerged for youth age. Unfortunately, there were insufficient degrees of freedom to produce reliable estimates for moderation by sex or race or ethnicity (Table 6).

School Characteristics—Significant moderating effects emerged for school characteristics, including school level, sector, and country (Table 7). Specifically, a significant difference in effect sizes emerged between middle and high school youth in which later SSTs were more strongly associated with lower levels of sleepiness for high school (compared with middle school) youth. No significant differences emerged for other outcomes. All subgroup analyses and coefficient estimates can be found in Table 8. For school sector (Table 7), significant differences emerged; for youth in private (compared with public) schools, later SSTs were more strongly associated with better overall sleep and

later wake times. For geographic differences, effect sizes among youth in North America, Europe, and Asia were compared (Table 7). A significant pattern emerged; for youth in North America (compared with Europe), later SSTs were more strongly associated with earlier bedtimes.

There were insufficient degrees of freedom to produce reliable estimates for moderation by school size, SES, or racial or ethnic composition (Table 5). Finally, no significant moderating effects for school urbanicity or US region were observed in the meta-regressions (see Table 7).

Sensitivity Analyses—Two sets of sensitivity analyses were conducted. The first set addressed the large age span in the analytic sample by controlling for age in all metaregression analyses; similar to the primary analyses, no significant moderating effects were observed for youth characteristics (see Supplemental Table 16). In addition, similar significant moderating effects emerged for school characteristics, including school sector and country (see Supplemental Table 17). Specifically, later SSTs showed a stronger association with later wake time among youth in private (compared with public) schools, and youth in North America fell asleep earlier than youth in Europe.

The second set of sensitivity analyses addressed potential heterogeneity by youth race or ethnicity, school sector, and urbanicity and focused on US studies only. The results mirrored the primary analyses in which significant moderating effects emerged for school sector but not for youth race or ethnicity or school urbanicity (see Supplemental Table 18). Specifically, later SSTs were associated with better overall sleep among youth in private (compared with public) schools.

Publication Bias

Publication bias was assessed using 2 approaches. First, funnel plots (Figs 3 A–K for overall outcomes and outcomes by domains) were created and their symmetry assessed using Egger's test (left portion of Supplemental Table 19). Significant asymmetries were observed for the aggregated developmental outcomes, overall sleep, and sleep duration, suggesting potential publication bias in these domains. Yet, trim-and-fill analyses (right portion of Supplemental Table 19) suggest that the significant patterns between SST and youth outcomes remained robust after removing studies with extreme estimates.

Risk of Bias and Strength of Evidence

Our risk of bias assessment identified 7 reports as high quality, 18 reports as moderate quality, and 4 reports as poor quality (Supplemental Table 20). We also observed moderate strength of evidence for domains with sufficient degrees of freedom for analyses (Supplemental Tables 21 and 22). As such, more high-/moderate-quality research would provide support for more conclusive effects of SST.

CONCLUSIONS

Overall, later SSTs were associated with better aggregated developmental outcomes, longer sleep duration, and less negative mood. With respect to which (initial) SSTs would benefit

the most from a later SST, this analysis suggests that youth in schools with 7:30 to 7:50 AM SSTs would benefit more than youth in schools with SSTs before 7:30 AM in the areas of aggregated outcomes and overall sleep. With respect to what new SSTs are associated with the most optimal youth outcomes, youth in schools with SSTs that started between 8:30 and 8:59 AM had better sleep quality compared with youth whose SSTs were between 8:00 and 8:29 AM. Although youth age did not moderate the association between SST and developmental outcomes, and youth sex, and race or ethnicity were not sufficiently powered to detect effects, several school characteristics were significant. In particular, later SSTs were associated with lower levels of sleepiness for high school (compared with middle school) students. In addition, students in private schools with later SSTs had better sleep and later wake times compared with students attending public schools. Finally, later SSTs in North America were associated with earlier bedtimes than youth in Europe.

The current study has direct educational and pediatric policy implications. First, although the analysis suggests that later SSTs were associated with better aggregated outcomes and overall sleep for youth whose initial SST was 7:30 to 7:59 AM (compared with initial SSTs before 7:30 AM), most of the schools included in this analysis that started before 7:30 AM implemented new SSTs between 8:00 and 8:29 AM ($n = 5$) and fewer implemented new SSTs in the more optimal window of 8:30 to 8:59 AM ($n = 2$). In contrast, schools that had initial SSTs between 7:30 AM and 7:59 AM were equally likely to implement new SSTs between 8:00 and 8:29 AM ($n = 6$) and 8:30 and 8:59 AM ($n = 7$). At the same time, the current analysis suggests that new SSTs between 8:30 and 8:59 AM were associated with better sleep quality compared with youth with new SSTs between 8:00 and 8:29 AM. Taken together, the data suggest youth with initial SSTs between 7:30 and 7:59 AM would benefit the most from a delayed SST, especially if that new SST is between 8:30 and 8:59 AM. Second, students in high schools (compared with middle schools) seemed to benefit from later SSTs; however, schools exist in systems embedded within communities, and changes in 1 component of the system often necessitate changes in another. For example, although the current analyses suggest that high school youth benefit the most from a SST delay, in reality such delays have reverberating consequences for middle and elementary schools in terms of busing, staffing, and scheduling (eg, many districts have elementary schools starting earlier to allow high schools to start later). Third, youth in private schools (compared with public schools) benefitted more from later SSTs, despite the lack of power to detect differences in associations with SST by school SES. The designation of private (versus public) schools serves as a proximal marker of SES, and SES has been associated with sleep disparities.[40] The current analyses suggest that SSTs may be leverageable policy that has the potential to drive (or remedy) socially determined disparities in sleep.[41] Finally, the observation that later SSTs in North American (versus European) schools were associated with earlier bedtimes suggests possible geographic or cultural differences in youth sleep hygiene and provides a counter-argument for those who claim that delaying SSTs will result in delayed bedtimes.

This study is not without limitations, many of which relate to insufficient data collection or reporting to conduct well-powered analyses. For example, developmental outcomes that would benefit from additional investigation include: positive socioemotional outcomes, behavioral health, physical health, and cognitive outcomes that were not sufficiently

powered in this analysis. In addition, limited reporting on youth characteristics such as sex and race or ethnicity precluded investigation of potential differences in SSTs by sociodemographic samples in diverse pediatric populations. Among the 28 studies that were excluded because of missing information, 11 studies observed nonsignificant or mixed findings that were, to some extent, inconsistent with the expected effects of SST. Focusing on the strength of the evidence, all of the included effect sizes were in the "moderate" range with no effect sizes in the "low" or "high" categories. Similarly, with respect to outcomes, the strength of the evidence was moderate for all outcomes except for sleep hygiene, which was coded as high. As such, it is possible that the current analyses overestimate associations between SSTs and pediatric outcomes.

Finally, 1 caveat about this area of research is that it is not possible to estimate the Hawthorne effect[42] (ie, how knowledge of treatment effects is related to observed outcomes), because youth, parents, educational personnel, and communities are not blind to the "treatment". Measurement over longer periods would help to judge the degree to which the Hawthorne effect is operative.

The hypotheses for these analyses were not preregistered, a protocol was not prepared, and data and analytic code are available by request from the first author and only include studies published through 2019.

Recommendations for Further Research

Building off of the strengths and limitations of the current analysis, as communities and school districts consider delaying school start times, it is important to collect and report youth and school characteristic data that support the investigation of effect sizes for meta-analytic purposes. In particular, future SST studies should collect, and report detailed youth characteristics such as age, sex, and race or ethnicity that were under investigation in this study as well as additional sociodemographic variables such as nativity status, language preference, and school generation status (eg, first-generation or continuing-generation). With respect to school characteristics, future SST research should include consideration of additional variables such as school size, school SES, geographic location, and school racial or ethnic composition. Inclusion of such variables will considerably advance the scope of research on the link between SSTs and pediatric outcomes to be applicable to a diverse range of young people.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ABBREVIATION

SST	school start time

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WHAT'S KNOWN ON THIS SUBJECT:

Sleep is a biological imperative linked to pediatric development, socioemotional functioning, academic achievement, and health. Adolescents undergo a sleep phase delay, which may not correspond with early school start times, resulting in compromised development and outcomes.

WHAT THIS STUDY ADDS:

While some evidence supports later school start times as beneficial for pediatric outcomes, less research has considered possible differences by individual characteristics such as age, sex, race, and school characteristics such as region, socioeconomic status, and ethnic/racial composition.

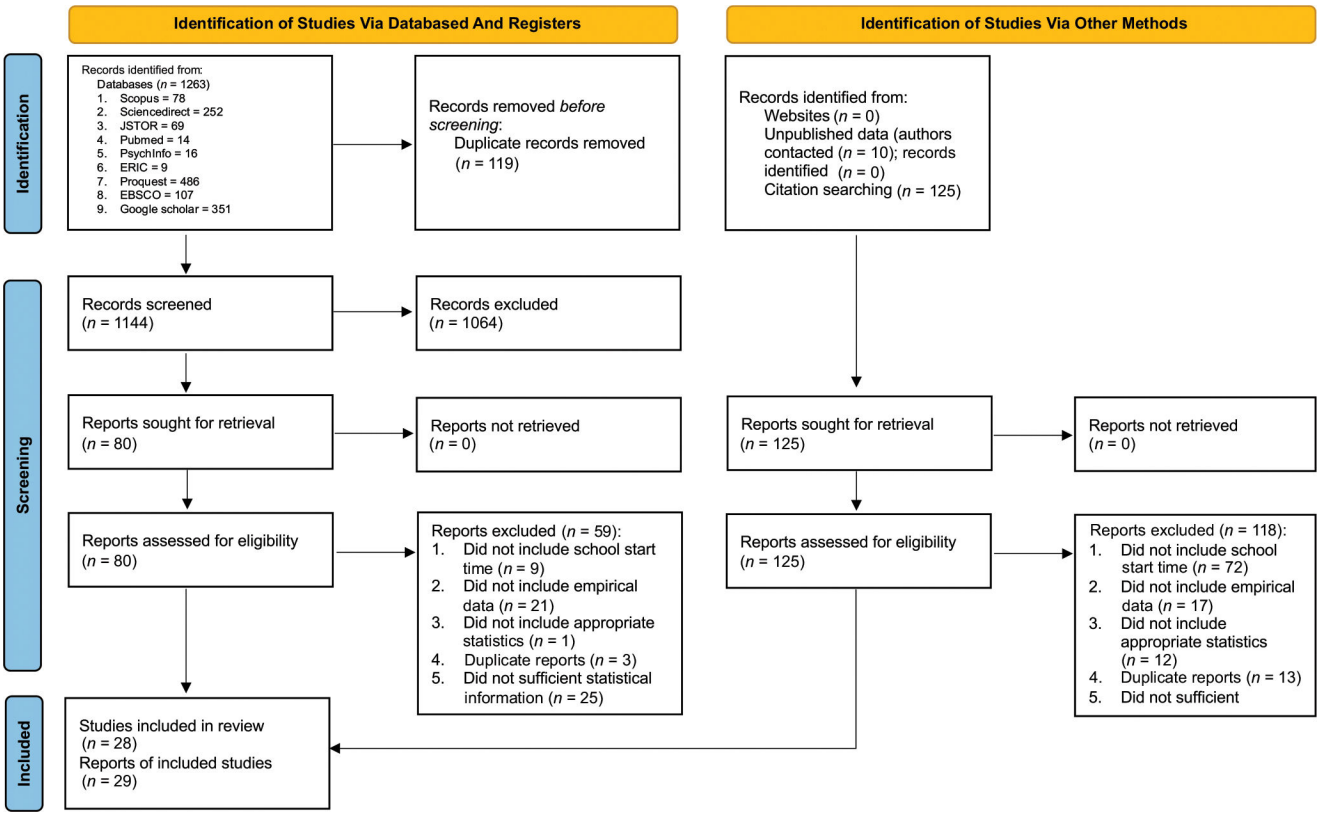
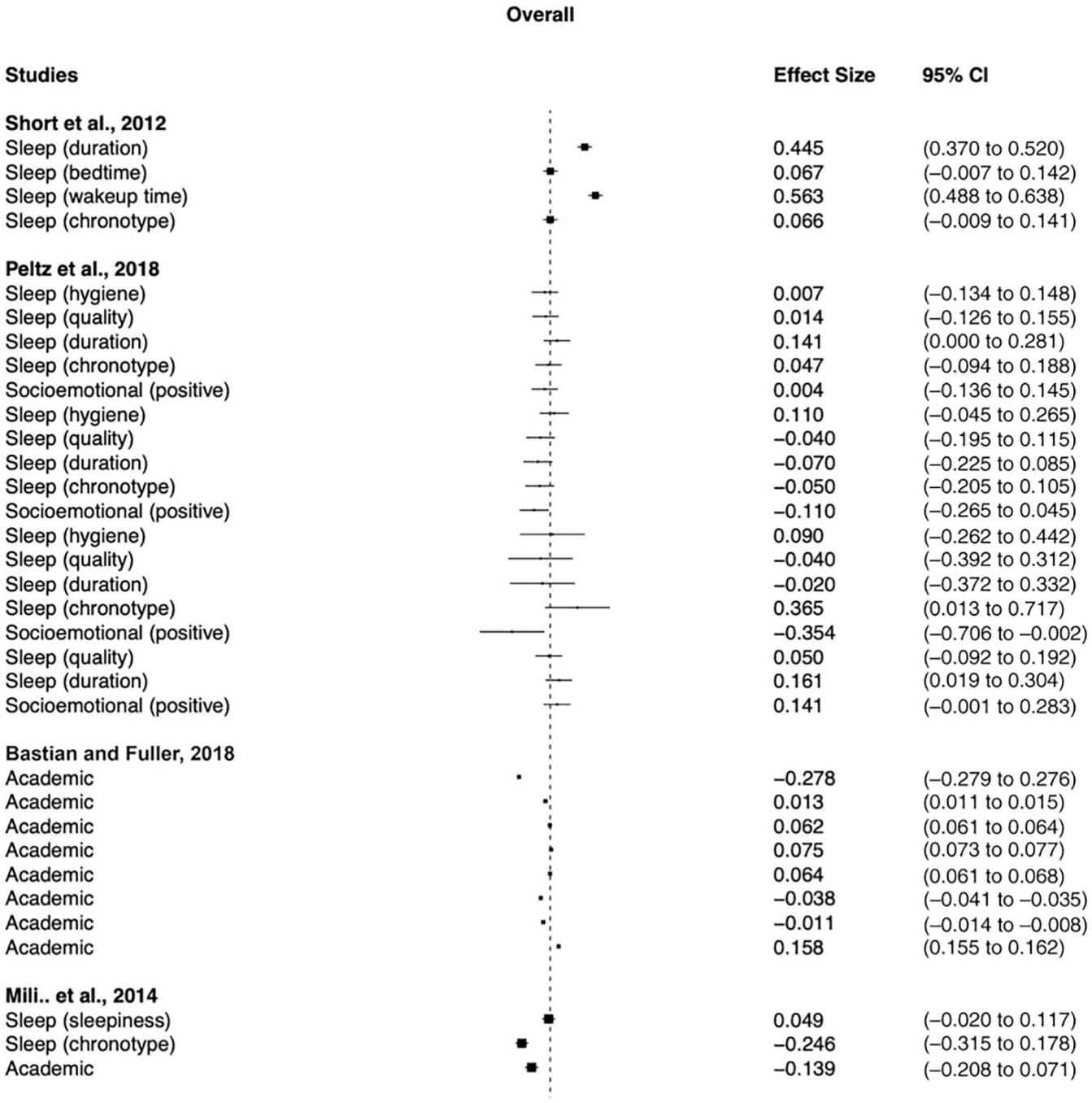
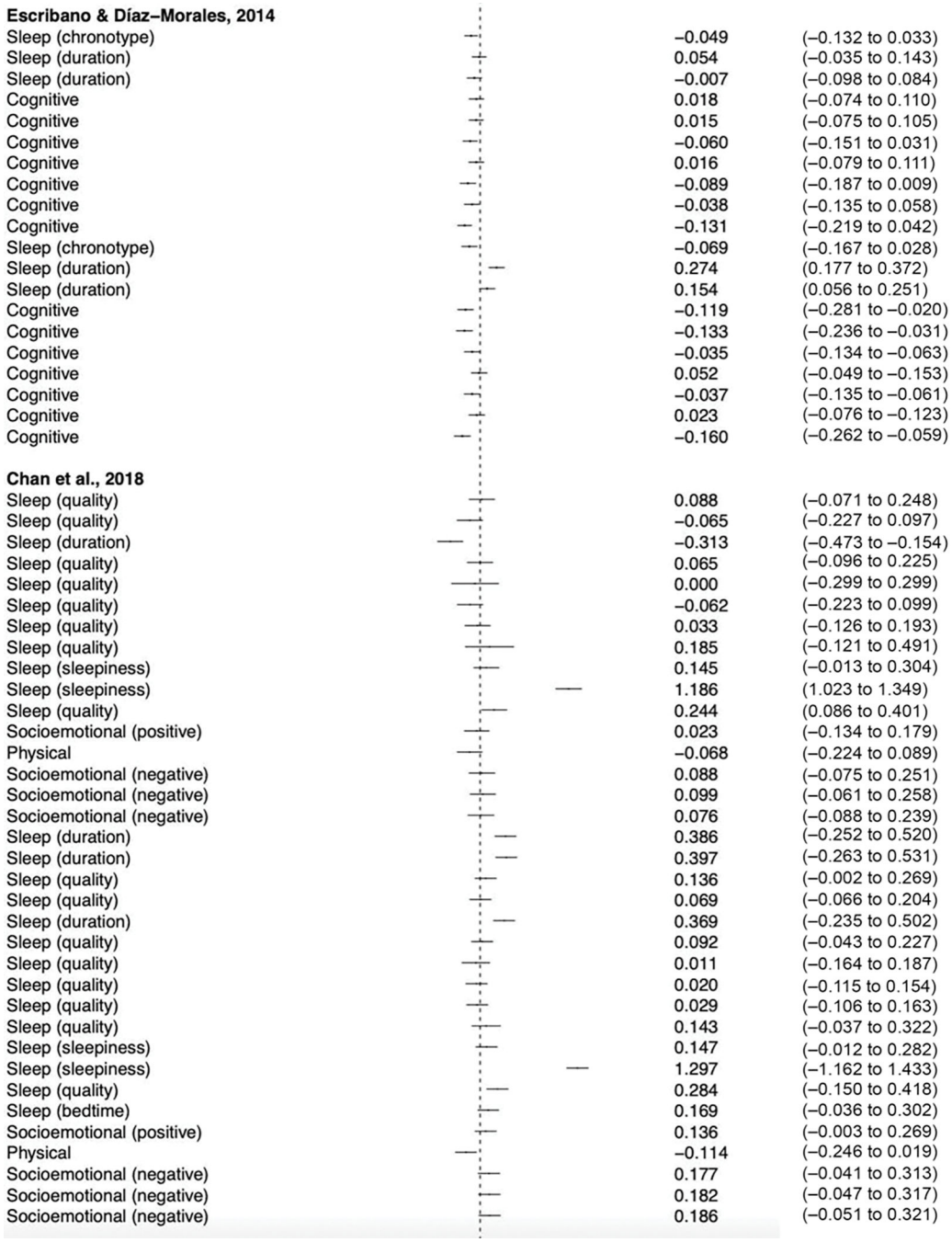


FIGURE 1.
PRISMA flowchart schematic.

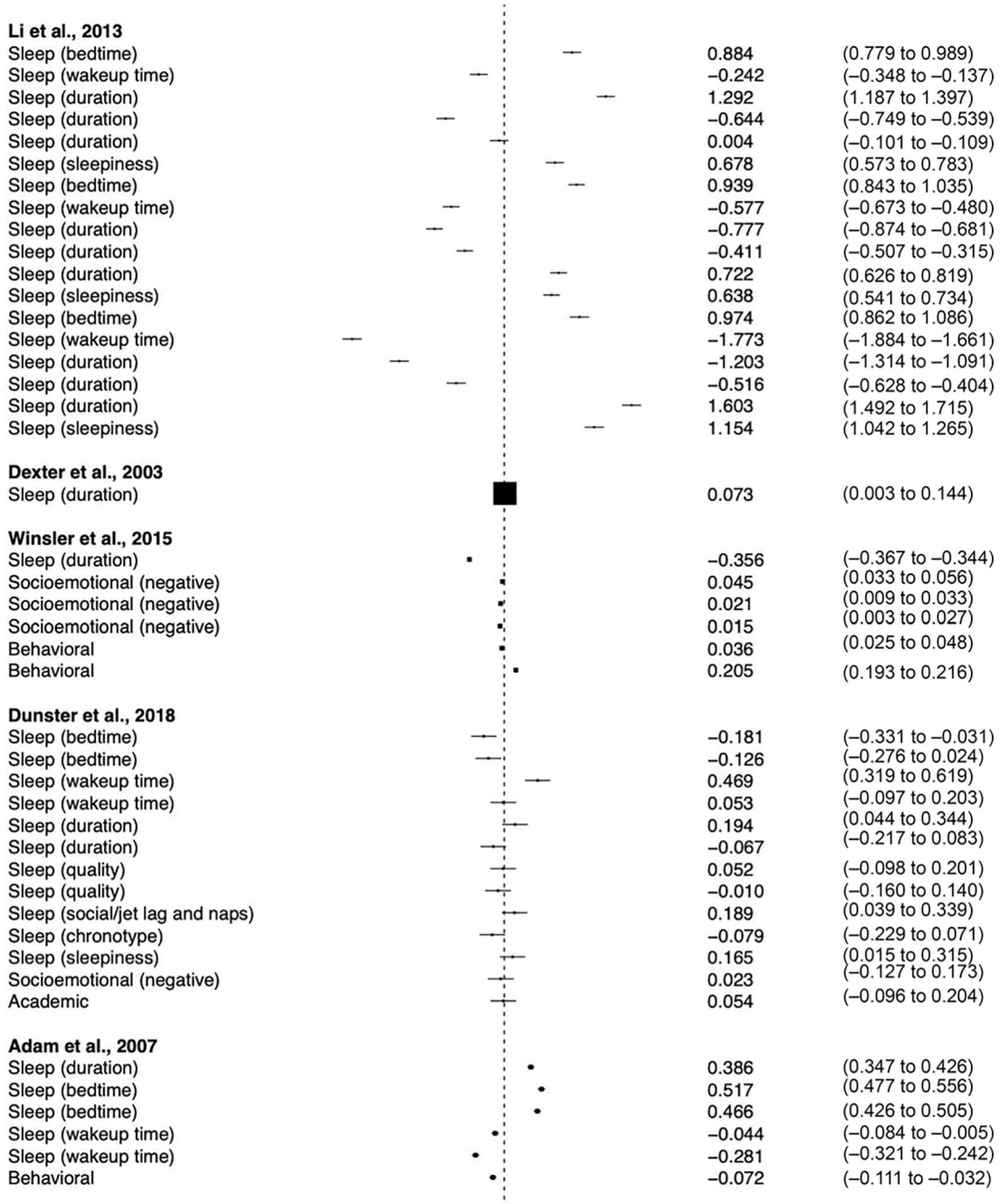




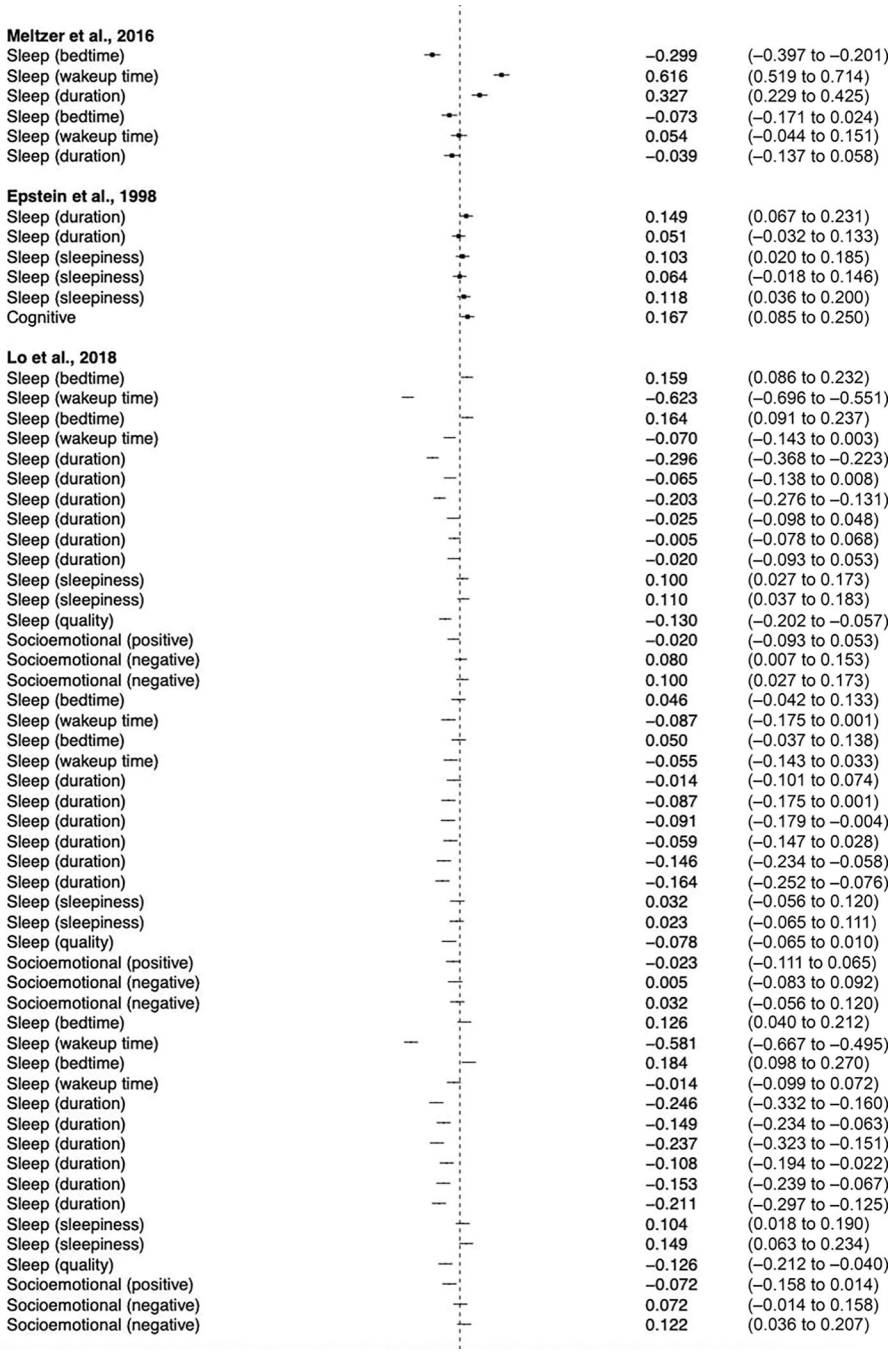
Escribano & Díaz–Morales, 2014		
Sleep (chronotype)	−0.049	(−0.132 to 0.033)
Sleep (duration)	0.054	(−0.035 to 0.143)
Sleep (duration)	−0.007	(−0.098 to 0.084)
Cognitive	0.018	(−0.074 to 0.110)
Cognitive	0.015	(−0.075 to 0.105)
Cognitive	−0.060	(−0.151 to 0.031)
Cognitive	0.016	(−0.079 to 0.111)
Cognitive	−0.089	(−0.187 to 0.009)
Cognitive	−0.038	(−0.135 to 0.058)
Cognitive	−0.131	(−0.219 to 0.042)
Sleep (chronotype)	−0.069	(−0.167 to 0.028)
Sleep (duration)	0.274	(0.177 to 0.372)
Sleep (duration)	0.154	(0.056 to 0.251)
Cognitive	−0.119	(−0.281 to −0.020)
Cognitive	−0.133	(−0.236 to −0.031)
Cognitive	−0.035	(−0.134 to −0.063)
Cognitive	0.052	(−0.049 to −0.153)
Cognitive	−0.037	(−0.135 to −0.061)
Cognitive	0.023	(−0.076 to −0.123)
Cognitive	−0.160	(−0.262 to −0.059)
Chan et al., 2018		
Sleep (quality)	0.088	(−0.071 to 0.248)
Sleep (quality)	−0.065	(−0.227 to 0.097)
Sleep (duration)	−0.313	(−0.473 to −0.154)
Sleep (quality)	0.065	(−0.096 to 0.225)
Sleep (quality)	0.000	(−0.299 to 0.299)
Sleep (quality)	−0.062	(−0.223 to 0.099)
Sleep (quality)	0.033	(−0.126 to 0.193)
Sleep (quality)	0.185	(−0.121 to 0.491)
Sleep (sleepiness)	0.145	(−0.013 to 0.304)
Sleep (sleepiness)	1.186	(1.023 to 1.349)
Sleep (quality)	0.244	(0.086 to 0.401)
Socioemotional (positive)	0.023	(−0.134 to 0.179)
Physical	−0.068	(−0.224 to 0.089)
Socioemotional (negative)	0.088	(−0.075 to 0.251)
Socioemotional (negative)	0.099	(−0.061 to 0.258)
Socioemotional (negative)	0.076	(−0.088 to 0.239)
Sleep (duration)	0.386	(−0.252 to 0.520)
Sleep (duration)	0.397	(−0.263 to 0.531)
Sleep (quality)	0.136	(−0.002 to 0.269)
Sleep (quality)	0.069	(−0.066 to 0.204)
Sleep (duration)	0.369	(−0.235 to 0.502)
Sleep (quality)	0.092	(−0.043 to 0.227)
Sleep (quality)	0.011	(−0.164 to 0.187)
Sleep (quality)	0.020	(−0.115 to 0.154)
Sleep (quality)	0.029	(−0.106 to 0.163)
Sleep (quality)	0.143	(−0.037 to 0.322)
Sleep (sleepiness)	0.147	(−0.012 to 0.282)
Sleep (sleepiness)	1.297	(−1.162 to 1.433)
Sleep (quality)	0.284	(−0.150 to 0.418)
Sleep (bedtime)	0.169	(−0.036 to 0.302)
Socioemotional (positive)	0.136	(−0.003 to 0.269)
Physical	−0.114	(−0.246 to 0.019)
Socioemotional (negative)	0.177	(−0.041 to 0.313)
Socioemotional (negative)	0.182	(−0.047 to 0.317)
Socioemotional (negative)	0.186	(−0.051 to 0.321)

Lufi et al., 2011		
Sleep (wakeup time)	0.619	(0.324 to 0.914)
Sleep (duration)	0.784	(0.488 to 1.079)
Sleep (quality)	0.203	(−0.093 to 0.498)
Cognitive	0.044	(−0.252 to 0.339)
Edwards, 2012		
Academic	0.373	(−0.151 to 0.897)
Academic	0.248	(−0.276 to 0.772)
Academic	0.560	(−0.006 to 1.126)
Academic	0.795	(0.229 to 1.361)
Nahmod et al., 2019		
Sleep (duration)	0.053	(−0.110 to 0.215)
Sleep (bedtime)	−0.048	(−0.210 to 0.114)
Sleep (wakeup time)	0.228	(0.066 to 0.390)
Sleep (quality)	−0.019	(−0.181 to 0.143)
Sleep (duration)	0.064	(−0.084 to 0.212)
Sleep (bedtime)	−0.146	(−0.293 to 0.002)
Sleep (wakeup time)	0.327	(0.180 to 0.475)
Sleep (quality)	−0.114	(−0.262 to 0.034)
Sleep (duration)	0.164	(0.008 to 0.320)
Sleep (bedtime)	−0.187	(−0.343 to −0.031)
Sleep (wakeup time)	0.542	(0.386 to 0.698)
Sleep (quality)	−0.136	(−0.292 to 0.020)
Sleep (duration)	0.020	(−0.113 to 0.152)
Sleep (bedtime)	−0.069	(−0.202 to 0.063)
Sleep (wakeup time)	0.158	(0.025 to 0.290)
Sleep (quality)	−0.109	(−0.241 to 0.024)
Sleep (duration)	0.129	(−0.009 to 0.268)
Sleep (bedtime)	−0.120	(−0.258 to 0.019)
Sleep (wakeup time)	0.408	(0.270 to 0.546)
Sleep (quality)	−0.129	(−0.268 to 0.009)
Sleep (duration)	0.109	(−0.020 to 0.238)
Sleep (bedtime)	−0.065	(−0.194 to 0.064)
Sleep (wakeup time)	0.247	(0.118 to 0.376)
Sleep (quality)	−0.015	(−0.144 to 0.114)
Chan et al., 2017		
Sleep (duration)	−0.030	(−0.087 to 0.027)
Sleep (bedtime)	−0.062	(−0.119 to −0.005)
Sleep (wakeup time)	0.071	(0.014 to 0.128)
Sleep (duration)	0.084	(0.026 to 0.141)
Sleep (bedtime)	0.049	(−0.009 to 0.106)
Sleep (wakeup time)	0.038	(−0.019 to 0.096)
Sleep (sleepiness)	−0.040	(−0.097 to 0.018)
Socioemotional (positive)	−0.081	(−0.138 to 0.023)
Socioemotional (positive)	0.292	(0.235 to 0.350)
Socioemotional (negative)	0.035	(−0.023 to 0.092)
Socioemotional (negative)	0.102	(0.044 to 0.159)
Socioemotional (negative)	0.099	(0.042 to 0.156)
Socioemotional (negative)	0.272	(0.215 to 0.329)
Socioemotional (negative)	0.163	(0.105 to 0.220)
Academic	−0.121	(−0.177 to −0.066)
Academic	−0.046	(−0.102 to 0.010)

Owens et al., 2010		
Sleep (bedtime)	0.162	(0.067 to 0.257)
Sleep (wakeup time)	0.472	(0.376 to 0.567)
Sleep (duration)	0.303	(0.208 to 0.398)
Sleep (bedtime)	0.087	(−0.009 to 0.182)
Sleep (duration)	−0.038	(−0.134 to 0.057)
Sleep (sleepiness)	0.326	(0.231 to 0.421)
Sleep (sleepiness)	0.372	(0.277 to 0.467)
Academic	−0.087	(−0.183 to 0.008)
Physical	0.259	(−0.164 to 0.354)
Wolfson et al., 2007		
Sleep (duration)	−0.232	(−0.369 to −0.094)
Sleep (duration)	0.179	(−0.041 to 0.317)
Sleep (bedtime)	0.213	(0.075 to 0.350)
Sleep (bedtime)	0.097	(−0.041 to 0.235)
Sleep (wakeup time)	−1.020	(−1.158 to −0.883)
Sleep (wakeup time)	0.097	(−0.041 to 0.235)
Sleep (sleepiness)	−0.126	(−0.264 to 0.012)
Sleep (sleepiness)	−0.049	(−0.187 to 0.089)
Sleep (hygiene)	0.054	(−0.084 to 0.191)
Sleep (duration)	−0.403	(−0.541 to −0.265)
Sleep (duration)	0.117	(−0.021 to 0.254)
Sleep (bedtime)	0.049	(−0.089 to 0.187)
Sleep (bedtime)	0.078	(−0.060 to 0.216)
Sleep (wakeup time)	−0.862	(−1.000 to −0.725)
Sleep (wakeup time)	0.092	(−0.046 to 0.230)
Sleep (sleepiness)	−0.107	(−0.245 to 0.031)
Sleep (sleepiness)	−0.217	(−0.355 to −0.079)
Sleep (hygiene)	0.097	(−0.041 to 0.235)
Paksarian et al., 2015		
Sleep (duration)	0.110	(0.088 to 0.133)
Sleep (duration)	0.000	(−0.023 to 0.023)
Sleep (duration)	0.161	(0.129 to 0.194)
Sleep (duration)	0.000	(−0.032 to 0.032)
Sleep (duration)	0.060	(0.028 to 0.092)
Sleep (duration)	0.000	(−0.032 to 0.032)
Vedaa et al., 2012		
Sleep (duration)	0.247	(0.054 to 0.440)
Sleep (bedtime)	−0.110	(−0.303 to 0.083)
Sleep (bedtime)	−0.203	(−0.397 to −0.010)
Sleep (sleepiness)	−0.120	(−0.313 to 0.073)
Socioemotional (positive)	0.125	(−0.069 to 0.318)
Socioemotional (negative)	−0.010	(−0.203 to 0.183)
Cognitive	−0.276	(−0.469 to −0.083)
Cognitive	0.267	(0.074 to 0.460)
Cognitive	0.242	(0.049 to 0.436)

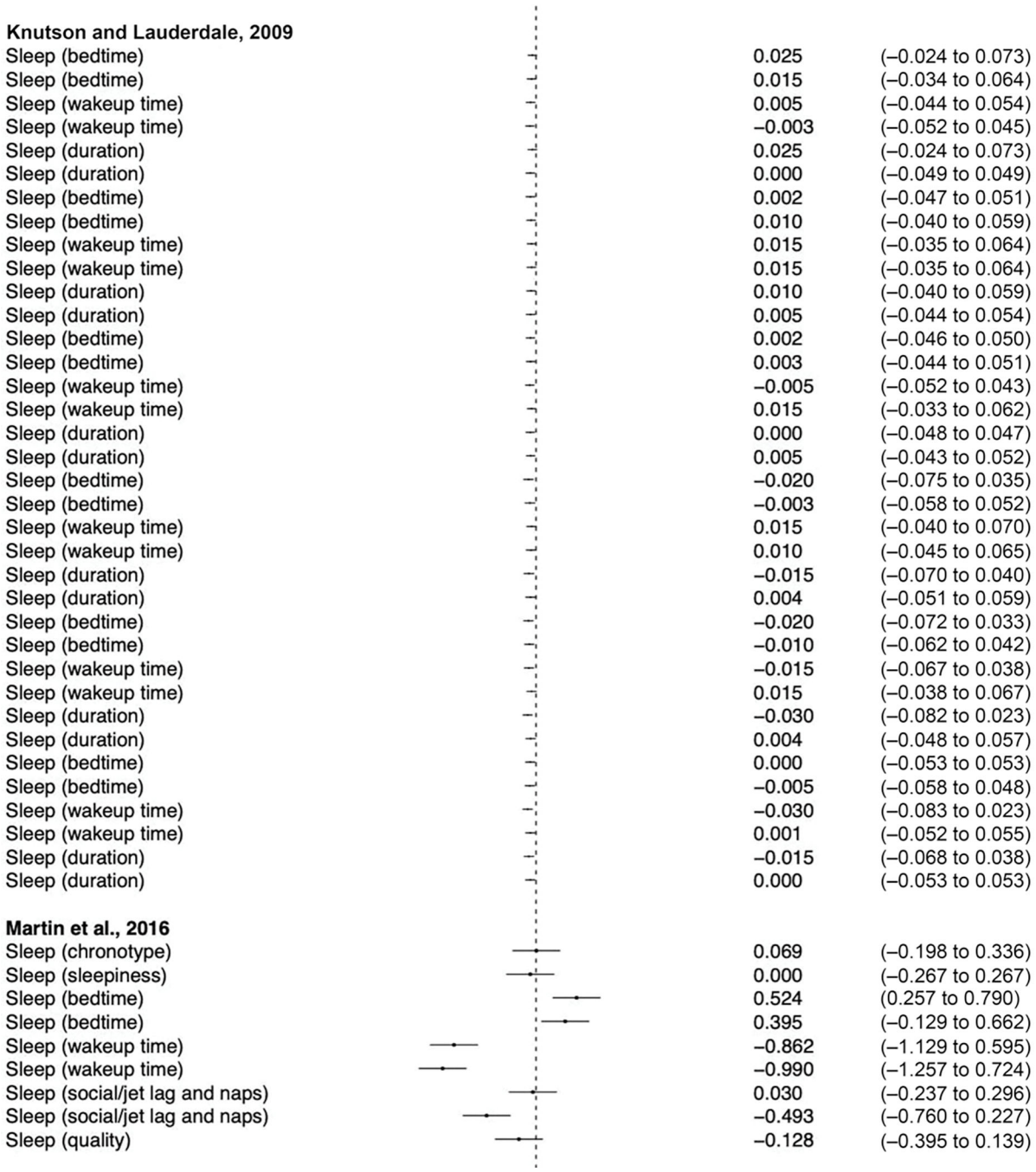


Li et al., 2013		
Sleep (bedtime)	0.884	(0.779 to 0.989)
Sleep (wakeup time)	−0.242	(−0.348 to −0.137)
Sleep (duration)	1.292	(1.187 to 1.397)
Sleep (duration)	−0.644	(−0.749 to −0.539)
Sleep (duration)	0.004	(−0.101 to −0.109)
Sleep (sleepiness)	0.678	(0.573 to 0.783)
Sleep (bedtime)	0.939	(0.843 to 1.035)
Sleep (wakeup time)	−0.577	(−0.673 to −0.480)
Sleep (duration)	−0.777	(−0.874 to −0.681)
Sleep (duration)	−0.411	(−0.507 to −0.315)
Sleep (duration)	0.722	(0.626 to 0.819)
Sleep (sleepiness)	0.638	(0.541 to 0.734)
Sleep (bedtime)	0.974	(0.862 to 1.086)
Sleep (wakeup time)	−1.773	(−1.884 to −1.661)
Sleep (duration)	−1.203	(−1.314 to −1.091)
Sleep (duration)	−0.516	(−0.628 to −0.404)
Sleep (duration)	1.603	(1.492 to 1.715)
Sleep (sleepiness)	1.154	(1.042 to 1.265)
Dexter et al., 2003		
Sleep (duration)	0.073	(0.003 to 0.144)
Winsler et al., 2015		
Sleep (duration)	−0.356	(−0.367 to −0.344)
Socioemotional (negative)	0.045	(0.033 to 0.056)
Socioemotional (negative)	0.021	(0.009 to 0.033)
Socioemotional (negative)	0.015	(0.003 to 0.027)
Behavioral	0.036	(0.025 to 0.048)
Behavioral	0.205	(0.193 to 0.216)
Dunster et al., 2018		
Sleep (bedtime)	−0.181	(−0.331 to −0.031)
Sleep (bedtime)	−0.126	(−0.276 to 0.024)
Sleep (wakeup time)	0.469	(0.319 to 0.619)
Sleep (wakeup time)	0.053	(−0.097 to 0.203)
Sleep (duration)	0.194	(0.044 to 0.344)
Sleep (duration)	−0.067	(−0.217 to 0.083)
Sleep (quality)	0.052	(−0.098 to 0.201)
Sleep (quality)	−0.010	(−0.160 to 0.140)
Sleep (social/jet lag and naps)	0.189	(0.039 to 0.339)
Sleep (chronotype)	−0.079	(−0.229 to 0.071)
Sleep (sleepiness)	0.165	(0.015 to 0.315)
Socioemotional (negative)	0.023	(−0.127 to 0.173)
Academic	0.054	(−0.096 to 0.204)
Adam et al., 2007		
Sleep (duration)	0.386	(0.347 to 0.426)
Sleep (bedtime)	0.517	(0.477 to 0.556)
Sleep (bedtime)	0.466	(0.426 to 0.505)
Sleep (wakeup time)	−0.044	(−0.084 to −0.005)
Sleep (wakeup time)	−0.281	(−0.321 to −0.242)
Behavioral	−0.072	(−0.111 to −0.032)

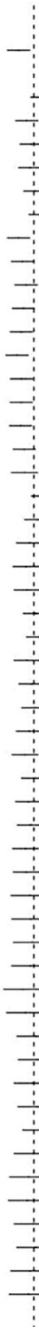


Meltzer et al., 2016		
Sleep (bedtime)	−0.299	(−0.397 to −0.201)
Sleep (wakeup time)	0.616	(0.519 to 0.714)
Sleep (duration)	0.327	(0.229 to 0.425)
Sleep (bedtime)	−0.073	(−0.171 to 0.024)
Sleep (wakeup time)	0.054	(−0.044 to 0.151)
Sleep (duration)	−0.039	(−0.137 to 0.058)
Epstein et al., 1998		
Sleep (duration)	0.149	(0.067 to 0.231)
Sleep (duration)	0.051	(−0.032 to 0.133)
Sleep (sleepiness)	0.103	(0.020 to 0.185)
Sleep (sleepiness)	0.064	(−0.018 to 0.146)
Sleep (sleepiness)	0.118	(0.036 to 0.200)
Cognitive	0.167	(0.085 to 0.250)
Lo et al., 2018		
Sleep (bedtime)	0.159	(0.086 to 0.232)
Sleep (wakeup time)	−0.623	(−0.696 to −0.551)
Sleep (bedtime)	0.164	(0.091 to 0.237)
Sleep (wakeup time)	−0.070	(−0.143 to 0.003)
Sleep (duration)	−0.296	(−0.368 to −0.223)
Sleep (duration)	−0.065	(−0.138 to 0.008)
Sleep (duration)	−0.203	(−0.276 to −0.131)
Sleep (duration)	−0.025	(−0.098 to 0.048)
Sleep (duration)	−0.005	(−0.078 to 0.068)
Sleep (duration)	−0.020	(−0.093 to 0.053)
Sleep (sleepiness)	0.100	(0.027 to 0.173)
Sleep (sleepiness)	0.110	(0.037 to 0.183)
Sleep (quality)	−0.130	(−0.202 to −0.057)
Socioemotional (positive)	−0.020	(−0.093 to 0.053)
Socioemotional (negative)	0.080	(0.007 to 0.153)
Socioemotional (negative)	0.100	(0.027 to 0.173)
Sleep (bedtime)	0.046	(−0.042 to 0.133)
Sleep (wakeup time)	−0.087	(−0.175 to 0.001)
Sleep (bedtime)	0.050	(−0.037 to 0.138)
Sleep (wakeup time)	−0.055	(−0.143 to 0.033)
Sleep (duration)	−0.014	(−0.101 to 0.074)
Sleep (duration)	−0.087	(−0.175 to 0.001)
Sleep (duration)	−0.091	(−0.179 to −0.004)
Sleep (duration)	−0.059	(−0.147 to 0.028)
Sleep (duration)	−0.146	(−0.234 to −0.058)
Sleep (duration)	−0.164	(−0.252 to −0.076)
Sleep (sleepiness)	0.032	(−0.056 to 0.120)
Sleep (sleepiness)	0.023	(−0.065 to 0.111)
Sleep (quality)	−0.078	(−0.065 to 0.010)
Socioemotional (positive)	−0.023	(−0.111 to 0.065)
Socioemotional (negative)	0.005	(−0.083 to 0.092)
Socioemotional (negative)	0.032	(−0.056 to 0.120)
Sleep (bedtime)	0.126	(0.040 to 0.212)
Sleep (wakeup time)	−0.581	(−0.667 to −0.495)
Sleep (bedtime)	0.184	(0.098 to 0.270)
Sleep (wakeup time)	−0.014	(−0.099 to 0.072)
Sleep (duration)	−0.246	(−0.332 to −0.160)
Sleep (duration)	−0.149	(−0.234 to −0.063)
Sleep (duration)	−0.237	(−0.323 to −0.151)
Sleep (duration)	−0.108	(−0.194 to −0.022)
Sleep (duration)	−0.153	(−0.239 to −0.067)
Sleep (duration)	−0.211	(−0.297 to −0.125)
Sleep (sleepiness)	0.104	(0.018 to 0.190)
Sleep (sleepiness)	0.149	(0.063 to 0.234)
Sleep (quality)	−0.126	(−0.212 to −0.040)
Socioemotional (positive)	−0.072	(−0.158 to 0.014)
Socioemotional (negative)	0.072	(−0.014 to 0.158)
Socioemotional (negative)	0.122	(0.036 to 0.207)

Carskadon et al., 1998		
Sleep (bedtime)	−0.055	(−0.319 to 0.210)
Sleep (wakeup time)	0.479	(0.215 to 0.743)
Sleep (duration)	0.212	(−0.052 to 0.477)
Sleep (bedtime)	0.055	(−0.210 to 0.319)
Sleep (wakeup time)	−0.025	(−0.289 to 0.239)
Sleep (duration)	0.055	(−0.210 to 0.319)
Sleep (bedtime)	−0.222	(−0.486 to 0.042)
Sleep (duration)	0.109	(−0.155 to 0.373)
Sleep (quality)	−0.099	(−0.364 to 0.165)
Sleep (quality)	−0.346	(−0.610 to −0.082)
Sleep	0.379	(0.114 to 0.643)
Sleep	0.050	(−0.215 to 0.314)
Sleep	−0.198	(−0.462 to 0.067)
Sleep (quality)	−0.237	(−0.501 to 0.028)
Sleep (quality)	−0.313	(−0.577 to −0.049)
Physical	0.553	(0.289 to 0.817)
Dupuis, 2015		
Academic	0.000	(−0.041 to 0.041)
Academic	0.009	(−0.032 to 0.049)
Academic	0.096	(−0.056 to 0.136)
Academic	0.103	(−0.064 to 0.142)
Academic	0.100	(−0.061 to 0.140)
Academic	−0.039	(−0.079 to 0.002)
Academic	−0.017	(−0.058 to 0.023)
Academic	0.048	(0.008 to 0.088)
Academic	0.076	(0.037 to 0.115)
Academic	0.087	(0.047 to 0.126)
Academic	0.004	(−0.069 to 0.078)
Academic	−0.022	(−0.094 to 0.050)
Academic	−0.067	(−0.139 to 0.004)
Academic	0.018	(−0.056 to 0.091)
Academic	0.036	(−0.036 to 0.108)
Academic	−0.109	(−0.183 to −0.036)
Academic	0.031	(−0.041 to 0.103)
Academic	−0.034	(−0.106 to 0.038)
Academic	−0.004	(−0.078 to 0.069)
Academic	0.014	(−0.059 to 0.086)
Academic	−0.013	(−0.088 to 0.062)
Academic	−0.035	(−0.109 to 0.038)
Academic	−0.047	(−0.121 to 0.027)
Academic	−0.031	(−0.105 to 0.044)
Academic	−0.044	(−0.118 to 0.029)
Academic	−0.169	(−0.243 to −0.095)
Academic	−0.004	(−0.080 to 0.071)
Academic	0.040	(−0.037 to 0.116)
Academic	−0.031	(−0.106 to 0.044)
Academic	−0.034	(−0.109 to 0.041)
Academic	−0.022	(−0.098 to 0.054)
Academic	0.040	(−0.035 to 0.115)
Academic	−0.042	(−0.117 to 0.033)



Knutson and Lauderdale, 2009		
Sleep (bedtime)	0.025	(–0.024 to 0.073)
Sleep (bedtime)	0.015	(–0.034 to 0.064)
Sleep (wakeup time)	0.005	(–0.044 to 0.054)
Sleep (wakeup time)	–0.003	(–0.052 to 0.045)
Sleep (duration)	0.025	(–0.024 to 0.073)
Sleep (duration)	0.000	(–0.049 to 0.049)
Sleep (bedtime)	0.002	(–0.047 to 0.051)
Sleep (bedtime)	0.010	(–0.040 to 0.059)
Sleep (wakeup time)	0.015	(–0.035 to 0.064)
Sleep (wakeup time)	0.015	(–0.035 to 0.064)
Sleep (duration)	0.010	(–0.040 to 0.059)
Sleep (duration)	0.005	(–0.044 to 0.054)
Sleep (bedtime)	0.002	(–0.046 to 0.050)
Sleep (bedtime)	0.003	(–0.044 to 0.051)
Sleep (wakeup time)	–0.005	(–0.052 to 0.043)
Sleep (wakeup time)	0.015	(–0.033 to 0.062)
Sleep (duration)	0.000	(–0.048 to 0.047)
Sleep (duration)	0.005	(–0.043 to 0.052)
Sleep (bedtime)	–0.020	(–0.075 to 0.035)
Sleep (bedtime)	–0.003	(–0.058 to 0.052)
Sleep (wakeup time)	0.015	(–0.040 to 0.070)
Sleep (wakeup time)	0.010	(–0.045 to 0.065)
Sleep (duration)	–0.015	(–0.070 to 0.040)
Sleep (duration)	0.004	(–0.051 to 0.059)
Sleep (bedtime)	–0.020	(–0.072 to 0.033)
Sleep (bedtime)	–0.010	(–0.062 to 0.042)
Sleep (wakeup time)	–0.015	(–0.067 to 0.038)
Sleep (wakeup time)	0.015	(–0.038 to 0.067)
Sleep (duration)	–0.030	(–0.082 to 0.023)
Sleep (duration)	0.004	(–0.048 to 0.057)
Sleep (bedtime)	0.000	(–0.053 to 0.053)
Sleep (bedtime)	–0.005	(–0.058 to 0.048)
Sleep (wakeup time)	–0.030	(–0.083 to 0.023)
Sleep (wakeup time)	0.001	(–0.052 to 0.055)
Sleep (duration)	–0.015	(–0.068 to 0.038)
Sleep (duration)	0.000	(–0.053 to 0.053)
Martin et al., 2016		
Sleep (chronotype)	0.069	(–0.198 to 0.336)
Sleep (sleepiness)	0.000	(–0.267 to 0.267)
Sleep (bedtime)	0.524	(0.257 to 0.790)
Sleep (bedtime)	0.395	(–0.129 to 0.662)
Sleep (wakeup time)	–0.862	(–1.129 to 0.595)
Sleep (wakeup time)	–0.990	(–1.257 to 0.724)
Sleep (social/jet lag and naps)	0.030	(–0.237 to 0.296)
Sleep (social/jet lag and naps)	–0.493	(–0.760 to 0.227)
Sleep (quality)	–0.128	(–0.395 to 0.139)



Onyper et al., 2013		
Sleep (bedtime)	−0.109	(−0.236 to 0.018)
Sleep (wakeup time)	0.316	(0.189 to 0.443)
Sleep (duration)	0.157	(0.029 to 0.284)
Sleep (bedtime)	−0.015	(−0.142 to 0.112)
Sleep (wakeup time)	0.035	(−0.092 to 0.162)
Sleep (duration)	0.021	(−0.106 to 0.148)
Sleep (social/jet lag and naps)	0.077	(−0.050 to 0.204)
Sleep (social/jet lag and naps)	0.137	(0.010 to 0.264)
Sleep (quality)	−0.109	(−0.236 to 0.018)
Sleep (chronotype)	−0.065	(−0.192 to 0.062)
Sleep (sleepiness)	−0.022	(−0.149 to 0.105)
Behavioral	−0.053	(−0.180 to 0.074)
Behavioral	−0.079	(−0.206 to 0.049)
Behavioral	−0.127	(−0.254 to 0.000)
Academic	−0.077	(−0.204 to 0.050)
Socioemotional (negative)	−0.079	(−0.206 to 0.049)
Socioemotional (negative)	−0.086	(−0.213 to 0.041)
Socioemotional (negative)	−0.044	(−0.171 to 0.083)
Sleep (bedtime)	−0.041	(−0.189 to 0.108)
Sleep (wakeup time)	0.184	(0.035 to 0.332)
Sleep (duration)	0.109	(−0.040 to 0.257)
Sleep (bedtime)	0.016	(−0.133 to 0.164)
Sleep (wakeup time)	−0.024	(−0.173 to 0.125)
Sleep (duration)	−0.011	(−0.159 to 0.138)
Sleep (social/jet lag and naps)	0.092	(−0.156 to 0.241)
Sleep (social/jet lag and naps)	0.130	(−0.118 to 0.279)
Sleep (quality)	−0.011	(−0.160 to 0.137)
Sleep (chronotype)	0.044	(−0.105 to 0.192)
Sleep (sleepiness)	0.077	(−0.72 to 0.225)
Behavioral	0.014	(−0.135 to 0.162)
Behavioral	−0.035	(−0.183 to 0.114)
Behavioral	0.074	(−0.075 to 0.222)
Academic	0.006	(−0.143 to 0.155)
Socioemotional (negative)	0.027	(−0.122 to 0.176)
Socioemotional (negative)	−0.029	(−0.178 to 0.119)
Socioemotional (negative)	−0.019	(−0.167 to 0.130)
Sleep (bedtime)	0.022	(−0.196 to 0.240)
Sleep (wakeup time)	0.031	(−0.187 to 0.248)
Sleep (duration)	0.051	(−0.167 to 0.269)
Sleep (bedtime)	0.028	(−0.189 to 0.246)
Sleep (wakeup time)	−0.060	(−0.278 to 0.158)
Sleep (duration)	−0.028	(−0.246 to 0.189)
Sleep (social/jet lag and naps)	0.092	(−0.126 to 0.309)
Sleep (social/jet lag and naps)	0.106	(−0.112 to 0.323)
Sleep (quality)	0.058	(−0.160 to 0.276)
Sleep (chronotype)	0.103	(−0.114 to 0.321)
Sleep (sleepiness)	0.155	(−0.062 to 0.373)
Behavioral	0.059	(−0.159 to 0.277)
Behavioral	0.007	(−0.211 to 0.224)
Behavioral	−0.009	(−0.227 to 0.209)
Academic	0.059	(−0.159 to 0.277)
Socioemotional (negative)	0.087	(−0.131 to 0.305)
Socioemotional (negative)	0.020	(−0.198 to 0.237)
Socioemotional (negative)	0.003	(−0.215 to 0.221)

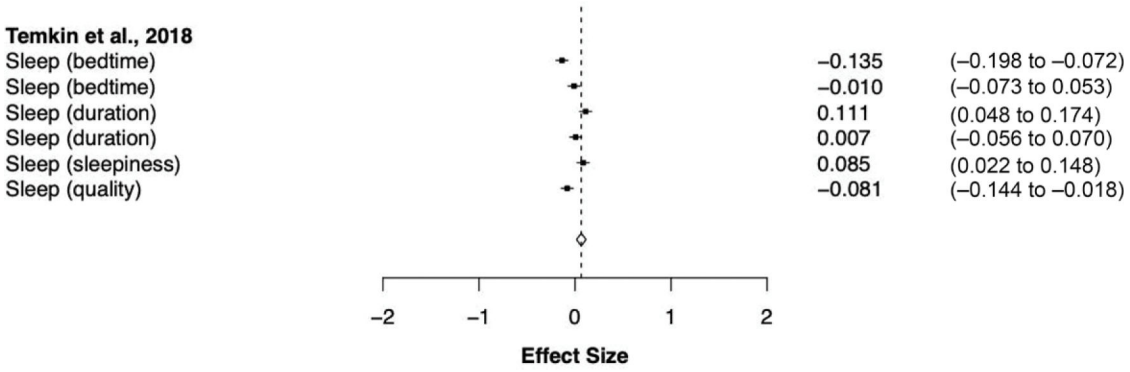


FIGURE 2.
Forest plot for associations between school start time and youth outcomes.

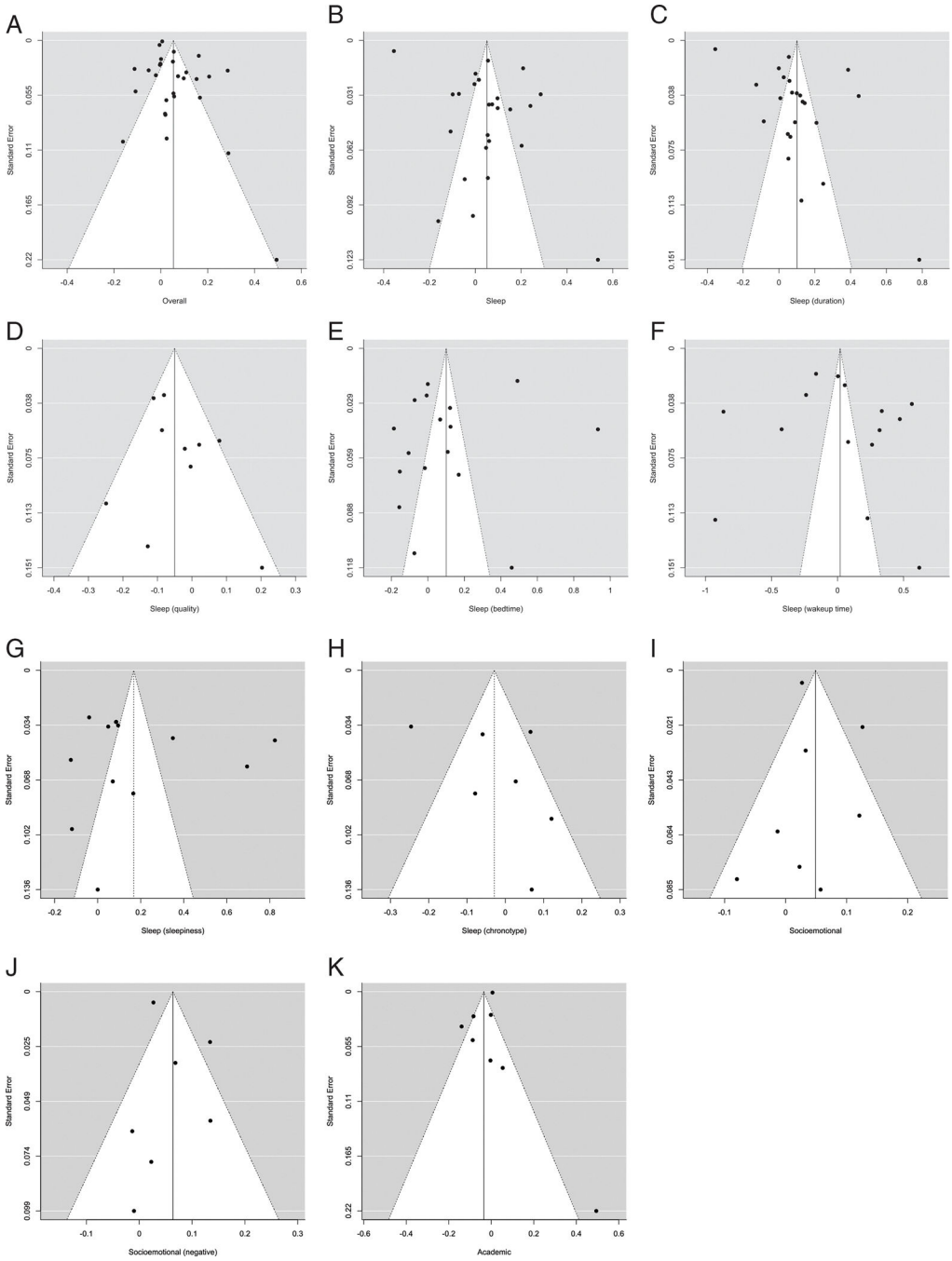


FIGURE 3.
Funnel plots for associations between school start time and youth outcomes.

TABLE 1

Overall Effects of School Start Time for Youth Outcomes

Developmental Outcomes	*n*	*m*	I^2	ES	95% CI Lower	95% CI Upper	*P*
Aggregated outcome	28	445	99.728	0.061	0.015	0.107	.01*
Sleep	25	305	99.160	0.054	−0.014	0.121	.11
Duration	23	94	99.282	0.109	0.019	0.199	.02*
Quality	10	41	37.060	−0.053	−0.113	0.008	.08**
Bedtime	17	58	97.789	0.101	−0.048	0.250	.17
Wake time	15	52	98.804	0.021	−0.236	0.278	.86
Sleepiness	13	31	96.854	0.167	−0.010	0.343	.06**
Chronotype	7	12	86.818	−0.029	−0.155	0.097	.59
Hygiene	2	5	—	—	—	—	—
Social/jet lags and naps	3	9	—	—	—	—	—
Socioemotional	8	43	82.900	0.046	−0.007	0.098	.08**
Positive	5	12	—	—	—	—	—
Negative	7	31	79.302	0.060	0.001	0.119	.04*
Academic	8	53	99.913	0.026	−0.132	0.184	.70
Cognitive	4	19	—	—	—	—	—
Behavioral	3	12	—	—	—	—	—
Physical	3	4	—	—	—	—	—

Age was adjusted in all analyses. Estimates with df < 4 are not considered to be reliable. ES, effect sizes assessed in correlation; *m*, number of effect sizes; *n*, number of studies; —, refers to analyses where the degrees of freedom was less than 4, which would provide unreliable estimates, therefore estimates were not analyzed.

*$P < .05$

**$P < .10$.

TABLE 2

Moderating Effects of Initial School Start Time for the Association between School Start Time and Youth Outcomes

Developmental Outcomes	Initial School Start Timing	ES	95% CI Lower	95% CI Upper	*P*
Aggregated outcome	7:30 to 7:59 vs before 7:30	0.135	0.023	0.246	.02*
	8:00 to 8:29 vs before 7:30	0.073	−0.088	0.234	.31
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	−0.060	−0.239	0.120	.43
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Sleep	7:30 to 7:59 vs before 7:30	0.193	0.027	0.358	.03*
	8:00 to 8:29 vs before 7:30	0.165	−0.031	0.361	.08**
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	−0.025	−0.207	0.156	.73
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Duration	7:30 to 7:59 vs before 7:30	0.220	−0.018	0.459	.07**
	8:00 to 8:29 vs before 7:30	0.131	−0.068	0.329	.16
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	−0.084	−0.264	0.097	.29
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Quality	7:30 to 7:59 vs before 7:30	0.081	−0.078	0.240	.24
	8:00 to 8:29 vs before 7:30	—	—	—	—
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	−0.049	−0.170	0.072	.34
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Bedtime	7:30 to 7:59 vs before 7:30	0.226	−0.086	0.538	.13
	8:00 to 8:29 vs before 7:30	—	—	—	—

Developmental Outcomes	Initial School Start Timing	ES	95% CI Lower	95% CI Upper	*P*
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Wake time	7:30 to 7:59 vs before 7:30	−0.015	−0.809	0.778	.96
	8:00 to 8:29 vs before 7:30	—	—	—	—
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	0.154	−0.249	0.556	.41
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Chronotype	7:30 to 7:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs before 7:30	—	—	—	—
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Sleepiness	7:30 to 7:59 vs before 7:30	0.272	−0.115	0.658	.14
	8:00 to 8:29 vs before 7:30	—	—	—	—
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Socioemotional	7:30 to 7:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs before 7:30	—	—	—	—
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Negative	7:30 to 7:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs before 7:30	—	—	—	—

Developmental Outcomes	Initial School Start Timing	ES	95% CI Lower	95% CI Upper	*P*
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
Academic	7:30 to 7:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs before 7:30	—	—	—	—
	8:30 to 8:59 vs before 7:30	—	—	—	—
	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—

Age was adjusted in all analyses. Estimates with df < 4 are not considered to be reliable. ES, effect sizes assessed in correlation. —, refer to analyses where the degrees of freedom was less than 4, which would provide unreliable estimates, therefore estimates were not analyzed.

*$P < .05$

**$P < .10$.

TABLE 3

Moderating Effects of Later School Start Time for the Association between School Start Time and Youth Outcomes

Developmental Outcomes	New School Start Time	ES	95% CI Lower	95% CI Upper	*P*
Aggregated outcome	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	0.056	−0.077	0.190	.39
	After 9 vs 8:00 to 8:29	−0.056	−0.232	0.120	.47
	After 9 vs 8:30 to 8:59	−0.112	−0.279	0.054	.15
Sleep	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	0.128	−0.018	0.274	.08**
	After 9 vs 8:00 to 8:29	−0.034	−0.200	0.132	.64
	After 9 vs 8:30 to 8:59	−0.162	−0.357	0.033	.08**
Duration	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	0.113	−0.108	0.334	.28
	After 9 vs 8:00 to 8:29	0.062	−0.184	0.309	.52
	After 9 vs 8:30 to 8:59	—	—	—	—
Quality	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	0.130	0.045	0.214	.01*
	After 9 vs 8:00 to 8:29	—	—	—	—
	After 9 vs 8:30 to 8:59	—	—	—	—
Bedtime	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—

Developmental Outcomes	New School Start Time	95% CI			
		ES	Lower	Upper	*P*
	8:30 to 8:59 vs 8:00 to 8:29	−0.066	−0.350	0.218	.61
	After 9 vs 8:00 to 8:29	−0.152	−0.612	0.308	.46
	After 9 vs 8:30 to 8:59	−0.086	−0.471	0.298	.61
Wake time	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	0.267	−0.240	0.775	.25
	After 9 vs 8:00 to 8:29	−0.076	−1.127	0.974	.85
	After 9 vs 8:30 to 8:59	−0.344	−1.523	0.835	.47
Chronotype	8:00 to 8:29 vs 7:30 to 7:59[a]	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59[a]	—	—	—	—
	After 9 vs 7:30 to 7:59[a]	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29[a]	—	—	—	—
	After 9 vs 8:00 to 8:29[a]	—	—	—	—
	After 9 vs 8:30 to 8:59[a]	—	—	—	—
Sleepiness	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	0.219	−0.166	0.604	.22
	After 9 vs 8:00 to 8:29	−0.137	−0.339	0.064	.13
	After 9 vs 8:30 to 8:59	−0.356	−0.844	0.132	.11
Socioemotional	8:00 to 8:29 vs 7:30 to 7:59[a]	—	—	—	—
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
	After 9 vs 8:00 to 8:29	—	—	—	—
	After 9 vs 8:30 to 8:59	—	—	—	—
Negative	8:00 to 8:29 vs 7:30 to 7:59	—	—	—	—

Developmental Outcomes	New School Start Time	ES	95% CI Lower	95% CI Upper	*P*
	8:30 to 8:59 vs 7:30 to 7:59	—	—	—	—
	After 9 vs 7:30 to 7:59	—	—	—	—
	8:30 to 8:59 vs 8:00 to 8:29	—	—	—	—
	After 9 vs 8:00 to 8:29	—	—	—	—
	After 9 vs 8:30 to 8:59	—	—	—	—

Age was adjusted in all analyses. Estimates with df < 4 are not considered to be reliable. ES, effect sizes assessed in correlation; —, refer to analyses where the degrees of freedom was less than 4, which would provide unreliable estimates, therefore estimates were not analyzed.

[a]These variables contain issues of convergence.

[*]$P < .05$

[**]$P < .10$.

TABLE 4

Subgroup Analyses for the Association between School Start Time and Youth Outcomes by Initial School Start Time

Developmental Outcomes	Initial School Start Time	*n*	*m*	ES	95% CI Lower	95% CI Upper	*P*
Aggregated outcome	Before 7:30	7	67	−0.006	−0.082	0.071	.86
	7:30 to 7:59	13	160	0.116	0.030	0.203	.01*
	8:00 to 8:29	5	58	—	—	—	—
	8:30 to 8:59	2	45	—	—	—	—
Sleep	Before 7:30	7	59	−0.063	−0.209	0.083	.33
	7:30 to 7:59	12	123	0.116	0.009	0.224	.04*
	8:00 to 8:29	5	34	—	—	—	—
	8:30 to 8:59	2	26	—	—	—	—
Duration	Before 7:30	6	15	−0.016	−0.216	0.185	.85
	7:30 to 7:59	11	37	0.180	0.018	0.343	.03*
	8:00 to 8:29	5	14	—	—	—	—
	8:30 to 8:59	2	5	—	—	—	—
Quality	Before 7:30	3	8	—	—	—	—
	7:30 to 7:59	6	24	−0.038	−0.166	0.091	.47
	8:00 to 8:29	3	3	—	—	—	—
	8:30 to 8:59[a]	—	—	—	—	—	—
Bedtime	Before 7:30	4	12	—	—	—	—
	7:30 to 7:59	10	21	0.182	−0.070	0.434	.14
	8:00 to 8:29	3	5	—	—	—	—
	8:30 to 8:59	2	6	—	—	—	—
Wake time	Before 7:30	3	9	—	—	—	—
	7:30 to 7:59	10	21	−0.016	−0.400	0.368	.93
	8:00 to 8:29	3	4	—	—	—	—
	8:30 to 8:59[a]	—	—	—	—	—	—
Chronotype	Before 7:30[a]	—	—	—	—	—	—
	7:30 to 7:59	3	3	—	—	—	—

Developmental Outcomes	Initial School Start Time	*n*	*m*	ES	95% CI Lower	95% CI Upper	*P*
	8:00 to 8:29	2	3	—	—	—	—
	8:30 to 8:59[a]	—	—	—	—	—	—
Sleepiness	Before 7:30	4	9	—	—	—	—
	7:30 to 7:59	6	14	0.295	−0.095	0.686	.11
	8:00 to 8:29	2	4	—	—	—	—
	8:30 to 8:59	2	3	—	—	—	—
Socioemotional	Before 7:30[a]	—	—	—	—	—	—
	7:30 to 7:59	4	22	—	—	—	—
	8:00 to 8:29	2	4	—	—	—	—
	8:30 to 8:59	2	8	—	—	—	—
Negative	Before 7:30[a]	—	—	—	—	—	—
	7:30 to 7:59	4	16	—	—	—	—
	8:00 to 8:29[a]	—	—	—	—	—	—
	8:30 to 8:59	2	7	—	—	—	—
Academic	Before 7:30[a]	—	—	—	—	—	—
	7:30 to 7:59	3	7	—	—	—	—
	8:00 to 8:29[a]	—	—	—	—	—	—
	8:30 to 8:59[a]	—	—	—	—	—	—

Age was adjusted in all analyses. Estimates with df < 4 are not considered to be reliable. ES, effect sizes assessed in correlation; *m*, number of effect sizes; *n*, number of studies. —, refer to analyses where the degrees of freedom was less than 4, which would provide unreliable estimates, therefore estimates were not analyzed

[a]These variables contain issues of convergence.

*$P < .05$.

TABLE 5

Subgroup Analyses for the Association between School Start Time and Youth Outcomes by Later School Start Time

Developmental Outcomes	Initial School Start Time	*n*	*m*	*ES*	95% CI		*P*
					Lower	Upper	
Aggregated outcome	7:30 to 7:59	3	24	—	—	—	—
	8:00 to 8:29	11	117	0.037	−0.046	0.120	.34
	8:30 to 8:59	11	123	0.100	0.018	0.182	.02*
	9 or after	4	78	—	—	—	—
Sleep	7:30 to 7:59	3	17	—	—	—	—
	8:00 to 8:29	9	89	0.026	−0.048	0.099	.44
	8:30 to 8:59	11	94	0.141	0.032	0.250	.02*
	9 or after	4	52	—	—	—	—
Duration	7:30 to 7:59	3	6	—	—	—	—
	8:00 to 8:29	8	33	0.056	−0.087	0.200	.38
	8:30 to 8:59	11	24	0.184	0.029	0.339	.02*
	9 or after	3	9	—	—	—	—
Quality	7:30 to 7:59[a]	—	—	—	—	—	—
	8:00 to 8:29	4	10	—	—	—	—
	8:30 to 8:59	5	23	—	—	—	—
	9 or after	2	4	—	—	—	—
Bedtime	7:30 to 7:59	3	4	—	—	—	—
	8:00 to 8:29	6	16	0.222	−0.221	0.665	.25
	8:30 to 8:59	7	14	0.168	−0.181	0.517	.28
	9 or after	4	12	—	—	—	—
Wake time	7:30 to 7:59	3	4	—	—	—	—
	8:00 to 8:29	5	13	—	—	—	—
	8:30 to 8:59	7	13	0.015	−0.785	0.815	.96
	9 or after	3	10	—	—	—	—
Chronotype	7:30 to 7:59[a]	—	—	—	—	—	—
	8:00 to 8:29	2	2	—	—	—	—

Developmental Outcomes	Initial School Start Time	*n*	*m*	*ES*	95% CI Lower	95% CI Upper	*P*
	8:30 to 8:59	4	4	—	—	—	—
	9 or after	2	4	—	—	—	—
Sleepiness	7:30 to 7:59	2	2	—	—	—	—
	8:00 to 8:29	5	12	0.188	−0.118	0.495	.16
	8:30 to 8:59	5	12	0.448	−0.166	1.060	.11
	9 or after	3	5	—	—	—	—
Socioemotional	7:30 to 7:59	1	7	—	—	—	—
	8:00 to 8:29	1	9	—	—	—	—
	8:30 to 8:59	3	10	—	—	—	—
	9 or after	2	11	—	—	—	—
Negative	7:30 to 7:59	1	5	—	—	—	—
	8:00 to 8:29	1	6	—	—	—	—
	8:30 to 8:59	2	7	—	—	—	—
	9 or after	2	10	—	—	—	—
Academic	7:30 to 7:59[a]	—	—	—	—	—	—
	8:00 to 8:29	3	7	—	—	—	—
	8:30 to 8:59	2	2	—	—	—	—
	9 or after[a]	—	—	—	—	—	—

Age was adjusted in all analyses. Estimates with df < 4 are not considered to be reliable. ES, effect sizes assessed in correlation; *m*, number of effect sizes; —, XXX. *n*, number of studies.

*$P < .05$.

TABLE 6

Moderating Effects of Individual Characteristics for the Association Between School Start Time and Youth Outcomes

Moderator	Developmental Outcomes	Predictor	ES	95% CI Lower	95% CI Upper	*P*
Age	Aggregated outcome	Age in months	−0.005	−0.025	0.015	.56
	Sleep	Age in months	−0.006	−0.035	0.023	.60
	Duration	Age in months	—	—	—	—
	Quality	Age in months	—	—	—	—
	Bedtime	Age in months	—	—	—	—
	Wake time	Age in months	—	—	—	—
	Chronotype	Age in months	—	—	—	—
	Sleepiness	Age in months	—	—	—	—
	Socioemotional	Age in months	—	—	—	—
	Negative	Age in months	—	—	—	—
	Academic	Age in months	—	—	—	—
Sex	Aggregated outcome	Female %	—	—	—	—
	Sleep	Female %	—	—	—	—
	Duration	Female %	—	—	—	—
	Quality	Female %	—	—	—	—
	Bedtime	Female %	—	—	—	—
	Wake time	Female %	—	—	—	—
	Chronotype	Female %	—	—	—	—
	Sleepiness	Female %	—	—	—	—
	Socioemotional	Female %	—	—	—	—
	Negative	Female %	—	—	—	—
	Academic	Female %	—	—	—	—
Race	Aggregated outcome	Black % vs White %	—	—	—	—
		Latinx % vs White %	—	—	—	—
		Asian % vs White %	—	—	—	—
		Other % vs White%	—	—	—	—
	Sleep	Black % vs White %	—	—	—	—

Moderator	Developmental Outcomes	Predictor	ES	95% CI Lower	95% CI Upper	*P*
		Latinx % vs White %	—	—	—	—
		Asian % vs White %	—	—	—	—
		Other % vs White%	—	—	—	—
	Duration	Black % vs White %	—	—	—	—
		Latinx % vs White %	—	—	—	—
		Asian % vs White %	—	—	—	—
		Other % vs White%	—	—	—	—
	Quality	Black % vs White %	—	—	—	—
		Latinx % vs White %	—	—	—	—
		Asian % vs White %	—	—	—	—
		Other % vs White%	—	—	—	—
	Bedtime	Black % vs White %	—	—	—	—
		Latinx % vs White %	—	—	—	—
		Asian % vs White %	—	—	—	—
		Other % vs White%	—	—	—	—
	Aggregated outcome	Minority % vs White %	—	—	—	—
	Sleep	Minority % vs White %	—	—	—	—
	Duration	Minority % vs White %	—	—	—	—
	Quality	Minority % vs White %	—	—	—	—
	Bedtime	Minority % vs White %	—	—	—	—
	Wake time	Minority % vs White %	—	—	—	—
	Chronotype	Minority % vs White %	—	—	—	—
	Sleepiness	Minority % vs White %	—	—	—	—
	Socioemotional	Minority % vs White %	—	—	—	—
	Negative	Minority % vs White %	—	—	—	—
	Academic	Minority % vs White %	—	—	—	—

Age was adjusted in all analyses. Estimates with df < 4 are not considered to be reliable. ES, effect sizes assessed in correlation; —, refer to analyses where the degrees of freedom was less than 4, which would provide unreliable estimates, therefore estimates were not analyzed.

TABLE 7

Moderating Effects of School Characteristics for the Association Between School Start Time and Youth Outcomes

Moderator	Developmental Outcomes	Predictor	95% CI			
			ES	Lower	Upper	*P*
School level	Aggregated outcome	Middle vs Elementary	0.008	−0.084	0.101	.85
		High vs Elementary	−0.097	−0.277	0.083	.25
		High vs Middle	−0.070	−0.300	0.161	.49
	Sleep	Middle vs Elementary	−0.043	−0.209	0.123	.59
		High vs Elementary	−0.126	−0.480	0.228	.38
		High vs Middle	—	—	—	—
	Duration	Middle vs Elementary	−0.045	−0.272	0.181	.68
		High vs Elementary	−0.089	−0.610	0.432	.67
		High vs Middle	—	—	—	—
	Quality	Middle vs Elementary	—	—	—	—
		High vs Elementary	—	—	—	—
		High vs Middle	—	—	—	—
	Bedtime	Middle vs Elementary	−0.078	−0.437	0.281	.64
		High vs Elementary	—	—	—	—
		High vs Middle	—	—	—	—
	Wake time	Middle vs Elementary	0.074	−0.542	0.690	.79
		High vs Elementary	—	—	—	—
		High vs Middle	—	—	—	—
	Sleepiness	Middle vs Elementary	−0.259	−0.632	0.114	.14
		High vs Elementary	—	—	—	—
		High vs Middle	0.268	0.081	0.455	.01*
	Academic	Middle vs Elementary	—	—	—	—
		High vs Elementary	—	—	—	—
		High vs Middle	—	—	—	—
School sector	Aggregated outcome	Private vs Public	0.093	−0.018	0.204	.09***
	Sleep	Private vs Public	0.151	0.001	0.301	.04*
	Duration	Private vs Public	0.108	−0.118	0.334	.32

Moderator	Developmental Outcomes	Predictor	95% CI			
			ES	Lower	Upper	*P*
	Quality	Private vs Public	—	—	—	—
	Bedtime	Private vs Public	−0.058	−0.285	0.169	.56
	Wake time	Private vs Public	0.489	0.030	0.947	.04**
	Chronotype	Private vs Public	—	—	—	—
	Sleepiness	Private vs Public	—	—	—	—
	Socioemotional	Private vs Public	—	—	—	—
	Negative[a]	Private vs Public				
	Academic	Private vs Public	−0.138	−0.367	0.091	.18
School size	Aggregated outcome	School size	—	—	—	—
	Sleep	School size	—	—	—	—
	Duration	School size	—	—	—	—
	Quality[a]	School size				
	Bedtime	School size	—	—	—	—
	Wake time	School size	—	—	—	—
	Chronotype[a]	School size	—	—	—	—
	Sleepiness	School size	—	—	—	—
	Socioemotional[a]	School size	—	—	—	—
	Negative[a]	School size	—	—	—	—
	Academic	School size	—	—	—	—
School SES	Aggregated outcome	School FRPL %	—	—	—	—
	Sleep	School FRPL %	—	—	—	—
	Duration[a]	School FRPL %	—	—	—	—
	Quality[a]	School FRPL %	—	—	—	—
	Bedtime[a]	School FRPL %	—	—	—	—
	Wake time[a]	School FRPL %	—	—	—	—
	Chronotype[a]	School FRPL %	—	—	—	—

Moderator	Developmental Outcomes	Predictor	ES	95% CI Lower	95% CI Upper	*P*
	Sleepiness[a]	School FRPL %	—	—	—	—
	Socioemotional[a]	School FRPL %	—	—	—	—
	Negative[a]	School FRPL %	—	—	—	—
	Academic	School FRPL %	—	—	—	—
Racial or ethnic composition	Aggregated outcome	School minority %	—	—	—	—
	Sleep	School minority %	—	—	—	—
	Duration[a]	School minority %	—	—	—	—
	Quality[a]	School minority %	—	—	—	—
	Bedtime[a]	School minority %	—	—	—	—
	Wake time[a]	School minority %	—	—	—	—
	Chronotype[a]	School minority %	—	—	—	—
	Sleepiness[a]	School minority %	—	—	—	—
	Socioemotional[a]	School minority %	—	—	—	—
	Negative[a]	School minority %	—	—	—	—
	Academic	School minority %	—	—	—	—
Urbanicity	Aggregated outcome	Suburb vs Urban	0.160	−0.147	0.468	.25
		Rural vs Urban	—	—	—	—
		Rural vs Suburb	—	—	—	—
	Sleep	Suburb vs Urban	−0.070	−0.584	0.444	.73
		Rural vs Urban	—	—	—	—
		Rural vs Suburb	0.012	−0.135	0.159	.84
	Duration	Suburb vs Urban	−0.024	−0.659	0.611	.92
		Rural vs Urban	—	—	—	—
		Rural vs Suburb	−0.036	−0.228	0.157	.65
	Sleepiness	Suburb vs Urban	—	—	—	—
		Rural vs Urban	—	—	—	—

Moderator	Developmental Outcomes	Predictor	ES	95% CI Lower	95% CI Upper	*P*
		Rural vs Suburb	—	—	—	—
	Academic	Suburb vs Urban	—	—	—	—
		Rural vs Urban	—	—	—	—
		Rural vs Suburb	—	—	—	—
Region	Aggregated outcome	South vs West	0.057	−0.203	0.316	.59
		Northeast vs West	0.006	−0.144	0.156	.92
		Midwest vs West	—	—	—	—
		Multi vs West	0.004	−0.122	0.129	.94
		Northeast vs South	−0.003	−0.183	0.177	.96
		Midwest vs South	—	—	—	—
		Multi vs South	−0.002	−0.153	0.148	.97
		Midwest vs Northeast	—	—	—	—
		Multi vs Northeast	0.003	−0.110	0.116	.95
		Multi vs Midwest	0.006	−0.119	0.132	.89
	Sleep	South vs West	—	—	—	—
		Northeast vs West	—	—	—	—
		Midwest vs West	—	—	—	—
		Multi vs West	—	—	—	—
		Northeast vs South	—	—	—	—
		Midwest vs South	—	—	—	—
		Multi vs South	—	—	—	—
		Midwest vs Northeast	—	—	—	—
		Multi vs Northeast	0.076	−0.108	0.260	.34
		Multi vs Midwest	—	—	—	—
	Duration	South vs West	—	—	—	—
		Northeast vs West	—	—	—	—
		Midwest vs West	—	—	—	—
		Multi vs West	—	—	—	—
		Northeast vs South	—	—	—	—
		Midwest vs South	—	—	—	—

Moderator	Developmental Outcomes	Predictor	ES	95% CI Lower	95% CI Upper	*P*
		Multi vs South	—	—	—	—
		Midwest vs Northeast	—	—	—	—
		Multi vs Northeast	0.100	−0.175	0.374	.40
		Multi vs Midwest	—	—	—	—
Geography	Aggregated outcome	EU vs NA	—	—	—	—
		Asia vs NA	0.018	−0.137	0.173	.77
		Asia vs EU	0.119	−0.052	0.289	.13
	Sleep	EU vs NA	—	—	—	—
		Asia vs NA	0.038	−0.156	0.232	.63
		Asia vs EU	0.101	−0.108	0.311	.26
	Duration	EU vs NA	—	—	—	—
		Asia vs NA	−0.054	−0.273	0.164	.55
		Asia vs EU	—	—	—	—
	Quality[1]	EU vs NA[1]	—	—	—	—
		Asia vs NA[1]	—	—	—	—
		Asia vs EU[1]	—	—	—	—
	Bedtime	EU vs NA	−0.209	−0.346	−0.071	.007**
		Asia vs NA	0.251	−0.312	0.813	.31
		Asia vs EU	—	—	—	—
	Wake time[1]	EU vs NA[1]	—	—	—	—
		Asia vs NA[1]	—	—	—	—
		Asia vs EU[a]	—	—	—	—
	Chronotype[a]	EU vs NA[a]	—	—	—	—
		Asia vs NA[a]	—	—	—	—
		Asia vs EU[a]	—	—	—	—
	Sleepiness	EU vs NA	—	—	—	—
		Asia vs NA	0.294	−0.247	0.834	.24
		Asia vs EU	—	—	—	—

Moderator	Developmental Outcomes	Predictor	95% CI			
			ES	Lower	Upper	*P*
	Socioemotional	EU vs NA	—	—	—	—
		Asia vs NA	0.095	−0.006	0.197	.06***
		Asia vs EU	—	—	—	—
	Negative	EU vs NA	—	—	—	—
		Asia vs NA	—	—	—	—
		Asia vs EU	—	—	—	—
	Academic	EU vs NA	−0.214	−0.430	0.001	.05***
		Asia vs NA	−0.158	−0.374	0.057	.12
		Asia vs EU	0.056	—	—	—

Age was adjusted in all analyses. Estimates with df < 4 are not considered to be reliable. ES, effect sizes assessed in correlation; —, refer to analyses where the degrees of freedom was less than 4, which would provide unreliable estimates, therefore estimates were not analyzed.

[a]These variables contain issues of convergence.

*$P < .05$

**$P < .01$

***$P < .001$.

TABLE 8

Subgroup Analyses for the Association Between School Start Time and Youth Outcomes by Youth and School Characteristics

Moderator	Developmental Outcomes	Category	*n*	*k*	ES	95% CI Lower	95% CI Upper	*P*
School level	Aggregated outcome	Elementary school	5	46	0.113	0.055	0.171	.006**
		Middle school	11	147	0.062	−0.023	0.147	.13
		High school	21	304	0.045	−0.001	0.091	.05***
		Secondary school	22	336	0.058	0.004	0.112	.03*
	Sleep	Elementary school	4	34	—	—	—	—
		Middle school	9	91	0.032	−0.142	0.207	.68
		High school	20	228	0.034	−0.035	0.103	.32
		Secondary school	19	229	0.044	−0.040	0.128	.28
	Duration	Elementary school	4	14	—	—	—	—
		Middle school	9	37	0.087	−0.147	0.322	.42
		High school	18	72	0.096	0.007	0.185	.03*
		Secondary school	18	74	0.098	−0.012	0.209	.08***
	Quality	Elementary school[a]	—	—	—	—	—	—
		Middle school	3	5	—	—	—	—
		High school	8	37	−0.068	−0.130	−0.006	.04*
		Secondary school	8	37	−0.050	−0.126	0.027	.16
	Bedtime	Elementary school	3	7	—	—	—	—
		Middle school	6	18	0.077	−0.171	0.325	.46
		High school	14	45	0.047	−0.072	0.167	.42
		Secondary school	12	43	0.014	−0.053	0.080	.66
	Wake time	Elementary school	3	7	—	—	—	—
		Middle school	6	17	0.015	−0.368	0.399	.92
		High school	11	38	0.092	−0.173	0.356	.46
		Secondary school	10	37	−0.179	−0.422	0.064	.13
	Chronotype	Elementary school[a]	—	—	—	—	—	—

Moderator	Developmental Outcomes	Category	*n*	*k*	ES	95% CI Lower	95% CI Upper	*P*
		Middle school[a]	—	—	—	—	—	—
		High school	6	9	−0.037	−0.189	0.115	.55
		Secondary school	5	8	—	—	—	—
	Sleepiness	Elementary school	2	6	—	—	—	—
		Middle school	4	12	—	—	—	—
		High school	9	18	0.144	−0.042	0.329	.11
		Secondary school	9	21	0.127	−0.065	0.318	.16
	Socioemotional	Elementary school[a]	—	—	—	—	—	—
		Middle school	3	19	—	—	—	—
		High school	7	34	0.052	−0.006	0.110	.07†
		Secondary school	7	34	0.052	−0.006	0.110	.07†
	Negative	Elementary school[a]	—	—	—	—	—	—
		Middle school	3	14	—	—	—	—
		High school	6	22	0.068	0.003	0.132	.04*
		Secondary school	6	22	0.068	0.003	0.132	.04*
	Academic	Elementary school	1	10	—	—	—	—
		Middle school	3	29	—	—	—	—
		High school	5	13	−0.050	−0.147	0.047	.22
		Secondary school	7	40	0.028	−0.162	0.217	.73
School sector	Aggregated outcome	Public school	20	254	0.050	−0.010	0.110	.09†
		Private school	7	74	0.122	0.033	0.210	.01*
	Sleep	Public school	17	171	0.026	−0.066	0.118	.55
		Private school	7	66	0.129	0.038	0.220	.01*
	Duration	Public school	15	55	0.088	−0.044	0.220	.17
		Private school	7	23	0.149	0.018	0.281	.03*
	Quality	Public school	8	22	—	—	—	—
		Private school	2	10	—	—	—	—
	Bedtime	Public school	10	30	0.001	−0.106	0.107	.99

Moderator	Developmental Outcomes	Category	*n*	*k*	ES	95% CI Lower	95% CI Upper	*P*
		Private school	4	11	—	—	—	—
	Wake time	Public school	10	28	0.081	−0.252	0.414	.60
		Private school	4	10	—	—	—	—
	Chronotype	Public school	5	7	—	—	—	—
		Private school	2	4	—	—	—	—
	Sleepiness	Public school	8	18	0.044	−0.026	0.113	.17
		Private school	2	5	—	—	—	—
	Socioemotional	Public school	5	24	—	—	—	—
		Private school	1	4	—	—	—	—
	Negative	Public school	4	15	—	—	—	—
		Private school[a]	—	—	—	—	—	—
	Academic	Public school	6	49	0.051	−0.178	0.280	.59
		Private school[a]	—	—	—	—	—	—
Urbanicity	Aggregated outcome	Urban	9	139	0.113	−0.023	0.249	.09***
		Suburb	6	34	0.127	−0.056	0.310	.13
		Rural	2	14	—	—	—	—
	Sleep	Urban	7	89	0.087	−0.031	0.205	.12
		Suburb	4	16	—	—	—	—
		Rural[a]	—	—	—	—	—	—
	Duration	Urban	7	23	0.131	−0.025	0.286	.08***
		Suburb	4	6	—	—	—	—
		Rural[a]	—	—	—	—	—	—
	Quality	Urban	2	22	—	—	—	—
		Suburb[a]	—	—	—	—	—	—
		Rural[a]	—	—	—	—	—	—
	Bedtime	Urban	5	14	—	—	—	—
		Suburb	2	3	—	—	—	—

Moderator	Developmental Outcomes	Category	*n*	*k*	ES	95% CI Lower	95% CI Upper	*P*
		Rural[a]	—	—	—	—	—	—
	Wake time	Urban	4	13	—	—	—	—
		Suburb[a]	—	—	—	—	—	—
		Rural[a]	—	—	—	—	—	—
	Chronotype	Urban	2	3	—	—	—	—
		Suburb[a]	—	—	—	—	—	—
		Rural[a]	—	—	—	—	—	—
	Sleepiness	Urban	4	12	—	—	—	—
		Suburb	2	4	—	—	—	—
		Rural[a]	—	—	—	—	—	—
	Socioemotional	Urban	2	15	—	—	—	—
		Suburb[a]	—	—	—	—	—	—
		Rural[a]	—	—	—	—	—	—
	Negative	Urban	2	11	—	—	—	—
		Suburb[a]	—	—	—	—	—	—
		Rural[a]	—	—	—	—	—	—
	Academic	Urban	3	14	—	—	—	—
		Suburb	2	12	—	—	—	—
		Rural[a]	—	—	—	—	—	—
Region	Aggregated outcome	West	2	19	—	—	—	—
		South	4	24	—	—	—	—
		Northeast	7	113	0.078	−0.049	0.205	.18
		Midwest	3	40	—	—	—	—
		Multi	5	57	—	—	—	—
	Sleep	West	2	17	—	—	—	—
		South	2	7	—	—	—	—

Moderator	Developmental Outcomes	Category	*n*	*k*	ES	95% CI Lower	95% CI Upper	*P*
		Northeast	7	89	0.082	−0.052	0.216	.18
		Midwest	2	7	—	—	—	—
		Multi	5	53	—	—	—	—
	Duration	West	2	4	—	—	—	—
		South	2	3	—	—	—	—
		Northeast	7	20	0.127	−0.030	0.284	.09***
		Midwest	2	3	—	—	—	—
		Multi	5	18	—	—	—	—
	Quality	West[a]	—	—	—	—	—	—
		South[a]	—	—	—	—	—	—
		Northeast	3	8	—	—	—	—
		Midwest			—	—	—	—
		Multi	2	9	—	—	—	—
	Bedtime	West	2	4	—	—	—	—
		South[a]	—	—	—	—	—	—
		Northeast	7	20	−0.004	−0.118	0.110	.94
		Midwest[a]	—	—	—	—	—	—
		Multi	3	10	—	—	—	—
	Wake time	West	2	4	—	—	—	—
		South[a]	—	—	—	—	—	—
		Northeast	6	16	0.211	−0.165	0.587	.21
		Midwest[a]	—	—	—	—	—	—
		Multi	3	10	—	—	—	—
	Chronotype	West[a]	—	—	—	—	—	—
		South[a]	—	—	—	—	—	—
		Northeast	2	4	—	—	—	—
		Midwest[a]	—	—	—	—	—	—

Moderator	Developmental Outcomes	Category	*n*	*k*	ES	95% CI Lower	95% CI Upper	*P*
		Multi[a]	—	—	—	—	—	—
	Sleepiness	West[a]	—	—	—	—	—	—
		South[a]	—	—	—	—	—	—
		Northeast	4	10	—	—	—	—
		Midwest[a]	—	—	—	—	—	—
		Multi[a]	—	—	—	—	—	—
	Socioemotional	West[a]	—	—	—	—	—	—
		South[a]	—	—	—	—	—	—
		Northeast[a]	—	—	—	—	—	—
		Midwest[a]	—	—	—	—	—	—
		Multi[a]	—	—	—	—	—	—
	Negative	West[a]	—	—	—	—	—	—
		South[a]	—	—	—	—	—	—
		Northeast[a]	—	—	—	—	—	—
		Midwest[a]	—	—	—	—	—	—
		Multi[a]	—	—	—	—	—	—
	Academic	West[a]	—	—	—	—	—	—
		South	2	12	—	—	—	—
		Northeast	2	4	—	—	—	—
		Midwest	1	33	—	—	—	—
		Multi[a]	—	—	—	—	—	—
Geography	Aggregated outcome	NA	19	278	0.061	0.002	0.119	.04*
		EU	3	36	—	—	—	—
		Asia	4	117	—	—	—	—

Moderator	Developmental Outcomes	Category	*n*	*k*	ES	95% CI Lower	95% CI Upper	*P*
	Sleep	NA	16	196	0.035	−0.049	0.119	.39
		EU	3	12	—	—	—	—
		Asia	4	89	—	—	—	—
	Duration	NA	15	53	0.082	−0.021	0.186	.11
		EU	2	5	—	—	—	—
		Asia	4	33	—	—	—	—
	Quality	NA	7	21	—	—	—	—
		EU[a]	—	—	—	—	—	—
		Asia	2	19	—	—	—	—
	Bedtime	NA	12	44	0.052	−0.086	0.189	.42
		EU	1	2	−0.157	—	—	—
		Asia	4	12	—	—	—	—
	Wake time	NA	11	40	0.076	−0.206	0.358	.56
		EU[a]	—	—	—	—	—	—
		Asia	3	11	—	—	—	—
	Chronotype	NA	5	9	—	—	—	—
		EU	2	3	—	—	—	—
		Asia[a]	—	—	—	—	—	—
	Sleepiness	NA	6	12	0.100	−0.081	0.280	.21
		EU	2	2	—	—	—	—
		Asia	4	14	—	—	—	—
	Socioemotional	NA	4	17	—	—	—	—
		EU	1	2	—	—	—	—
		Asia	3	24	—	—	—	—
	Negative	NA	3	13	—	—	—	—
		EU[a]	—	—	—	—	—	—
		Asia	3	17	—	—	—	—
	Academic	NA	6	50	0.075	−0.141	0.290	.41

Moderator	Developmental Outcomes	Category	*n*	*k*	ES	95% CI Lower	95% CI Upper	*P*
		EU[a]	—	—	—	—	—	—
		Asia[a]	—	—	—	—	—	—

Age was adjusted in all analyses. Estimates with df < 4 are not considered to be reliable. ES, effect sizes assessed in correlation; EU, European Union; *m*, number of effect sizes; *n*, number of studies; NA, North America; —, refer to analyses where the degrees of freedom was less than 4, which would provide unreliable estimates, therefore estimates were not analyzed.

[a]These variables contain issues of convergence.

*$P < .05$

***$P < .001$

+$P < .10$.