

Children with more sleep problems could also feel lonelier: a latent profile analysis

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Abstract

Sleep problems are common during childhood and have been associated with adverse emotional, behavioural, and psychosocial outcomes. Although previous research has linked poor sleep with loneliness, little is known about how patterns of sleep problems relate to loneliness during middle childhood. This study aimed to identify sleep problem profiles across two assessment waves and examine whether these profiles were associated with loneliness at the later assessment, after accounting for earlier loneliness and demographic characteristics. Data were drawn from the Development of Emotional Resilience cohort of primary school children in East London ($N = 879$ at baseline; aged 7–11 years; 47.7% male; 57.5% British Asian). Latent profile analysis included 778 children and identified low (53.6%), moderate (36.2%), and high (10.2%) sleep problem profiles. After adjustment for T2 loneliness, sex, age, ethnicity, and Index of Multiple Deprivation, sleep profile was significantly associated with T3 loneliness, $F(2, 445) = 11.30, p < .001$. Bonferroni-adjusted comparisons showed higher loneliness in the moderate than low (mean difference = 0.44, $p = .010$) and high than low profiles (mean difference = 1.06, $p < .001$). Future research is needed to clarify the direction of this association and the mechanisms linking sleep and loneliness over development.

Introduction

Loneliness, a subjective and distressing experience that occurs when individuals perceive their social relationships as inadequate or unsatisfactory [1] has become an urgent global health issue with governmental and non-governmental organisations worldwide highlighting the urgent need for interventions that promote social connection [2]. Loneliness has significant impacts on health, wellbeing, and society [3, 4, 5] with recent data suggesting that these feelings can be common during certain life transitions. This includes adolescence and young adulthood, where, as with adults, loneliness can be associated with poorer mental health, greater health complaints, and lower educational attainment [5, 6, 7]. Within research on loneliness, middle childhood, a period characterised by substantial social and emotional development, with increasing participation in peer relationships and the acquisition of more advanced social and emotional skills [8] remains under-studied. Although children were once thought to lack the cognitive maturity to experience loneliness, research suggests that they are able to recognise and report feelings of loneliness as a subjective emotional experience that is distinct from simply being alone [1]. Understanding loneliness during this developmental period is therefore also important especially as we recently demonstrated negative health correlates of loneliness in pre-adolescent children [9] and others have highlighted the paucity of evidence-based interventions for this age group [10, 11]. In the present study, we explore the role of sleep as a precursory factor contributing to loneliness outcomes in pre-adolescents. We focus on sleep because of a) evidence in adults of cross-sectional and longitudinal associations between sleep and loneliness [12]; b) there are plausible biological and psychosocial mechanisms by which sleep can impact loneliness in youth [13, 14, 15]; and c) sleep is a modifiable factor targeted by several preventative interventions [16].

Sleep is a fundamental biological process that plays a critical role in children's development and their physical, emotional, social, and cognitive functioning [17–23]. Sleep disturbances encompass a range of difficulties, including problems with bedtime routines and behaviours, sleep onset, sleep quality and duration, sleep-related anxiety, abnormal sleep events, disruptive nocturnal behaviours (e.g., nightmares, parasomnias, night terrors, restless sleep, and night awakenings), and daytime impairments [24, 25]. Sleep problems are highly prevalent among typically developing children, affecting approximately 25–50% worldwide [26, 25], and are commonly associated with several mental health conditions, including depression, anxiety, and bipolar disorder [27]. More recently, growing evidence suggests that sleep and loneliness are closely interconnected too, with poor sleep quality and insomnia consistently associated with increased feelings of loneliness alongside poorer mental health outcomes [28, 29]. However, this literature is mostly dominated by cross-sectional research in adults. A meta-analysis of 84 articles comprising 110 samples, including over 227,000 participants, found that 108 samples contributed to cross-sectional analyses, whereas only six examined sleep problems in relation to subsequent loneliness and six examined loneliness in relation to subsequent sleep problems. The meta-analysis found a moderate cross-sectional association between overall sleep problems and loneliness, alongside significant longitudinal associations, indicating that sleep problems and loneliness may influence one another over time.

However, only 14 (12.7%) of the 110 samples were classified as child/adolescent samples, highlighting an important gap in the evidence for younger populations [12]. Within this research, findings among adolescents and young adults have shown that poorer sleep patterns are cross-sectionally associated with greater loneliness and depressive symptoms, with associations also observed between sleep patterns and academic engagement reported for a subsequent period [23]. However, in late childhood, these findings are even less consistent. Harris et al. [30] found that children aged 8–11 with relatively high but decreasing loneliness reported greater subsequent sleep disturbance than those with low, stable loneliness. In contrast, Eccles et al. [10] found no significant differences in parent-reported sleep outcomes across loneliness trajectories among young adolescents aged 10–13 years. Considerably less is known about whether sleep problems are associated with subsequent loneliness in children despite there being plausible mechanisms that exist through which sleep problems may contribute to loneliness. Poor sleep may affect emotional and behavioural functioning in children and adolescents, including emotion regulation, which could in turn interfere with social interactions and relationships [31, 14, 15]. Sleep loss has also been associated with altered emotional reactivity and social functioning, including changes in amygdala activity and its prefrontal regulation, providing a possible neurobiological pathway through which poor sleep could affect children's social experiences [13].

These findings highlight the need for further research examining the relationship between loneliness and sleep, particularly during middle childhood, where evidence remains limited and inconsistent. This developmental period is characterised by increasing participation in peer relationships and the acquisition of more advanced social and emotional skills, making it a particularly important stage for understanding how sleep and loneliness may relate to each other [8, 10, 28]. Such research is especially important given the emerging sex differences in both sleep problems and psychosocial functioning during this developmental stage, with girls often reporting poorer sleep, greater loneliness, and worse mental health outcomes than boys [32]. Furthermore, both loneliness and sleep difficulties disproportionately affect children and adolescents from socioeconomically disadvantaged backgrounds, reinforcing the need to understand these relationships within the context of health inequalities, where adequate sleep has increasingly been recognised as a social privilege rather than solely an individual behaviour [33, 34].

Although previous research has identified distinct sleep profiles in children and adolescents and demonstrated that these profiles are associated with differences in emotional, behavioural, and academic functioning [35, 23], no study, to our knowledge, has examined whether children with different patterns of sleep problems differ in levels of loneliness during middle childhood. Identifying such profiles could help identify children who may be at greater risk of loneliness and inform the development of more targeted prevention and intervention strategies. Therefore, the present study focused on primary school children aged 8–12 years growing up in East London, a geographically and socioeconomically diverse area that includes neighbourhoods with high levels of child poverty, where children and families are exposed to multiple stressors that may adversely affect both sleep and psychosocial functioning. It was hypothesised that distinct profiles characterised by low, moderate, and high levels of sleep problems would emerge and that children belonging to profiles with greater sleep problems would report higher levels of loneliness at T3, after accounting for T2 loneliness and demographic characteristics.

Method

Sample

Our participants were drawn from the Development of Emotional Resilience (DEER) observational cohort study (van Loggerenberg et al., 2025), a longitudinal study investigating emotional risk and resilience in primary school children attending schools in East London. The study received ethical approval by Queen Mary Research Ethics Committee (ref: QMERC22.251) and comprised three waves of data collection. Time 1 (T1) took place between November 2022 and November 2023, Time 2 (T2) between February and October 2024, and Time 3 (T3) between November 2024 and July 2025. Children were recruited from 10 primary schools across East London. Schools that expressed an interest in taking part were visited by members of the research team, who introduced the study to pupils during a school assembly. Parents were then provided with an information sheet and invited to consent to their child's participation using either an opt-in or opt-out procedure, depending on the school's preference. All participating children provided written assent before completing any study activities. At each wave, children completed questionnaires and experimental tasks using Android tablets during school hours. Assessments were administered through Qualtrics [58] and REDCap [56, 57], with trained research assistants available throughout to explain instructions and answer questions. Teachers also completed questionnaires about each participating child's behavioural and emotional functioning.

At T1, the sample comprised 879 children aged 7–11 years ($M = 8.76$, $SD = 0.95$), of whom 47.7% were male and 46.5% were female. Over half of the participants identified as Asian or Asian British (57.5%). Of the original cohort, 757 children (86.1%) participated at T2 and 491 (55.9%) at T3. The present study draws on data collected at T2 and T3, when the key measures of sleep problems, loneliness, and demographic characteristics were available. As many children had moved from primary to secondary school by T3, selective attrition analyses were conducted to examine whether those who remained in the study differed from those who no longer participated especially on key variables of sleep and loneliness. Children who completed the T3 assessment reported slightly higher sleep problem scores at T2 ($M = 37.15$) than those who did not complete T3 ($M = 35.56$), $t(483.92) = 3.14$, $p = .002$. This effect was small and likely reflects the accelerated cohort design, whereby many children transitioned to secondary school before T3. There was no significant difference in T2 loneliness between children who completed the T3 assessment and those who did not ($M = 4.64$ vs. $M = 4.44$), $t(603.84) = -1.66$, $p = .097$.

Measures

Sleep problems

Sleep problems were assessed at T2 and T3 using the Sleep Self-Report (SSR) [24], a self-report questionnaire designed to assess sleep and circadian difficulties in school-aged children. The SSR comprises 26 items assessing bedtime routines, sleep behaviours, sleep quality, and daytime sleepiness, with responses rated on a 3-point Likert scale ranging from rarely (0–1 times per week or never) to usually (5–7 times per week). Example items include "Is it hard for you to go to bed?", "Do you sometimes go to someone else's bed during the night?", and "Do you have trouble waking up in the morning?" Positively worded items were reverse scored so that higher total scores reflected greater sleep problems. The SSR demonstrated good internal consistency in the present sample (Cronbach's $\alpha = .79$ at T2 and $\alpha = .82$ at T3). Previous research has demonstrated good convergent validity with established parent-report sleep measures, including the Children's Sleep Habits Questionnaire [48, 47], and good discriminant validity in distinguishing typically developing children from those with clinical sleep disorders and other forms of psychopathology [48, 49]. The SSR was administered only at T2 and T3 because it was omitted from the baseline (T1) assessment to minimise participant burden during the initial phase of the DEER study.

Loneliness

Loneliness was assessed at T1, T2 and T3 using a modified version of the three-item University of California, Los Angeles Loneliness Scale (UCLA-3A), adapted by The Children's Society (2019) for use with children and adolescents. The measure assesses three aspects of loneliness: how often they felt that they had no one to talk to, how often they felt left out, and how often they felt alone [50]. Responses were rated on a three-point Likert scale ("Hardly ever or never", "Some of the time", and "Often"). In the present study, we used loneliness data collected at T2 and T3. The scale demonstrated acceptable internal consistency at both assessment waves (Cronbach's $\alpha = .72$ at T2 and Cronbach's $\alpha = .73$ at T3). Item scores were summed to produce a total loneliness score, with higher scores indicating greater perceived loneliness.

Data Analysis

To identify distinct patterns of sleep problems over time, latent profile analysis LPA [51] was conducted using children's sleep problem scores at Time 2 (T2) and Time 3 (T3). LPA is a person-centred approach that identifies unobserved subgroups based on similarities in individuals' scores across multiple

continuous indicators [52]. Given that sleep was assessed at two time points, LPA was selected to identify groups of children with similar longitudinal patterns of sleep problems rather than to model developmental trajectories.

Latent profile models were estimated using a custom implementation in OpenMx [53] with full-information maximum likelihood FIML, [54]. OpenMx is an open-source structural equation modelling package that provides the flexibility to specify and estimate latent profile models using maximum likelihood estimation. All available sleep data contributed to parameter estimation under the assumption that data were missing at random. Of the 879 children in the dataset from baseline, 765 had sleep data at T2 and 485 had sleep data at T3. Overall, 472 children had sleep data at both waves, 293 had T2 sleep data only, 13 had T3 sleep data only, and 101 had no sleep data at either wave. Consequently, 778 children with at least one observed sleep score contributed to the FIML analyses.

Models specifying between one and four profiles were estimated to evaluate solutions of increasing complexity while maintaining parsimony given the sample size and number of sleep indicators. Multiple random starts were used to reduce the risk of converging on suboptimal maximum likelihood solutions. Consistent with recommendations for latent profile analysis, model selection was based on the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), sample-size adjusted Bayesian Information Criterion (SABIC), together with the substantive interpretability and parsimony of the resulting profile solutions [52]. Classification quality was additionally evaluated using entropy and average posterior probabilities, with higher values indicating clearer separation between profiles. Following model selection, children were assigned to their most likely latent profile based on posterior probabilities, and average posterior probabilities were examined to evaluate classification quality.

Demographic predictors of profile membership were examined using multinomial logistic regression, implemented in the nnet package [55]. Sleep profile membership served as the dependent variable, while sex, age, ethnicity, and Index of Multiple Deprivation (IMD) score were entered simultaneously as predictors. The low sleep problems profile was specified as the reference category, and odds ratios (ORs), 95% confidence intervals, and p values are reported.

To examine whether loneliness differed across latent sleep profiles, we conducted a multiple linear regression with T3 loneliness as the dependent variable. Sleep profile membership was entered as the main predictor while adjusting for T2 loneliness, sex, age, ethnicity, and IMD score. By adjusting for T2 loneliness, the analysis examined whether longitudinal sleep profile membership was associated with differences in T3 loneliness over and above earlier levels of loneliness. This analysis was conducted using participants with complete data on the dependent variable and all covariates. As a sensitivity analysis, the latent profile analysis and regression were repeated using a complete case (children with complete data on all variables) sample to evaluate the robustness of the findings.

All analyses were pre-registered <https://osf.io/gpsw8> and are considered confirmatory.

Results

Descriptive analyses

Descriptive statistics for the study variables are presented in Table 1. Mean loneliness scores were similar across T2 and T3 (T2: M = 4.56, SD = 1.55; T3: M = 4.39, SD = 1.52). Younger children reported higher loneliness at T2 ($r = -.17, p < .001$), although this association was no longer statistically significant at T3 ($r = -.08, p = .074$). Loneliness was not significantly associated with IMD at either assessment point (both $ps > .33$). Girls reported higher loneliness than boys at both T2 ($p = .002$) and T3 ($p = .024$). Loneliness did not differ significantly across ethnic groups at either assessment wave (both $ps > .05$).

Table 1
Descriptive statistics (N = 879)

Variable	N	Range	Mean (SD)			Correlation with age (p value, 95%CI)	Correlation with IMD (p value, 95%CI)	Ethnicity Mean (SD)			
			total	male	female			Asian/Asian British	Black/African/Caribbean/ Mixed/Multiple ethnic	Other	
Child-reported											
Loneliness (T1)	837	3–9	4.96 (1.48)	4.93 (1.55)	5.00 (1.43)	-0.175 (p < .001)	0.013 (p = 0.7)	4.93 (1.49)	5.11 (1.54)	4.75 (1.63)	5.00 (1.52)
Loneliness (T2)	769	3–9	4.56 (1.55)	4.40 (1.47)	4.74 (1.60)	-0.17 (p<.001)	-0.03 (p = 0.3)	4.50 (1.54)	4.79 (1.66)	4.22 (1.39)	4.39 (1.52)
Loneliness (T3)	490	3–9	4.39 (1.52)	4.22 (1.49)	4.53 (1.53)	-0.08 (p = 0.07)	0.04 (p = 0.3)	4.35 (1.57)	4.61 (1.50)	4.14 (1.53)	4.39 (1.52)
Sleep Problems (T2)	765	23–57	36.54 (6.92)	35.81 (6.74)	37.22 (7.12)	– .21 (p<.001)	0.05 (p=.19)	36.20(6.80)	37.30 (7.30)	36.50 (7.16)	35.81 (6.74)
Sleep Problems (T3)	485	23–57	35.04 (6.99)	34.43 (6.89)	35.59 (7.07)	– .13 (p<.004)	– .02 (p=.67)	34.50(7.00)	35.60 (5.85)	34.20 (6.83)	35.59 (7.07)

Mean sleep problem scores decreased slightly from 36.54 (SD = 6.92) at T2 to 35.04 (SD = 6.99) at T3. Younger children reported significantly more sleep problems at both T2 ($r = -.21, p < .001$) and T3 ($r = -.13, p = .004$), whereas IMD was not significantly associated with sleep problems at either assessment (T2: $r = .05, p = .192$; T3: $r = -.02, p = .674$). Girls reported significantly higher sleep problem scores than boys at T2 ($M = 37.22$ vs. 35.81), $t(742.88) = -2.77, p = .006$, although the sex difference at T3 was not statistically significant ($p = .071$). Sleep problems did not differ significantly across ethnic groups at T2, $F(4, 756) = 0.91, p = .456$. At T3, there was a significant overall effect of ethnicity, $F(4, 480) = 3.17, p = .014$, with post hoc comparisons indicating that White children reported significantly higher sleep problem scores than Asian/Asian British children ($p = .014$), while no other pairwise comparisons were statistically significant.

Latent profile analysis of sleep problems

Model selection

Latent profile models comprising between one and four profiles representing distinct patterns of children's sleep problem scores across T2 and T3 were estimated and compared. Model fit generally improved as the number of profiles increased. The one profile model had a log likelihood of -4196.12, AIC of 8400.24, BIC of 8418.87, and SABIC of 8406.17. The two profile model had a log likelihood of -4081.66, AIC of 8177.32, BIC of 8209.91, and SABIC of 8187.69. The three profile model had a log likelihood of -4052.43, AIC of 8124.86, BIC of 8171.43, and SABIC of 8139.67. The four profile model had a log likelihood of -4038.73, AIC of 8103.45, BIC of 8163.99, and SABIC of 8122.71. Although the four profile model showed the lowest AIC, BIC, and SABIC values, inspection of the additional profile indicated that it represented a small subdivision of an existing profile rather than a qualitatively distinct pattern of sleep problems. Given the limited improvement in fit and the greater interpretability of the three profile solution, the three profile model was retained for subsequent analyses.

Profile characteristics

The three-profile model identified groups characterised by low, moderate, and high sleep problem scores across the two timepoints. The model estimated means for the low sleep problems profile were 31.92 at T2 and 30.34 at T3. The estimated means for the moderate sleep problems profile were 40.55 at T2 and 37.30 at T3. The high sleep problems profile had estimated means of 46.77 at T2 and 47.68 at T3 (Figure 1).

The model estimated profile proportions were 53.6% for the low profile, 36.2% for the moderate profile, and 10.2% for the high profile. Using each participant's most likely class assignment, 434 children were classified in the low sleep problems profile (55.8% of the FIML sample), 278 in the moderate profile (35.7%), and 66 in the high profile (8.5%).

The average maximum posterior probability was .876 for the low profile, .785 for the moderate profile, and .846 for the high profile. The minimum maximum posterior probabilities were .507, .502, and .520, respectively. Classification was therefore clearest for the low and high profiles and somewhat less precise for the moderate profile.

The common within-profile variance was estimated as 19.93 for T2 sleep and 17.65 for T3 sleep, corresponding to within-profile standard deviations of approximately 4.46 at T2 and 4.20 at T3.

Demographic predictors of sleep profile membership

A multinomial logistic regression was conducted to examine whether demographic characteristics predicted latent sleep profile membership using the FIML-derived profile assignments ($N = 731$), with the low sleep problems profile as the reference category. Older age was associated with lower odds of membership in both the moderate sleep problems profile ($OR = 0.62, 95\% CI [0.52, 0.75], p < .001$) and the high sleep problems profile ($OR = 0.52, 95\% CI [0.38, 0.72], p < .001$), relative to the low sleep problems profile. Girls had higher odds of membership in both the moderate sleep problems profile ($OR = 1.43, 95\% CI [1.04, 1.98], p = .028$) and the high sleep problems profile ($OR = 2.60, 95\% CI [1.45, 4.66], p = .001$). IMD score was associated with greater odds of membership in the high sleep problems profile ($OR = 1.04, 95\% CI [1.01, 1.08], p = .025$). Ethnicity was not significantly associated with profile membership (all $ps > .05$).

Loneliness across sleep profiles

The latent profile analysis was estimated using FIML and included 778 children with at least one observed sleep score. Subsequent analyses examining loneliness at T3 were restricted to the 456 children with complete data on T2 and T3 loneliness and all demographic covariates.

The overall regression model was statistically significant, $F(10, 445) = 12.27, p < .001$, explaining 21.6% of the variance in T3 loneliness ($R^2 = .216$; adjusted $R^2 = .199$). The residual standard error was 1.36. Sleep profile membership was significantly associated with T3 loneliness after adjustment for loneliness at T2 and all demographic covariates, $F(2, 445) = 11.30, p < .001$.

Adjusted profile means and pairwise comparisons

After adjustment for T2 loneliness, sex, age, ethnicity, and IMD score, the estimated marginal mean for loneliness at T3 was 4.14 (SE = 0.12, 95% CI [3.92, 4.37]) in the low sleep problems profile, 4.59 (SE = 0.13, 95% CI [4.33, 4.84]) in the moderate profile, and 5.21 (SE = 0.22, 95% CI [4.78, 5.63]) in the high profile (see Figure 2).

Bonferroni-adjusted pairwise comparisons indicated that children in the low sleep problems profile reported significantly lower loneliness than those in the moderate profile (mean difference = -0.44, SE = 0.15, adjusted $p = .010$) and the high profile (mean difference = -1.06, SE = 0.23, adjusted $p < .001$). Children

in the moderate sleep problems profile also reported significantly lower loneliness than those in the high profile (mean difference = -0.62, SE = 0.23, adjusted $p = .019$). These comparisons demonstrated a graded pattern, with loneliness increasing from the low to the moderate and high sleep problems profiles.

Loneliness at T2 was a significant positive predictor of loneliness at T3 ($B = 0.30$, SE = 0.05, $t = 6.45$, $p < .001$). A one unit increase in T2 loneliness was associated with an approximately 0.30-unit increase in loneliness at T3.

Sex, age, ethnicity, and IMD score were not significantly associated with T3 loneliness. Full regression coefficients for all predictors included in the adjusted model are presented in Supplementary Table S1.

Sensitivity analyses (complete-case analysis)

Sensitivity analyses using complete cases yielded findings that were largely consistent with the primary FIML analyses (see Supplementary Materials). A three-profile solution was again retained, and children in the moderate and high sleep problems profiles reported significantly higher T3 loneliness than those in the low sleep problems profile after adjustment for T2 loneliness and demographic characteristics. However, unlike the primary analysis, loneliness did not differ significantly between the moderate and high sleep problems profiles.

Discussion

In this study, we examined whether children with distinct profiles of sleep problems differed in loneliness in a sample of primary school children from East London, a geographically, ethnically, and socioeconomically diverse area characterised by high levels of social disadvantage [36, 37]. We used a person-centred latent profile analysis of sleep problems across two waves of data collection (T2 and T3) and examined the differences in loneliness at T3 between the identified sleep profiles while adjusting for loneliness at T2, sex, age, ethnicity, and neighbourhood deprivation. Grounded in previous literature, we hypothesised that distinct profiles characterised by low, moderate, and high levels of sleep problems would emerge and that children belonging to profiles with greater sleep problems would also report higher levels of loneliness. The findings supported our hypotheses. Three distinct sleep profiles, characterised by low, moderate, and high levels of sleep problems, were identified and children in the moderate and high sleep problems profiles reported significantly higher levels of loneliness at T3 than those in the low sleep problems profile after adjustment for loneliness at T2 and demographic characteristics. Together, these findings indicate that higher levels of sleep problems were associated with higher levels of loneliness in this sample of primary school children.

We identified three distinct profiles characterised by low, moderate, and high levels of sleep problems. This finding supports the view that sleep problems are heterogeneous during middle childhood, with children differing in their patterns of sleep problems rather than representing a single homogeneous population, consistent with previous person-centred research. For example, Mitchell et al. [35] identified three distinct sleep profiles among elementary school children that differed in levels of sleep disturbance and daytime impairment. Similarly, Williamson et al. [38] identified five longitudinal sleep trajectories from infancy to middle childhood, including a persistent sleep problems group, and showed that children with persistent sleep problems experienced poorer psychological wellbeing, academic functioning, and health related quality of life than children with more favourable sleep trajectories. McVeigh et al. [39] also identified three developmental trajectories of sleep problems across childhood and adolescence and found that persistent sleep problems were associated with poorer physical and mental health in young adulthood. Taken together, these studies suggest that sleep problems cluster into distinct developmental patterns that are associated with important differences in children's psychosocial and health outcomes. Consistent with this previous longitudinal research, our findings indicate that these patterns are also associated with differences in later loneliness during middle childhood. Importantly, these differences remained after adjustment for loneliness at T2 and demographic characteristics, extending previous research by demonstrating that longitudinal sleep profiles derived from sleep problems assessed across two time points, are also associated with loneliness during middle childhood.

Children in the moderate and high sleep problems profiles reported higher levels of loneliness than children in the low sleep problems profile, even after adjustment for loneliness at T2 and demographic characteristics. This finding is consistent with a substantial body of research showing that sleep problems are associated with poorer emotional, behavioural, and mental health outcomes across childhood and adolescence [40, 41]. However, the present findings extend this literature by suggesting that loneliness may represent another important psychosocial correlate of persistent sleep problems during middle childhood. This extends previous evidence linking poor sleep with loneliness, which has primarily been reported in adults [12], although more recent research has also identified similar associations in a racially and ethnically diverse sample of adolescents [42]. Our findings further extend this literature by demonstrating a similar association during middle childhood. Longitudinal research has also suggested that negative peer relationships and poor sleep may influence one another over time [43]. Our findings also align with Sasser et al. [23], who found that poorer sleep patterns were associated with greater loneliness and poorer psychosocial functioning among university students. Our findings differ somewhat from those of Eccles et al. [10], who found no significant differences in parent-reported sleep outcomes across loneliness trajectories among adolescents aged 10–13 years. Importantly, the association between sleep profiles and loneliness remained after adjustment for T2 loneliness and demographic characteristics, indicating that the higher loneliness observed among children with moderate and high sleep problems was not explained solely by their earlier levels of loneliness. Nevertheless, because sleep profile membership was based partly on sleep assessed at T3 and loneliness was also assessed at T3, these findings should not be interpreted as evidence that sleep problems caused later loneliness. Rather, children experiencing greater sleep problems across the two assessment waves reported higher levels of loneliness at T3, even after accounting for earlier levels of loneliness and demographic characteristics.

The association between sleep difficulties and loneliness may be particularly important during middle childhood, as peer relationships become increasingly important to children's emotional wellbeing. During this developmental stage, children become increasingly able to evaluate their friendships and social inclusion, and loneliness is closely related to peer acceptance, victimisation, friendship availability, and friendship quality [1]. Good sleep may support emotion regulation, attention, and social competence, which may facilitate successful engagement with peers and the development of positive peer relationships [18, 14, 44]. Conversely, persistent sleep difficulties may interfere with children's ability to establish and maintain positive peer relationships. Sleep difficulties can contribute to daytime tiredness, irritability, impaired emotion regulation, and reduced social engagement, all of which may hinder

children's ability to initiate and maintain positive peer relationships [18, 14]. Consistent with this, sleep disturbances have also been associated with bullying victimisation during adolescence [45], and the association between poor sleep and loneliness has been shown to be strongest among individuals who have experienced victimisation or maltreatment [29]. In addition to these social pathways, there may also be biological mechanisms underlying this association. Experimental and neurobiological research suggests that sleep loss can alter neural processes involved in emotion regulation and emotional reactivity, including amygdala activity and its prefrontal regulation, which may in turn influence social functioning [13, 15]. It is also plausible that loneliness and reduced social connectedness may adversely affect sleep, for example by increasing vigilance and reducing feelings of safety that facilitate healthy sleep [29]. More longitudinal research is needed to clarify the direction and underlying mechanisms of the association between sleep difficulties and loneliness.

Demographic characteristics were associated with sleep profile membership, with age, sex, and IMD predicting membership in the moderate and/or high sleep problems profiles. However, sex, age, ethnicity, and IMD were not significantly associated with T3 loneliness after accounting for sleep profile membership. This suggests that the association between sleep profiles and loneliness was not explained by the demographic and socioeconomic characteristics included in the present study. Although previous research has reported demographic differences in both sleep and loneliness, as well as socioeconomic gradients in children's sleep [14, 41, 5, 33], these factors did not account for the observed association in the present study. Future research could examine whether demographic and socioeconomic characteristics influence loneliness indirectly through sleep problems or moderate the association between sleep problems and loneliness during middle childhood.

This study has several limitations. Firstly, both sleep problems and loneliness were assessed using child self-report. Although self-report is appropriate for capturing children's subjective experiences, the use of the same informant for both constructs may have inflated the observed associations because of shared method variance. Future studies would benefit from combining child self-report with parent reports and objective measures of sleep, such as actigraphy [46]. Second, sleep was assessed at only two time points (T2 and T3), which limited our ability to characterise longer-term developmental trajectories and determine when persistent sleep problems first emerged. Additional assessments across childhood would provide a more comprehensive understanding of the developmental relationship between sleep and loneliness. Classification was also somewhat less distinct for the moderate sleep problems profile than for the low and high profiles, which should be considered when interpreting differences between the identified profiles. Future research should examine whether similar sleep profiles are replicated in other samples. Given the community based nature of the sample, it included both typically developing and neurodivergent children. The association between sleep problems and loneliness may differ between these groups, and future research should examine whether neurodevelopmental status influences this association. Finally, the sample was drawn from a socioeconomically disadvantaged and ethnically diverse area of East London.

This is a key strength, as children from underrepresented backgrounds are often excluded from developmental research, increasing the relevance of the findings for diverse populations. Future research should examine whether contextual factors associated with socioeconomic disadvantage, such as neighbourhood safety, influence the relationship between sleep difficulties and loneliness. However, the findings may not generalise to children living in more affluent or less ethnically diverse communities, and replication in other populations is needed. Despite these limitations, our study provides novel insights into the temporal association between sleep problems and loneliness during middle childhood. By adopting a person-centred approach in a large, ethnically diverse community sample, this study extends previous research by showing that children with more persistent sleep problems also reported higher levels of loneliness, independent of loneliness at T2 and demographic characteristics. These findings highlight the importance of considering sleep as a potential indicator of children's social wellbeing and support further research into linking sleep and loneliness across development.

In conclusion, this study identified distinct prospective sleep problem profiles during middle childhood and suggested that children with persistent moderate and high sleep problems reported higher levels of loneliness than children with consistently low sleep problems, even after accounting for early loneliness and demographic characteristics. These findings extend previous research by showing that the association between sleep and loneliness is evident during middle childhood and highlight the importance of considering persistent sleep difficulties as a marker of children's social and emotional wellbeing. Given the potential long-term consequences of both poor sleep habits and loneliness for children's development, early identification and intervention targeting sleep problems may also help promote positive social adjustment and wellbeing. Future longitudinal research is needed to clarify the mechanisms underlying this association and to determine whether improving children's sleep leads to reductions in loneliness over time.

Declarations

Declaration of conflicting interests

There are no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author Contribution

Alina A. Marinca: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing – original draft, Writing – review & editing. Julia E. Michalek: Writing – review & editing. Alice M. Gregory: Writing – review & editing. Afia Ali: Supervision, Writing – review & editing. Jennifer Y. F. Lau: Conceptualization, Supervision, Writing – review & editing.

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Data Availability

Fully anonymized data arising from the study and any other study materials will be available on reasonable request from the study principal investigators (j.lau@qmul.ac.uk and d.ougrin@qmul.ac.uk) governed by a signed data sharing agreement after the publication of the findings of the study by the research team.

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Figures

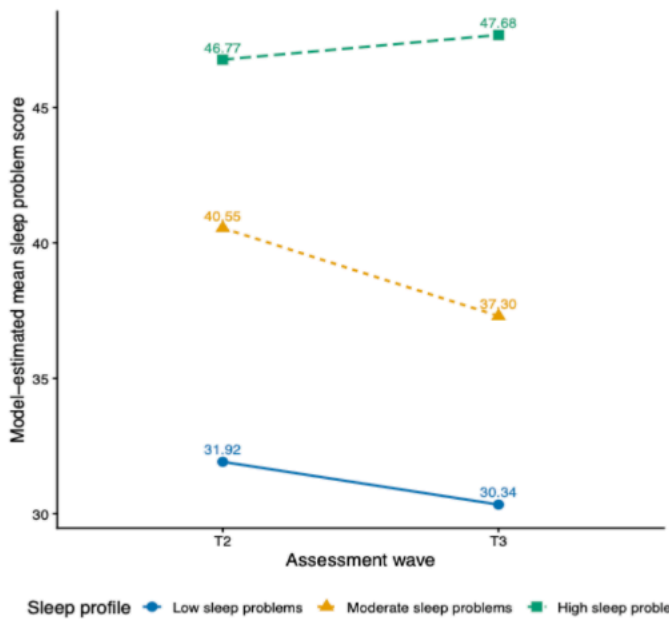


Figure 1

Model-estimated mean sleep problem scores at T2 and T3 across the three latent sleep profiles

Note. Higher scores indicate greater sleep problems. T2 = Time 2; T3 = Time 3

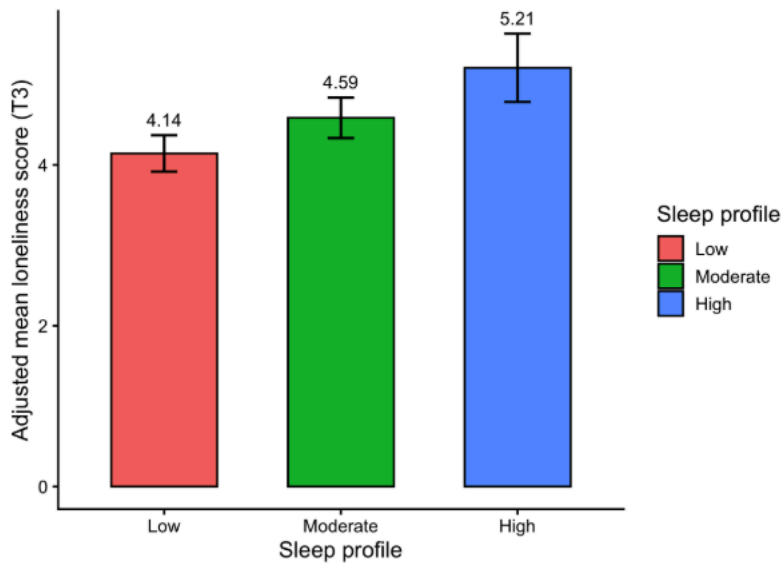


Figure 2

Adjusted mean loneliness at Time 3 by sleep profile

Note. Estimated marginal means of T3 loneliness across the three latent sleep profiles identified by the latent profile analysis (low, moderate, and high sleep problems), adjusted for T2 loneliness, sex, age, ethnicity, and Index of Multiple Deprivation (IMD). Error bars represent 95% confidence intervals.

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