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Sociodemographic, temporal and bedtime routine correlates of sleep timing and duration in South Asian and white children: A Born in Bradford study☆

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ABSTRACT

Objective: The study aimed to examine sociodemographic, temporal and bedtime routine correlates of parent-reported sleep duration and timing in a biethnic sample of 18 month and 36 month old children from a disadvantaged location.

Methods: Between October 2010 and September 2012, parents completed a bespoke three day sleep diary when their child was approximately 18 months ($n = 276$) and 36 months of age ($n = 262$) (45.1% South Asian; 54.9% white). Parents reported their child's overnight sleep duration (h/day), the time their child fell asleep, their wake time and their child's bedtime and napping routines. Data were available at both time points for 135 children.

Results: In line with previous literature, South Asian children had shorter overnight sleep duration and later sleep and wake times than white children. In both ethnic groups, children slept and woke up later on weekends, and children went to bed earlier and slept longer in winter. In white children only, napping duration was associated with overnight sleep period. No significant associations were found between napping frequency and overnight sleep duration. Based on parent-reported data, children who consistently adhered to regular bedtimes and had set times for sleeping tended to go to sleep earlier, wake earlier and have longer overnight sleep.

Conclusions: The data showed parent-reported variation in sleep patterns between two ethnic groups within a single geographical and deprived area. It is important that researchers, clinicians and early years workers are considerate of cultural norms in sleep practices.

1. Introduction

Adequate sleep is needed in order to maintain both physical and psychological health. Inadequate sleep in children is associated with poorer cognitive performance, health markers [1], psychosocial well-being and family relationships [2,3]. The amount of sleep recommended for satisfactory function during the day changes with age [4]. Galland et al. conducted a systematic review & meta-analysis of the scientific literature with regard to normal sleep patterns in infants and children [5]. The results demonstrated that sleep patterns show developmental trends for sleep duration (decreasing from 0 to 12 years), the number of night wakings (decreasing from 0 to 2 years), the longest sleep period (increasing from 0 to 2 years), and the number of daytime naps (decreasing up to age 2 years). The parent-reported mean sleep duration for infants (0–23 months) was 12.8 h and 11.9 h for toddlers and preschoolers (2–5 years old). The review showed that most children discontinued daytime napping between 3 and 5 years of age with napping frequency reducing from 3.1 naps per day on average in 0–5 month olds to 1.2 naps per day in 1–2 year olds. As the meta-analysis combined data from different countries and cultures, the authors highlight that the reference values should be considered as

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international norms, rather than culture-specific norms [5].

It is important for researchers to understand that what constitutes 'normal sleep' may be defined differently across cultures giving rise to cross-cultural differences in parental expectations and perceptions of their child's sleep needs and sleep outcomes [6,7]. Rudzik and Ball highlight that western practices and perceptions should not provide a benchmark against which all child sleep outcomes are measured [6].

Questionnaire and sleep diary data have been used to investigate how cultural practices influence sleep development and timings. The majority of cross-cultural studies exploring sleep in children have either compared children from different countries (rather than ethnic group), or predominately been American studies comparing white children with their Hispanic or black peers living in a similar location. The literature indicates substantial differences in parentally-reported sleep patterns of young children across culturally diverse countries/regions [8]. In addition, a large-scale, cross-cultural internet-based survey of infant and toddler sleep across 17 countries/regions revealed, based on parental reports, that children from predominantly-Asian countries (China, Hong Kong, India, Indonesia, Korea, Japan, Malaysia, Philippines, Singapore, Taiwan, Thailand, Vietnam) had significantly later bedtimes, shorter total sleep times, increased parental perception of sleep problems, and were more likely to room-share than children from predominantly-white countries/regions (Australia, Canada, New Zealand, United Kingdom, United States) [9]. A systematic review and meta-analysis of normal sleep patterns in infants and children also highlighted that sleep duration of predominantly Asian cultures was shorter over the 0–12 year age range (1 h less) compared to white/non-Asian countries [5]. Another systematic review found that non-Hispanic white children went to bed earlier, at a more regular time, slept longer overnight (on average by 20 min) and napped less than their ethnic minority peers, but total daily sleep was similar [10]. Finally, a study by Zreik et al. [11] in Israel found that despite living in similar social and geographical locations, sleep patterns differed between Arab children and Jewish children.

In this study, to extend information about ethnic differences in childhood sleep patterns, we investigated differences in parentally-reported sleep timing, duration, and adherence to set bedtimes in a biethnic sample of South Asian and white children from a disadvantaged city in the UK. We also investigated correlates of behaviours to aid understanding about the potential differences in sleep practices across ethnic groups. This information can be used to ensure that the most vulnerable populations who are at risk of sleep problems can be targeted, with intervention programs that are culturally and socioeconomically sensitive.

2. Methods

2.1. Study design and population

This study was conducted in Bradford, the fifth largest local authority in England and one of the most deprived and ethnically diverse cities in the UK [12]. Participants were part of the Born in Bradford (BiB) 1000 study [13] which is nested within the larger BiB birth cohort [14,15]. Pregnant women ($n = 1916$) were invited to the BiB 1000 study when they attended routine hospital appointments at 26–28 weeks gestation; 90.6% of women accepted the invitation ($n = 1735$). Women consented to medical records access and periodic postnatal assessments were conducted when their offspring were approximately 6, 12, 18, 24, and 36 months old. Parents of children who participated at the 18 month ($n = 1228$; 70.7% of all BiB 1000 participants) or 36 month time point ($n = 1232$; 71%) were asked to complete a sleep diary for their child. Diary data were available for approximately 15% of children at each time point (18 months: $n = 276$; 36 months: $n = 262$), and data were available at both time points for 135 children. Sleep diaries were completed between October 2010 and September 2012. This complete-case analysis included only children with sleep diary data and full information about potential correlates. Maternal ethnicity was used as a proxy for child ethnicity, and children with a mother belonging to an ethnic group other than South Asian (Pakistani/Indian/Bangladeshi) or white (British/other) were excluded due to small numbers. Ethical approval for all aspects of the study was granted by Bradford Research Ethics Committee (Reference 07/H1302/112).

2.2. Sleep duration and timing

Parents completed sleep diaries, providing free text responses about the time their child fell asleep on an evening and woke-up the next morning. The sleep period was calculated as elapsed time between sleep onset and waking. Because the sleep period does not account for periods of wakefulness, which can be common in young children [16], parents also reported their child's overnight sleep duration. Parents provided values for two weekdays and one weekend day.

2.3. Sociodemographic and temporal factors

Child sex and birthdates were abstracted from medical records, the latter was combined with postnatal assessment dates to calculate child age. A multidimensional marker of socioeconomic status (SES) was synthesised from information collated at recruitment via interviews with parents (usually mothers). The metric was synthesised from multiple components comprising a mixture of objective (e.g. Education, employment, housing tenure, receipt of benefits, up to date payment of bills) and subjective (Mother's perception of affluence/deprivation) information [17]. For the purposes of this study, from an initial five categories, families were classified as belonging to one of three SES groups: least deprived (least socioeconomically deprived and most educated), moderately deprived (employed and not materially deprived/employed but no access to money) and most deprived (benefits but not materially deprived/most economically deprived). Maternal age was self-reported in pregnancy and dichotomised (<25 years/≥25 years). Women were categorised as primiparous (pregnant for the first time) or multiparous (having experienced one or more previous pregnancies) based on the number of previous births as stated in medical records; parity was considered a proxy for older siblings. Sleep diary days were classified as weekdays (covering Tuesday evening into Wednesday morning and Thursday evening into Friday morning) or weekends (Saturday evening into Sunday morning). Date-stamps were used to determine the season in which diaries were completed (winter: December to February/spring: March to May/summer: June to August/autumn: September to November).

2.4. Bedtime routine factors

As part of sleep diaries, parents provided information about their child's normal weekday sleep habits. Parents selected one of four possible responses (always/usually/sometimes/never) to indicate if their child normally slept during the day, if they had a regular bedtime, and if they adhered to set bedtimes. Due to consistently small cell numbers the last two response categories were combined. If a child normally slept during the day, parents were prompted to provide free text information about how long their child normally napped for. Similarly, if a child had a regular bedtime, parents were asked to report free text clock times for the

Table 1
Descriptive characteristics of the study population.

Data level	Characteristic	Total (n = 348)	South Asian (n = 157)	White (n = 191)	p-value ethnicity
Participant	Sex (n (%))				
	Male	166 (47.7)	78 (49.7)	88 (46.1)	
	Female	182 (52.3)	79 (50.3)	103 (53.9)	0.50
	Socioeconomic status (n (%))				
	Least deprived	86 (24.7)	36 (22.9)	50 (26.2)	
	Moderately deprived	158 (45.4)	51 (32.5)	107 (56.0)	
	Most deprived	104 (29.9)	70 (44.6)	34 (17.8)	<0.001
	Maternal age (n (%))				
	<25 years	99 (28.5)	48 (30.6)	51 (26.7)	
	≥25 years	249 (71.5)	109 (69.4)	140 (73.3)	0.43
	Parity (n (%))				
	Primiparous	160 (46.0)	54 (34.4)	106 (55.5)	
	Multiparous	188 (54.0)	103 (65.6)	85 (44.5)	<0.001
		Total (n=474)	South Asian (n=195)	White (n=279)	
Time point	Season (n (%))				
	Winter	313 (23.2)	114 (21.1)	199 (24.5)	
	Spring	317 (23.4)	127 (23.5)	190 (23.4)	
	Summer	364 (26.9)	135 (25.0)	229 (28.2)	
	Autumn	358 (26.5)	164 (30.4)	194 (23.9)	0.71
		Total (n=1352)	South Asian (n=540)	White (n=812)	
Daily	Type of day (n (%))				
	Weekday	904 (66.9)	358 (66.3)	546 (67.2)	
	Weekend	448 (33.1)	182 (33.7)	266 (32.8)	0.72

Ethnic comparisons performed using chi-square tests at the participant level, ordered logistic regression with a random intercept to account for clustering of data within children at the time point level, and ordered logistic regression with two random intercepts at the daily level to account for days clustered within measurement time points further nested within children. Maternal age was measured in pregnancy. South Asian includes Pakistani (n = 138), Indian (n = 13), and Bangladeshi (n = 6). White includes white British (n = 179) and white 'other' (n = 12).

set bedtime, from which three ethnic-specific categories were derived (South Asian: ≤8pm/>8pm to ≤9pm/>9pm; white: ≤7pm/>7pm to ≤8pm/>8pm).

2.5. Statistics

Participant characteristics were described and compared between South Asian and white children using chi-square tests at the participant level; child ages were compared using ANOVA. Ethnic group comparisons for measurement season were made using multilevel ordered logistic regression, including a random intercept to account for repeated-measures data from children who participated at both the 18 and 36 month time point. The number of weekdays and weekend days for which sleep diaries were completed was also compared between ethnic groups using multilevel logistic regression, but with the addition of another random intercept to account for sleep diary days, which were nested within measurement time points, further clustered within children.

To investigate correlates of sleep duration and timing three-tier linear multilevel models were used, this allowed inclusion of random intercepts to account for multiple sleep diary days, nested within measurement time points, further clustered within children. Following whole-sample models to explore ethnic differences in sleep timing and duration, all subsequent analyses were stratified by ethnic group, and separate models were created for each dependent variable. To investigate sociodemographic and temporal correlates, models were initially specified with child sex, child age (modelled continuously), socioeconomic status, maternal age, parity, type of day, and season, all simultaneously included as independent variables to mutually adjust for each other. Subsequently, each bedtime routine correlate was added to models; bedtime routine variables were added individually rather than simultaneously, because they all contained different patterns of missing data. The results are presented as estimated marginal means with 95% confidence intervals. Age and napping duration were both modelled continuously; addition of squared-terms for these variables provided no evidence against the assumption of linear associations. For ordinal categorical variables trend tests were performed. All analyses were carried out in Stata/SE version 15.0 software; statistical significance was deemed $p < 0.05$ but focus is placed on the range of plausible values of associations as indicated by confidence intervals [18].

3. Results

3.1. Descriptive characteristics of the study population

Table 1 provides a description of the 348 children (45.1% South Asian; 52.3% female) who comprised the study sample. Complete outcome and covariable data were available at the 18 and 36 month time point for 126 children, hence the total number of participant-time points was 474. South Asian children were slightly younger than white children at the 18 month time point (mean (range) child ages: 18.3 (16.4–21.0) months in South Asian children versus 18.6 (16.7–22.8) months in white children, $p < 0.01$), but there was no age difference at the 36 month time point (36.8 (35.5–39.6) months in South Asian children versus 36.8 (35.7–39.5) months in white children, $p = 0.49$). In total, parents provided sleep diary data for 1352 days, one-third of which were weekends. A higher proportion of South Asian than white children were from families who were most deprived, and a higher proportion of South Asian than white women were multiparous.

3.2. Sociodemographic and temporal correlates of sleep timing and duration in South Asian and white children

Table 2 shows associations between sociodemographic and temporal factors with parentally-reported sleep timing and duration. There were marked ethnic differences, with South Asian children reported as falling asleep later, waking later, and having a shorter sleep period and duration compared to white children.

Table 2
Sociodemographic and temporal correlates of sleep timing and duration in South Asian and white children.

	Characteristic	Time fell asleep (pm)	*p*-value	Awake time (am)	*p*-value	Sleep period (h)	*p*-value	Sleep duration (h)	*p*-value
South Asian (*n* participants: 157; *n* time points: 195; *n* days: 540)	Overall	21:23 (21:14 to 21:32)	Ref	08:22 (08:14 to 08:31)	Ref	11.0 (10.8 to 11.1)	Ref	10.7 (10.6 to 10.9)	Ref
	Sex								
	Boys	21:18 (21:04 to 21:31)	Ref	08:19 (08:07 to 08:31)	Ref	11.0 (10.8–11.2)	Ref	10.9 (10.6 to 11.1)	Ref
	Girls	21:25 (21:11 to 21:38)	0.50	08:25 (08:12 to 08:37)	0.54	11.0 (10.8–11.2)	0.94	10.5 (10.3 to 10.8)	0.039
	Age								
	18 months	21:32 (21:19 to 21:46)		08:24 (08:12 to 08:37)		10.9 (10.7–11.1)		10.6 (10.3–10.9)	
	36 months	21:10 (20:57 to 21:23)	0.020	08:19 (08:07 to 08:32)	0.60	11.1 (10.9–11.3)	0.082	10.8 (10.5–11.1)	0.48
	Socioeconomic status								
	Least deprived	21:23 (21:03 to 21:44)	Ref	08:32 (08:13 to 08:50)	Ref	11.1 (10.9–11.4)	Ref	10.6 (10.3–11.0)	Ref
	Moderately deprived	21:19 (21:03 to 21:36)	0.74	08:08 (07:53 to 08:23)	0.052	10.8 (10.6–11.0)	0.079	10.6 (10.3–10.9)	0.92
	Most deprived	21:22 (21:07 to 21:36)	0.90	08:27 (08:14 to 08:40)	0.70	11.1 (10.9–11.3)	0.83	10.8 (10.5–11.1)	0.44
		p-trend	0.95	*p*-trend	0.98	*p*-trend	0.87	*p*-trend	0.39
	Maternal age								
	<25 years	21:34 (21:15 to 21:53)	Ref	08:46 (08:29 to 08:03)	Ref	11.2 (10.9–11.5)	Ref	11.1 (10.7 to 11.4)	Ref
	≥25 years	21:16 (21:05 to 21:28)	0.15	08:13 (08:02 to 08:23)	0.002	10.9 (10.8–11.1)	0.096	10.6 (10.4 to 10.8)	0.040
	Parity								
	Primiparous	21:32 (21:14 to 21:50)	Ref	08:30 (08:14 to 08:46)	Ref	11.0 (10.7–11.2)	Ref	10.6 (10.3–10.9)	Ref
	Multiparous	21:16 (21:03 to 21:28)	0.16	08:17 (08:06 to 08:28)	0.24	11.0 (10.9–11.2)	0.71	10.8 (10.5–11.0)	0.51
	Type of day								
	Weekday	21:17 (21:08 to 21:27)	Ref	08:16 (08:07 to 08:25)	Ref	11.0 (10.8–11.1)	Ref	10.7 (10.5–10.9)	Ref
	Weekend	21:29 (21:19 to 21:39)	<0.001	08:33 (08:23 to 08:42)	<0.001	11.1 (10.9–11.2)	0.24	10.7 (10.5–10.9)	0.83
	Season								
	summer	21:39 (21:24 to 21:54)	Ref	08:26 (08:11 to 08:40)	Ref	10.8 (10.5 to 11.0)	Ref	10.8 (10.5–11.2)	Ref
	autumn	21:18 (21:00 to 21:35)	0.059	08:16 (07:59 to 08:33)	0.37	11.0 (10.7–11.2)	0.28	10.5 (10.1–10.8)	0.19
	winter	21:07 (20:49 to 21:25)	0.003	08:16 (07:59 to 08:33)	0.33	11.2 (10.9 to 11.4)	0.019	10.5 (10.2–10.9)	0.28
	spring	21:19 (21:01 to 21:38)	0.11	08:31 (08:13 to 08:49)	0.68	11.2 (10.9 to 11.4)	0.042	11.1 (10.7–11.6)	0.30
	Characteristic	Time fell asleep (pm)	*p*-value	Wake time (am)	*p*-value	Sleep period (h)	*p*-value	Sleep duration (h)	*p*-value
White (*n* participants: 191; *n* time points: 279; *n* days: 812)	Overall	19:52 (19:45 to 20:00)	<0.001	07:14 (07:07 to 07:21)	<0.001	11.4 (11.3 to 11.5)	<0.001	11.2 (11.1 to 11.4)	<0.001
	Sex								
	Boys	19:49 (19:40 to 19:59)	Ref	07:12 (07:03 to 07:22)	Ref	11.4 (11.2–11.5)	Ref	11.2 (11.0–11.4)	Ref
	Girls	19:56 (19:47 to 20:04)	0.32	07:16 (07:07 to 07:25)	0.58	11.3 (11.2–11.5)	0.80	11.3 (11.1–11.4)	0.74
	Age								
	18 months	19:47 (19:37 to 19:56)		07:15 (07:06 to 07:25)		11.5 (11.3–11.6)		11.3 (11.1–11.5)	
	36 months	19:58 (19:49 to 20:07)	0.089	07:13 (07:04 to 07:22)	0.75	11.3 (11.1–11.4)	0.11	11.2 (11.0–11.4)	0.84
	Socioeconomic status								
	Least deprived	19:41 (19:28 to 19:54)	Ref	07:08 (06:55 to 07:21)	Ref	11.5 (11.3–11.6)	Ref	11.2 (10.9–11.4)	Ref
	Moderately deprived	19:56 (19:47 to 20:04)	0.059	07:17 (07:08 to 07:25)	0.26	11.3 (11.2–11.5)	0.29	11.3 (11.1–11.5)	0.29
	Most deprived	20:04 (19:47 to 20:21)	0.040	07:17 (07:00 to 07:34)	0.42	11.2 (11.0–11.4)	0.12	11.2 (10.8–11.5)	0.99
		p-trend	0.027	*p*-trend	0.33	*p*-trend	0.11	*p*-trend	0.75
	Maternal age								
	<25 years	19:52 (19:38 to 20:06)	Ref	07:23 (07:09 to 07:38)	Ref	11.5 (11.3–11.7)	Ref	11.2 (10.9–11.5)	Ref
	≥25 years	19:53 (19:45 to 20:01)	0.92	07:11 (07:03 to 07:19)	0.16	11.3 (11.2–11.4)	0.081	11.3 (11.1–11.4)	0.87
	Parity								
	Primiparous	19:58 (19:50 to 20:07)	Ref	07:15 (07:07 to 07:24)	Ref	11.3 (11.2–11.4)	Ref	11.2 (11.1–11.4)	Ref
	Multiparous	19:46 (19:36 to 19:56)	0.075	07:13 (07:03 to 07:22)	0.68	11.4 (11.3–11.6)	0.11	11.3 (11.1–11.5)	0.82
	Type of day								
	Weekday	19:50 (19:44 to 19:57)	Ref	07:10 (07:03 to 07:16)	Ref	11.3 (11.2–11.4)	Ref	11.3 (11.1–11.4)	Ref
	Weekend	19:59 (19:52 to 20:06)	<0.001	07:24 (07:16 to 07:31)	<0.001	11.4 (11.3–11.5)	0.10	11.2 (11.1–11.4)	0.72
	Season								
	summer	19:57 (19:46 to 20:07)	Ref	07:10 (06:59 to 07:20)	Ref	11.2 (11.1 to 11.4)	Ref	11.2 (11.0–11.5)	Ref
	autumn	20:05 (19:52 to 20:17)	0.28	07:14 (07:01 to 07:26)	0.56	11.2 (11.0–11.4)	0.65	10.9 (10.7–11.2)	0.075
	winter	19:42 (19:31 to 19:54)	0.043	07:14 (07:02 to 07:25)	0.58	11.5 (11.3 to 11.7)	0.042	11.3 (11.1–11.6)	0.62
	spring	19:47 (19:35 to 20:00)	0.28	07:21 (07:08 to 07:34)	0.20	11.5 (11.3–11.7)	0.068	11.5 (11.2–11.8)	0.16

Sleep period is the time elapsed between the diary reported clock times that children fell asleep and woke the next morning. Sleep duration accounted for periods of wakefulness, and was only collected when parents reported they knew how long their child had slept overnight (*n* participants: 138; *n* time points: 169; *n* days: 426). The statistical analysis was performed using multilevel linear regression to account for clustering of days within time points and children. Overall estimates are from analyses of the total sample with ethnic group modelled as an independent variable, *p*-values represent differences compared to the South Asian ethnic group. All factors were mutually adjusted for each other. Maternal age was measured in pregnancy and child age was modelled continuously. *p*-trend represents trend tests for ordered categories.

Parentally-reported sleep duration was shorter in South Asian girls than boys, and there was a significant age effect with regard to the time that parents reported children fell asleep, indicating that younger South Asian children fell asleep later than older South Asian children. There was also some indication (albeit no statistically significant difference was detected) that South Asian children from moderately deprived families woke up earlier and had a shorter sleep period compared to South Asian children from the least deprived families. In white children, higher deprivation was associated with later parentally-reported time of falling asleep. South Asian children with older mothers (aged ≥25 years when pregnant) were reported to wake up earlier and have a shorter sleep duration compared to South Asian children with younger mothers (aged <25 years when pregnant), and in both ethnic groups there was some indication that children with older mothers had a shorter sleep period. There was some evidence that white children with mothers who were multiparous fell asleep earlier than white children with mothers who were primiparous. Children of both ethnic groups were reported to fall asleep later and wake up later at the weekend than on weekdays. Compared to summer, children of both ethnic groups fell asleep earlier in winter and the sleep period was longer in winter and spring. There was also some evidence that South Asian children fell asleep earlier in autumn than summer.

3.3. Napping, bedtimes and adherence to bedtimes

Fig. 1 shows the proportions of children for whom their parents reported that they never or sometimes, usually, and always napped during the day, had a regular bedtime, and adhered to set bedtimes, stratified by ethnicity and time point. The vast majority of children in both ethnic groups always or usually napped during the day at 18 months; at 36 months, most children never or sometimes napped. At 18 months, the parentally-reported median (IQR) nap duration was 2 (0.5) hours in South Asian children and 1.5 (0.9) hours in white children. For children who napped at 36 months, the parentally-reported median nap duration was 0.5 (1) hours in South Asian children and 1 (2) hours in white children. The majority of children always or usually had a regular bedtime, and the majority always or usually adhered to set bedtimes. Fig. 2 highlights that ~90% of white children at both time points had a set bedtime ≤8pm. In contrast, the majority of South Asian children had a set bedtime >8pm.

3.4. Napping and bedtime correlates of sleep timing and duration in South Asian and white children

Table 3 shows associations between bedtime routine components with sleep timing and duration. In white children, longer reported napping duration was associated with a shorter reported sleep period. In both ethnic groups, children who were reported to have less regular bedtimes were also reported to fall asleep later, wake up later, and have a shorter sleep period; white children who had less regular bedtimes also had a shorter sleep duration. South Asian and white children reported to have later set bedtimes were reported to fall asleep later, wake up later, and have shorter sleep period and duration. Children of both ethnic groups who were less adherent to set bedtimes reportedly fell asleep later and had a shorter sleep period; lower adherence was further associated with parentally-reported shorter sleep duration in white children.

4. Discussion

This descriptive paper outlined the diarised sleep duration and patterns of young children aged 18 and 36 months within a subset of the Born in Bradford cohort study. We found differences in parental reports of sleep time onset, duration and bedtime practices between two different ethnic groups living in a socioeconomically deprived city. According to parental reports, South Asian children (on average) went to bed later, woke later and had a shorter sleep duration compared to their white peers. In both ethnic groups, children were reported to sleep and wake up later on weekends, and children went to bed earlier and slept longer in winter. Our parental reports indicated that white children from a more deprived background went to bed on average 23 min later than their less deprived peers, however no similar association was seen in South Asian children. Children who adhered to set bedtimes in both ethnic groups went to bed earlier, woke earlier and slept longer.

4.1. Sleep patterns and ethnicity

Sleep pattern differences between ethnicities/countries have been observed in previous studies [8–10]. In line with the existing literature [8,9] our study also found differences between white and South Asian children living in the UK. Based on parent report, white children appeared to go to bed on average 1.5 h earlier, had a 1 h longer night-time sleep period, and slept 0.5 h more overnight than their South Asian peers. This result is supported by other parent-reported single point and longitudinal studies which have shown that East Asian children have later bedtimes and a shorter sleep duration compared to white children [8] and children from predominantly white countries [9]. If parents are reporting their child's sleep parameters accurately, later bedtimes in South Asian children may be due to cultural practices such as later meal times, religious activities, bedroom sharing, family time in the evening and parent working patterns. Our data showed that older South Asian children went to bed earlier than younger South Asian children, this may be explained by cultural practices, such as younger children room sharing with carers and therefore having a bedtime in line with their parents', or physiological reasons such as older children dropping their afternoon nap resulting in an earlier build-up of sleep pressure leading to an earlier sleep onset time. Later sleep onset times have been linked to shorter overnight sleep duration, possibly due to fixed morning routines such as childcare or work resulting in children's sleep being truncated, or possibly related to biological circadian rhythm [19]. Conscious or unconscious bias due to historical-cultural norms in different populations may influence the accuracy of parent reported child sleep. For example, in the UK, historic-cultural norms prioritise early bedtime routines and parents sleeping separately from their children [6], this could lead to reporting of earlier bed-times and sleep onset times, and longer reported sleep duration among white children. However, our results are consistent with previous cross-cultural/ethnicity studies. Verification of the parental report data with studies that incorporate child actigraphy or polysomnography would be valuable.

To the best of our knowledge this is the first study to explore sociodemographic, temporal and bedtime routine correlates of sleep timing and duration in South Asian and white children living in a single geographical and deprived location (Bradford, UK). Most previous within-country child sleep studies have compared white children with Hispanic or African American children. A systematic review of American studies by Smith et al. found non-Hispanic preschool white children went to bed earlier, at a more regular time, slept longer overnight (on average by 20 min) and napped less than their ethnic minority (African American/Hispanic) peers [10]. It is potentially problematic that white children recruited to previous studies were often from a higher SES than black/Hispanic peers. Emerging evidence suggests total daily sleep is similar across ethnicities [10]. A recent study [11] found that despite living in a

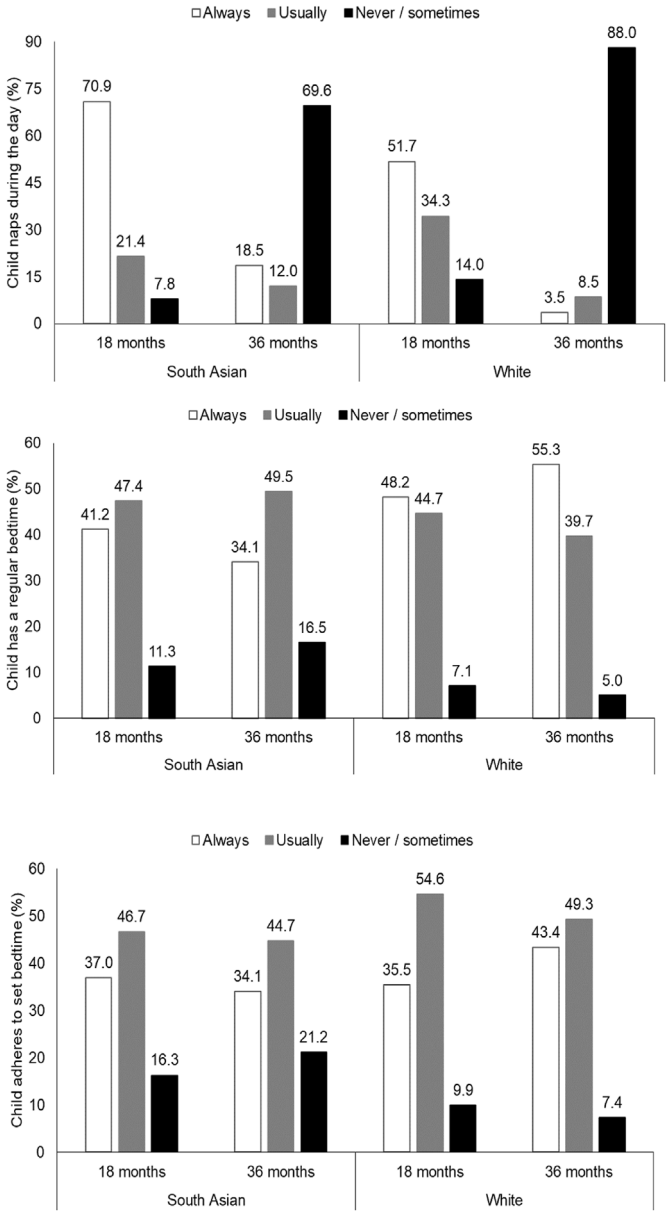

Fig. 1. The proportions of children who nap during the day, have a regular bedtime, and adhere to set bedtimes, stratified by time point and ethnic group. Sample sizes (n) were as follows: napping frequency (South Asian children at 18 months: 103; South Asian children at 36 months: 90; white children at 18 months: 139; white children at 36 months: 138), regular bedtime (South Asian children at 18 months: 97; South Asian children at 36 months: 89; white children at 18 months: 137; white children at 36 months: 137), adherence to bedtime (South Asian children at 18 months: 92; South Asian children at 36 months: 80; white children at 18 months: 136; white children at 36 months: 132).

similar social and geographical location, Israeli Arab children slept less, had later bedtimes and longer overnight wake periods compared to Jewish Israeli children. Our results are in line with previous studies and indicate that differences in parentally-reported sleep patterns and duration have a basis independent of geographical location, and can relate to cultural and socioeconomic factors.

4.2. Routines and bedtimes

Children gain positive benefits including a sense of security and predictability from routines within their daily lives. Bedtime routines have been linked to improved dental health, cognitive function, school readiness, literacy, and emotional and behavioural regulation in children and family functioning [20,21]. A good routine can consist of a regular bedtime, and in the hour before bed limiting screen time, teeth brushing and reading a story [19,20]. A recent systematic review found that a regular sleep routine correlated with longer sleep duration [19]. A clinical review also found a strong correlation between a consistent bedtime and positive sleep outcomes, such as sleep onset time and sufficient sleep duration [22]. We also found that children who had less regular bedtimes fell asleep later, woke up later, and had a shorter sleep period; white children in this group also had a shorter sleep duration.

The majority of white children at 18 and 36 months had a set bedtime before 8pm, and the majority of South Asian children had a bedtime after 8pm. The marked difference in bedtime likely reflects that the structure of the evening varies between cultures. Cultural differences between evening and sleeping practices are well documented [5,23,24], and include differences in bed sharing and mealtimes. These practices, along with differences in parents' cultural beliefs and priorities regarding child sleep, and the wider structure of a family's day (e.g., working patterns) may account for the difference in bedtime between the two groups of children.

There is growing literature linking the impact of poor quality sleep to negative health, psychological and educational outcomes [1,2,25–28]. Modifiable factors such as regular sleep routines and reduced screen use [29] could contribute to improved outcomes such as reduced risk of obesity [30]. Should these apparent differences be confirmed via objective measures, having a more in depth understanding of the modifiable sleep behaviours that occur in families will support culturally appropriate interventions.

4.3. Day of the week variation

Variation in sleep behaviours throughout the week has been documented in school age children, with later bedtimes and corresponding catch up sleep [31]. Weekday/weekend sleep patterns begin early in childhood [32]. In our study, children in both ethnic groups fell asleep later and woke up later at the weekend than on weekdays, though there was no difference in duration. These results fit with cultural and societal norms of children and adults attending work, education and nursery in the week, and there being more free time at the weekend when family life may not be so regimented and thus allow longer sleep.

4.4. Napping

Sleep patterns are well known to alter with age as a child moves from a multi-modal sleep pattern to bimodal to finally consolidating sleep into one overnight stretch by 4 years old. The findings of our study are consistent with previous literature [16], as we established that most children napped at 18 months but by 36 months the majority no longer did. We also ascertained that naps were reportedly 30 min shorter in white children than South Asian children at both 18 and 36 months. This difference is consistent with South Asian children compensating for a 30 min shorter overnight sleep duration. Longer naps reduce sleep pressure and are linked to later bedtimes [19].

4.5. Deprivation/socioeconomic status

There is limited data about ethnicity-specific associations between SES and sleep parameters. Due to the equal split in ethnicity and a range of SES in our cohort we were able to explore possible associations in more detail. Our study showed that the most

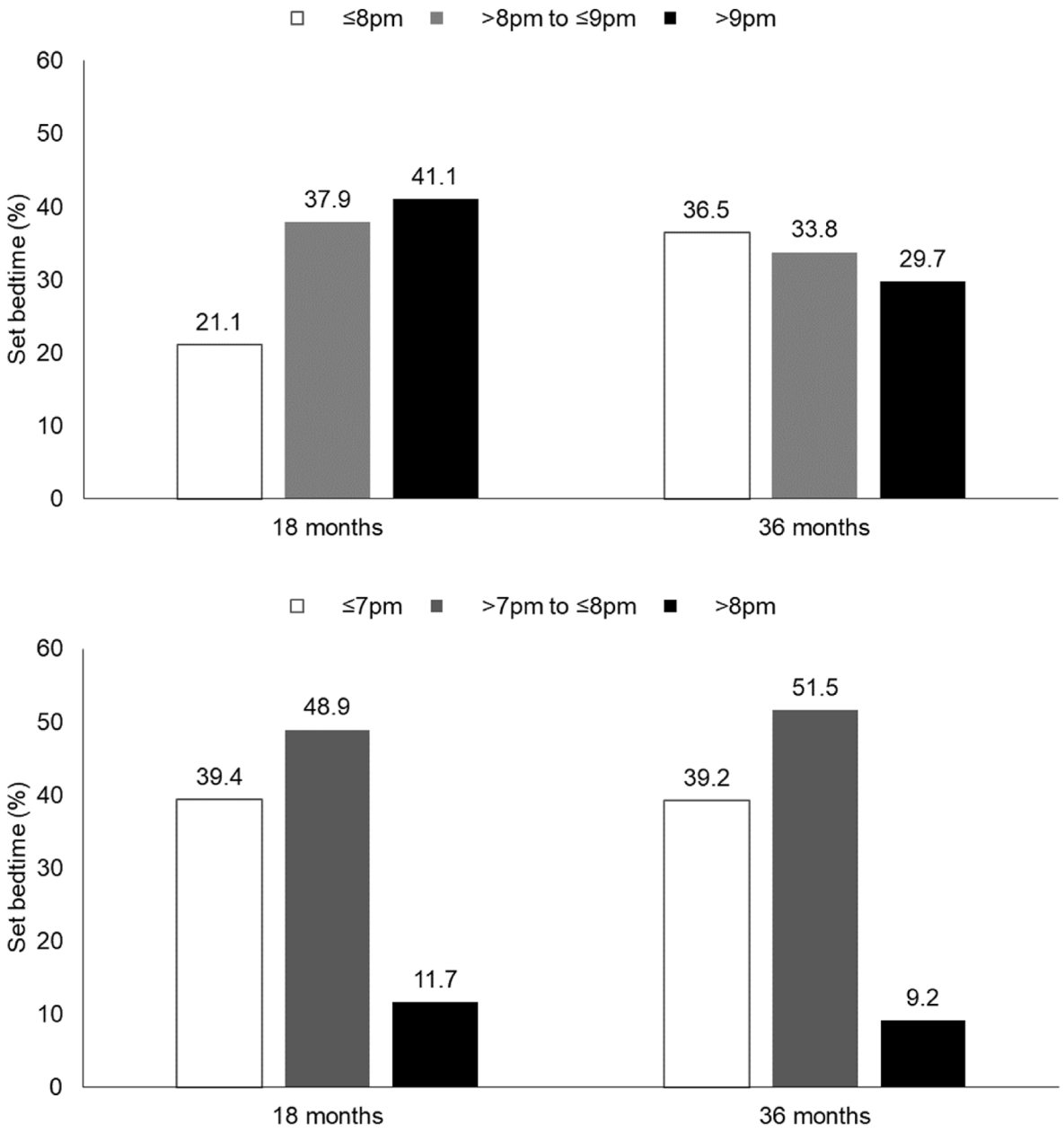

Fig. 2. The timings of bedtimes, stratified by age and ethnic group. The top tile relates to South Asian children and the bottom tile to white children. Sample sizes (*n*) were as follows: South Asian children at 18 months: 95; South Asian children at 36 months: 74; white children at 18 months: 137; white children at 36 months: 130.

deprived white children fell asleep on average 25 min later than their least deprived peers. Other studies have also shown children from low income families have a shorter sleep duration than those from higher income families [19]. Reasons for this may include modifiable variables such as absence of bedtime routines, chaotic households, poor parental sleep knowledge, and non-parental-modifiable factors such as crowded conditions, shared sleep space and adverse pressures within the family and community [19,33,34]. In our sample, white children from lower income families may not have had suitable sleep space, impacting on sleep, however data on location of sleep was not included in our analysis. There was some evidence that children from South Asian families who were moderately deprived woke up earlier than their least deprived peers, however, this trend did not continue into the most deprived group. Future studies should endeavour to collect additional data around evening and daytime routines and sleep location, to assist the interpretation of results, and highlight factors that could be leveraged to protect against the impact of deprivation on children's sleep.

4.6. Strengths and limitations

Our study has several strengths, the biethnic sample of children provided the opportunity to look at sleep patterns across two different ethnicities living in a single deprived urban geospatial location. The majority of previous cross-cultural studies have explored sleep patterns between countries or compared white children with Hispanic or black peers predominantly in the USA. Our study had contributions from across the socio-economic spectrum, an almost equal split in terms of ethnic group participation, and a detailed dataset allowed a comparison of sleep patterns across a wide range of covariables.

Table 3
Napping and bedtime correlates of sleep timing and duration in South Asian and white children.

	Characteristic	Time fell asleep (pm)	*p*-value	Awake time (am)	*p*-value	Sleep period (h)	*p*-value	Sleep duration (h)	*p*-value
South Asian	Napping frequency								
	Always	21:27 (21:13 to 21:41)	Ref	08:24 (08:11 to 08:37)	Ref	10.9 (10.7–11.1)	Ref	10.7 (10.4–11.0)	Ref
	Usually	21:17 (20:58 to 21:36)	0.37	08:34 (08:15 to 08:53)	0.36	11.3 (11.0–11.5)	0.051	10.8 (10.3–11.2)	0.80
	Never/sometimes	21:17 (21:01 to 21:34)	0.40	08:14 (07:59 to 08:30)	0.39	11.0 (10.7–11.2)	0.74	10.7 (10.3–11.0)	0.95
		p-trend	0.36	*p*-trend	0.51	*p*-trend	0.53	*p*-trend	0.99
	Napping duration								
	1 h	21:22 (21:10 to 21:34)		08:26 (08:15 to 08:37)		11.0 (10.9–11.2)		10.6 (10.4–10.9)	
	2 h	21:23 (21:12 to 21:35)		08:21 (08:10 to 08:32)		11.0 (10.8–11.1)		10.7 (10.5–10.9)	
	3 h	21:25 (21:06 to 21:45)	0.77	08:16 (07:59 to 08:32)	0.27	10.9 (10.6–11.2)	0.40	10.8 (10.4–11.2)	0.52
	Regular bedtime								
	Always	20:53 (20:41 to 21:06)	Ref	08:10 (07:57 to 08:23)	Ref	11.3 (11.1 to 11.5)	Ref	10.8 (10.5–11.1)	Ref
	Usually	21:31 (21:19 to 21:43)	<0.001	08:23 (08:11 to 08:34)	0.15	10.9 (10.7 to 11.0)	0.001	10.6 (10.3–10.9)	0.38
	Never/sometimes	22:09 (21:47 to 22:31)	<0.001	08:59 (08:37 to 09:20)	<0.001	10.8 (10.5 to 11.1)	0.010	10.9 (10.4–11.5)	0.57
		p-trend	<0.001	*p*-trend	<0.001	*p*-trend	0.001	*p*-trend	0.99
	Set bedtime								
	≤8pm	20:13 (20:01 to 20:25)	Ref	07:42 (07:29 to 07:56)	Ref	11.5 (11.3 to 11.7)	Ref	11.1 (10.8 to 11.4)	Ref
	>8pm to ≤9pm	21:19 (21:08 to 21:29)	<0.001	08:16 (08:05 to 08:28)	<0.001	10.9 (10.7 to 11.1)	<0.001	10.5 (10.3 to 10.8)	0.014
	>9pm	22:06 (21:55 to 22:17)	<0.001	08:44 (08:32 to 08:56)	<0.001	10.6 (10.4 to 10.8)	<0.001	10.4 (10.1 to 10.7)	0.004
		p-trend	<0.001	*p*-trend	<0.001	*p*-trend	<0.001	*p*-trend	0.005
	Adherence to bedtime								
	Always	21:00 (20:46 to 21:14)	Ref	08:11 (07:58 to 08:24)	Ref	11.2 (11.0 to 11.4)	Ref	10.8 (10.5–11.1)	Ref
	Usually	21:23 (21:11 to 21:36)	0.009	08:23 (08:11 to 08:36)	0.17	11.0 (10.8–11.2)	0.12	10.6 (10.3–10.9)	0.42
	Never/sometimes	21:40 (21:22 to 21:59)	<0.001	08:31 (08:13 to 08:50)	0.068	10.8 (10.5 to 11.1)	0.025	10.7 (10.3–11.2)	0.88
		p-trend	<0.001	*p*-trend	0.052	*p*-trend	0.019	*p*-trend	0.70
	Characteristic	Time fell asleep (pm)	*p*-value	Awake time (am)	*p*-value	Sleep period (h)	*p*-value	Sleep duration (h)	*p*-value
White	Napping frequency								
	Always	20:00 (19:47 to 20:12)	Ref	07:18 (07:05 to 07:30)	Ref	11.3 (11.1–11.5)	Ref	11.3 (11.0–11.5)	Ref
	Usually	20:02 (19:49 to 20:14)	0.80	07:17 (07:04 to 07:29)	0.90	11.3 (11.1–11.5)	0.98	11.2 (10.9–11.5)	0.81
	Never/sometimes	19:45 (19:35 to 19:56)	0.11	07:11 (07:01 to 07:21)	0.48	11.4 (11.3–11.6)	0.27	11.3 (11.0–11.5)	0.97
		p-trend	0.18	*p*-trend	0.52	*p*-trend	0.31	*p*-trend	0.95
	Napping duration								
	1 h	19:53 (19:47 to 20:00)		07:14 (07:08 to 07:21)		11.4 (11.3 to 11.5)		11.2 (11.1–11.4)	
	2 h	20:01 (19:50 to 20:11)		07:15 (07:04 to 07:26)		10.8 (10.4 to 11.2)		11.2 (10.9–11.4)	
	3 h	20:08 (19:49 to 20:27)	0.11	07:16 (06:56 to 07:35)	0.88	10.3 (9.5 to 11.1)	0.009	11.1 (10.7–11.5)	0.52
	Regular bedtime								
	Always	19:39 (19:31 to 19:46)	Ref	07:07 (06:59 to 07:16)	Ref	11.5 (11.4 to 11.6)	Ref	11.4 (11.3 to 11.6)	Ref
	Usually	20:03 (19:54 to 20:11)	<0.001	07:19 (07:10 to 07:28)	0.046	11.3 (11.1 to 11.4)	0.019	11.1 (10.9 to 11.3)	0.010
	Never/sometimes	20:43 (20:21 to 21:05)	<0.001	07:34 (07:11 to 07:58)	0.031	10.8 (10.5 to 11.2)	0.001	10.6 (10.1 to 11.1)	0.002
		p-trend	<0.001	*p*-trend	0.009	*p*-trend	<0.001	*p*-trend	<0.001
	Set bedtime								
	≤7pm	19:21 (19:14 to 19:28)	Ref	06:52 (06:43 to 07:00)	Ref	11.5 (11.4 to 11.6)	Ref	11.4 (11.2 to 11.6)	Ref
	>7pm to ≤8pm	19:59 (19:53 to 20:05)	<0.001	07:18 (07:10 to 07:25)	<0.001	11.3 (11.2–11.4)	0.062	11.2 (11.1–11.4)	0.15
	>8pm	21:12 (20:58 to 21:25)	<0.001	08:06 (07:50 to 08:22)	<0.001	10.9 (10.6 to 11.2)	<0.001	10.7 (10.4 to 11.1)	0.001
		p-trend	<0.001	*p*-trend	<0.001	*p*-trend	0.001	*p*-trend	0.002
	Adherence to bedtime								
	Always	19:34 (19:26 to 19:43)	Ref	07:08 (06:58 to 07:17)	Ref	11.6 (11.4 to 11.7)	Ref	11.4 (11.3 to 11.6)	Ref
	Usually	20:01 (19:53 to 20:09)	<0.001	07:17 (07:09 to 07:26)	0.11	11.3 (11.2 to 11.4)	0.003	11.2 (11.0–11.4)	0.057
	Never/sometimes	20:11 (19:52 to 20:29)	<0.001	07:13 (06:54 to 07:33)	0.61	11.0 (10.6 to 11.3)	0.001	10.8 (10.4 to 11.2)	0.005
		p-trend	<0.001	*p*-trend	0.23	*p*-trend	<0.001	*p*-trend	0.004

Sleep period is the time elapsed between the diary reported clock times that children fell asleep and woke the next morning. Sleep duration accounted for periods of wakefulness and was only collected when parents reported they knew how long their child had slept overnight. The statistical analysis was performed using multilevel linear regression to account for clustering of days within time points and children. All factors occupied separate models which were adjusted for child sex, age, socioeconomic status, maternal pregnancy age, parity, type of day, and season. Napping duration was modelled continuously. *p*-trend represents trend tests for ordered categories. With the exception of parent-reported sleep duration, models for South Asian children were based on the following sample sizes (*n*): napping frequency (participants: 155; time points: 193; days: 534), napping duration (participants: 126; time points: 151; days: 424), regular bedtime (participants: 153; time points: 186; days: 515), set bedtime (participants: 139; time points: 169; days: 474), adherence to bedtime (participants: 141; time points: 172; days: 481). For parent-reported sleep duration the sample sizes (*n*) for South Asian children were: napping frequency (participants: 136; time points: 167; days: 420), napping duration (participants: 113; time points: 133; days: 335), regular bedtime (participants: 135 time points: 162; days: 409), set bedtime (participants: 123; time points: 149; days: 387), adherence to bedtime (participants: 123; time points: 149; days: 383). With the exception of parent-reported sleep duration models for white children were based on the following sample sizes (*n*): napping frequency (participants: 191; time points: 277; days: 806), napping duration (participants: 180; time points: 249; days: 726), regular bedtime (participants: 188; time points: 274 days: 798), set bedtime (participants: 185; time points: 267; days: 776), adherence to bedtime (participants: 185; time points: 268; days: 783). For parent-reported sleep duration sample sizes (*n*) for white children were: napping frequency (participants: 187; time points: 265; days: 718), napping duration (participants: 176; time points: 237; days: 640), regular bedtime (participants: 184; time points: 262; days: 710), set bedtime (participants: 181; time points: 255; days: 692), adherence to bedtime (participants: 181; time points: 256; days: 700).

The use of sleep diaries is well documented to have both strengths and limitations. Sleep diaries are useful for exploring bedtime behaviours, routines and cultural practices. However, due to the time needed to complete diaries, obtaining complete results can be challenging. This may have contributed to the relatively low number of diaries completed in comparison to the BiB 1000 cohort size. Sleep diaries are also prone to error, and participant responses and can be biased by cultural expectations [6] and social desirability [35], which may affect the robustness of the outcomes reached. The sample was relatively small and larger studies using

objective sleep measures such as actigraphy in conjunction with sleep diaries would be needed to strengthen the observations and results found in this study. The majority of the South Asian population in our study had a Pakistani background, therefore extrapolating the results to other ethnic groups should be done with caution.

5. Conclusion

Parental reports of sleep onset, wake times and the duration of sleep of white and South Asian children at 18 and 36 months appear to be influenced by ethnic/cultural background, and regular set bedtimes are favourably associated with sleep onset, wake times and the duration of sleep in young children. The results suggest that sleep and bedtime interventions should accommodate cultural norms and expectations.

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Data availability

Data generated and analysed for the current study are available from the corresponding author on reasonable request.

CRediT authorship contribution statement

Elizabeth Pal: Writing – original draft, Writing – review & editing, Visualization. **Jane E. Blackwell:** Writing – original draft, Writing – review & editing. **Helen L. Ball:** Methodology, Investigation, Writing – review & editing. **Paul J. Collings:** Conceptualization, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization.

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