Sleep Medicine Reviews 16 (2012) 213–222

Contents lists available at ScienceDirect

Sleep Medicine Reviews

journal homepage: www.elsevier.com/locate/smrv

CLINICAL REVIEW

Normal sleep patterns in infants and children: A systematic review of observational studies

Barbara C. Galland [a,*], Barry J. Taylor [a,d], Dawn E. Elder [b,e], Peter Herbison [c,f]

[a] Department of Women's & Children's Health, University of Otago, PO Box 913, Dunedin, New Zealand
[b] Department of Paediatrics, University of Otago, PO Box 7343, Wellington, New Zealand
[c] Department of Preventive & Social Medicine, University of Otago, PO Box 913, Dunedin, New Zealand

ARTICLE INFO

Article history:
Received 28 April 2011
Received in revised form
12 June 2011
Accepted 13 June 2011
Available online 23 July 2011

Keywords:
Development
Meta-analysis
Normal sleep
Sleep diaries
Sleep questionnaires

SUMMARY

This is a systematic review of the scientific literature with regard to normal sleep patterns in infants and children (0–12 years). The review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Mean and variability data for sleep duration, number of night wakings, sleep latency, longest sleep period overnight, and number of daytime naps were extracted from questionnaire or diary data from 34 eligible studies. Meta-analysis was conducted within age-bands and categories. In addition, fractional polynomial regression models were used to estimate best-fit equations for the sleep variables in relation to age. Reference values (means) and ranges (±1.96 SD) for sleep duration (hours) were: infant, 12.8 (9.7–15.9); toddler/preschool, 11.9 (9.9–13.8); and child, 9.2 (7.6–10.8). The best-fit ($R^2 = 0.89$) equation for hours over the 0–12 year age range was $10.49 - 5.56 \times [(\text{age}/10)\text{^}0.5 - 0.71]$. Meta-regression showed predominantly Asian countries had significantly shorter sleep (1 h less over the 0–12 year range) compared to studies from Caucasian/non-Asian countries. Night waking data provided 4 age-bands up to 2 years ranging from 0 to 3.4 wakes per night for infants (0–2 months), to 0–2.5 per night (1–2 year-olds). Sleep latency data were sparse but estimated to be stable across 0–6 years. Because the main data analysis combined data from different countries and cultures, the reference values should be considered as global norms.

Introduction

Sleep-wake regulation and sleep states evolve rapidly during the first year of life with continued maturation across childhood. Because newborns do not have an established circadian rhythm, their sleep is distributed throughout the day and night with each period of sleep short because of feeding frequency.[1] At around 10–12 weeks of age, the circadian rhythm begins to emerge, and infant sleep becomes increasingly nocturnal.[2] Parents can aid the development of a regular nocturnal sleep pattern by facilitating social cues to sleep (e.g., by implementing consistent feed times and bed-time routines).[1] Between the ages of 1 and 4 years, children continue to take daytime naps in order achieve their sleep requirements.[3] Night wakings are common in infancy and early childhood. A variety of factors influence these but children's ability to return to sleep unaided plays a major role in determining whether or not wakings will persist and become problematic.[4] The frequency of night wakings is one of the main factors by which parents judge the quality of their child's sleep.[5] By age 5, daytime napping ceases and overnight sleep duration gradually declines throughout childhood, due to a shift to later bedtimes, with wake times remaining stable during the routine week.[3] However, sleep-wake patterns, driven by a complex interplay between biological processes, and environmental, behavioural and social factors, can vary widely. In infants and children, for example, daycare and school schedules, parenting practices and expectations, family routines and cultural practices, will all strongly influence sleep and timing. Added to this are individual differences in genetic make-up influencing sleep–wake regulation.

Measurement of sleep in infants and children can be subjective or objective. Subjective data are considered here, from sleep diaries or questionnaires filled out by the caregiver, or asked about in a structured interview. Across studies, several forms of sleep diaries have been used and adapted.[6,7] Diaries have been shown to have

* Corresponding author. Tel.: +64 3 4740999; fax: +64 3 474 7817.
E-mail addresses: barbara.galland@otago.ac.nz (B.C. Galland), barry.taylor@otago.ac.nz (B.J. Taylor), dawn.elder@otago.ac.nz (D.E. Elder), peter.herbison@otago.ac.nz (P. Herbison).
[d] Tel.: +64 3 4740999; fax +64 3 474 7817.
[e] Tel.: +64 4 3855999x6145; fax +64 4 3855898.
[f] Tel.: +64 3 479 7217; fax: +64 3 479 7298.

1087-0792/$ – see front matter
doi:10.1016/j.smrv.2011.06.001

a good correlation with objective measures recording sleep schedules over 24-h periods in the home, or for a designated number of days/weeks. However diaries are not so accurate for recording night waking; parents do not always recognise infant awakenings in which the infant has self soothed back to sleep and not audibly awoken.[8] There are many questionnaires, some of which are validated such as the Children's Sleep Habits Questionnaire and the Brief Infant Sleep Questionnaire.[9] The majority cover questions addressing universal sleep measures of bedtime, wake time and sleep duration and may or may not cover both weekday and weekend schedules.

An accurate description of normal sleep patterns in infants and children necessitates measurement and documentation of sleep patterns and requirements over a long period of rapid maturation, allowing for normal development, and in apparently healthy subjects. Data from prospective observational studies of longitudinal, or cross-sectional design can be used to portray this. Smaller studies can add to the datasets, but carry less weight. Extracting data from studies conducted after 1990 is necessary to relate the information to the current era because sleep duration (an indicator of sleep need) has apparently decreased across time probably in relation to modern lifestyle changes.[3,10] However a recent systematic review of the evidence that children are sleeping less has been challenged; Matricani et al.[11] found the evidence to be conflicting, of low methodological quality, and specific to particular populations.

As far as we are aware, no systematic reviews have been published specifically for infants and children. One covers objective polysomnographic measures from age 5 across the lifespan.[12] The usefulness of collating a systematic review is to provide a standard against which abnormal sleep patterns can be measured, to in turn inform policy and strategies for intervention, and to contribute to and advance our knowledge regarding developmental patterns of sleep. We have extracted and summarized age-specific data from sleep measures in relation to the quantity of sleep over a 24-h period, the number of episodes of waking during nocturnal sleep, the time taken to fall asleep (sleep latency), the longest sleep over a 24-h period, and the number of daytime naps.

Methods

The protocol and data extraction was conducted according to the 2009 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[13]

Literature search

A search strategy was developed to identify studies related to normal sleep patterns from birth to age 12. An extensive literature search of 5 electronic databases was conducted: Ovid MEDLINE, Web of Science, CINAHL, Scopus and PsycINFO. All databases were searched for relevant articles published from 1990 to 2010 whose title, abstract or keywords included reference to *sleep* and *infant* (age 0–23 months) or *child, preschool* (age 2–5 years) or *child* (age 6–12 years) and *diary* or *questionnaires* or *actigraphy*. The search was limited to English-language articles. Titles and abstracts were examined to extract potentially relevant articles, subsequently examined in more depth for inclusion/exclusion criteria by the main author (BG), and the research assistant (CL).

Inclusion and exclusion criteria

For inclusion, studies were required to fulfil the following criteria: a) original article, b) prospective cohort design, c) non-clinic studies, d) participants aged 0–12 years, e) sample was well described (e.g., number of subjects, gender, recruitment criteria, etc.), f) include one or more of the following variables of interest: sleep duration, sleep latency, number of night wakings, longest sleep period, number of daytime sleeps, g) data for variables of interest were presented numerically with a measure of central tendency and variance.

Studies were excluded if: a) case-control design was used, b) the work was published as a dissertation or abstract only, c) if more than one report from the same study was published, we included only the first publication with data meeting the inclusion/exclusion criteria.

Scientific literature quality assessment

The quality of the studies used in the review were evaluated by the Downs & Black quality index (QI) score system,[14] a validated checklist used for assessing the quality of non-randomized studies (as well as randomized controlled trials). The score system for non-randomized prospective studies consists of 19 items distributed between five subscales. Several of the questions were not relevant for observational studies; therefore a consensus was reached by the authors to use 11 of the questions. These 11 questions from the Downs & Black QI score system[14] were distributed among criteria for: reporting (5 subscales; questions 2, 3, 5, 7 and 9), external validity (2 subscales; questions 11 and 12), bias (2 subscales; questions 16 and 20), confounding (1 subscale; question 26), and power (1 subscale; question 27). The highest possible score was 12 because question 5 from the QI score system has a maximum score of 2, with all others, a maximum of 1. A QI score >8 was considered good, 5–8 moderate, and <5 of poor quality. Two investigators (BG and DE) scored the articles independently and discrepancies were resolved through discussion.

Data extraction

The mean and standard deviation (SD) or standard error (SE) data from variables of interest were extracted from the articles. When the studies included weekend and weekday data, weekday data were taken to align with the majority of studies and represent the routine sleep pattern. Where data for males and females were only available separately, data were combined.

Meta-analysis and reference values

Meta-analysis was conducted for sleep measures in appropriate age-bands identified within the 3 age group categories as follows: 1) infants (0–23 months), 2) toddlers (2–5 years), 3) child (6–12 years). The age-bands (e.g., 3–4 years) within age categories depended on the supply of data. Analysis was performed with the *metan* command in Stata statistical software version 11 using the mean and standard error for each study to produce the pooled estimate mean and the 95% confidence intervals (CIs). As the majority of data describing variability was given as the SD, the SE was calculated using the number of participants for each study. Reference values are given as the estimated mean and range; estimated range representing $1\text{SD} \times 1.96$ either side of the mean. An example of the meta-analysis to produce these reference values and ranges is given in Fig. 1 (sleep duration at approximately 9 months of age). In this example, the reference value (or pooled mean estimate) is 12.6 h and pooled estimated lower and upper 95% CIs are 12.53 and 12.67 respectively. To calculate the range, we assume normality and that 95% of all observations are located within the mean $\pm$ 1.96 SD. Thus using this example, the following calculations were performed to obtain the lower and upper range for the total sample size ($n = 2140$).

- $\text{SE} = (\Delta\text{CI}/2)/1.96 = 0.035$
- $\text{SD} = \text{SE} \times \text{SQRT}(n) = 1.65$

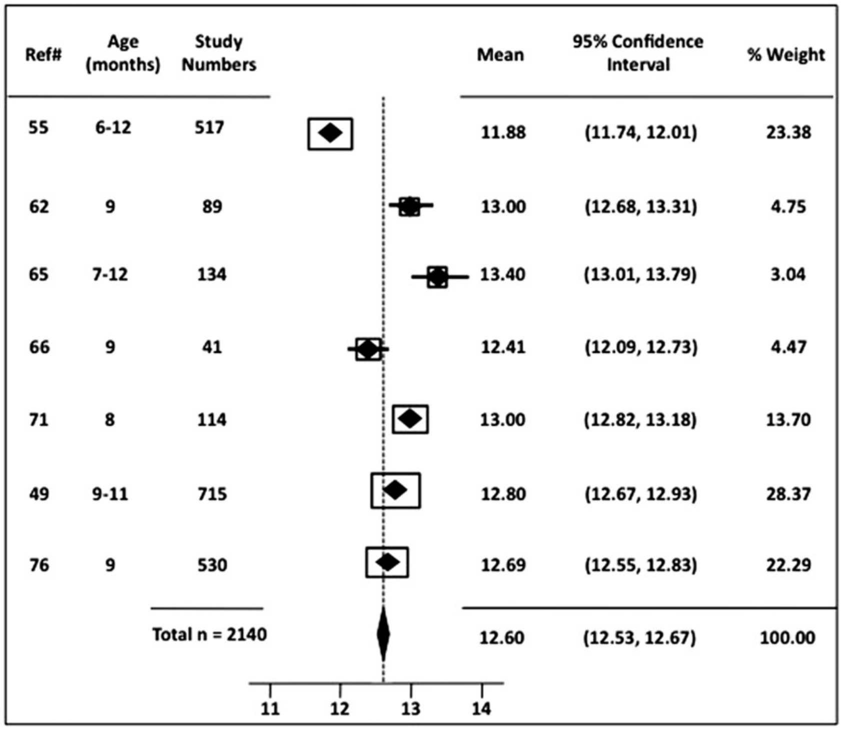

Fig. 1. A forest plot example of the meta-analysis using data from 7 studies to calculate the pooled mean estimate for sleep duration at approximately 9 months of age; heterogeneity test: $I^2 = 96.1\%$, $P < 0.0001$.

- lower range = mean − 1.96 × SD = 9.36
- upper range = mean + 1.96 × SD = 15.84

The QI score was not considered in the weighting for meta-analysis, rather *metan* creates its own weighting based on the inverse of the variance. Where the study data from a longitudinal study appeared more than once in the meta-analysis, we opted to take the first set of data within the longitudinal study, to avoid bias from an individual study contributing more than once to a dataset. Datasets excluded in the meta-analysis are denoted by an asterisk in the relevant Tables. For example, the study of Iglowstein et al.[15] contributes sleep duration data to the meta-analysis for each year from 6 to 12 years; the meta-analysis for 6–12 years incorporated the age 6 data only. A meta-regression of sleep duration was conducted using the *metareg* command in Stata for variables of interest; namely year of study publication and ethnic origin of study (predominantly Asian versus Caucasian/non-Asian).

Overall age-related trends

To describe age-related trends, the mean data were plotted for 4 sleep variables showing developmental trends (sleep duration, number of night wakings, longest sleep period and number of daytime naps). Weighted regression (weighted by 1/SE) was used to explore the relationship between the different outcomes and age. Fractional polynomials were used to calculate a non-linear relationship with age using the *fracpoly* command in Stata. As for the meta-analyses, where the study data from a longitudinal study appeared more than once, we took the first set of data to avoid bias by overweighting.

Results

Database searches

The search criteria from all databases (with duplicates eliminated) rendered 2114 articles (Fig. 2). Of those, 195 were deemed to be of potential interest and downloaded to examine and apply the more stringent inclusion/exclusion criteria. One hundred and forty-five articles were excluded, leaving 50 articles for review. Reasons for exclusion are listed in Fig. 2. During data extraction, a further 16 were excluded because age ranges were too wide or articles contained actigraphy data only that was subsequently excluded because of limited data for a meta-analysis. Data were captured by longitudinal design in 10 studies, and by cross-sectional design in 24. Three authors were contacted to obtain more numerical data, successful in two[76,8] with the data from one subsequently published.[46]

Articles reviewed

Table 1 summarizes the important aspects of the 34 articles included in this review. All studies recruited males and females; two did not supply a breakdown. In the majority, gender was evenly distributed (median M:F = 1.07). The review includes studies from 18 different countries. Higher points on the QI scale reflected a superior quality of investigation but did not negate data accuracy. Twenty-seven were considered good quality based on the criteria, with 6 of moderate quality and 1 of poor quality.

Sleep duration

Sleep duration was the most common sleep measure and was found in 82% of the articles, the majority from questionnaire data. Meta-analyses were conducted within age-bands for: infant (<2 months, 3 months, 6 months, 9 months, 1 year, 18 months and 2 years); toddler/preschool (2–3 and 4–5 years); child (6, 7, 8, 9, 10, 11 and 12 years), the results of which appear in Table 2. Fig. 3 illustrates a wide range in sleep duration in young infants and the inverse relationship between age and sleep duration with less variation around ages 5–6 through to age 12. The paucity of data around the toddler age group is evident. Fig. 4a plots the raw data for sleep duration (in hours) by age (years) for the best-fit fractional

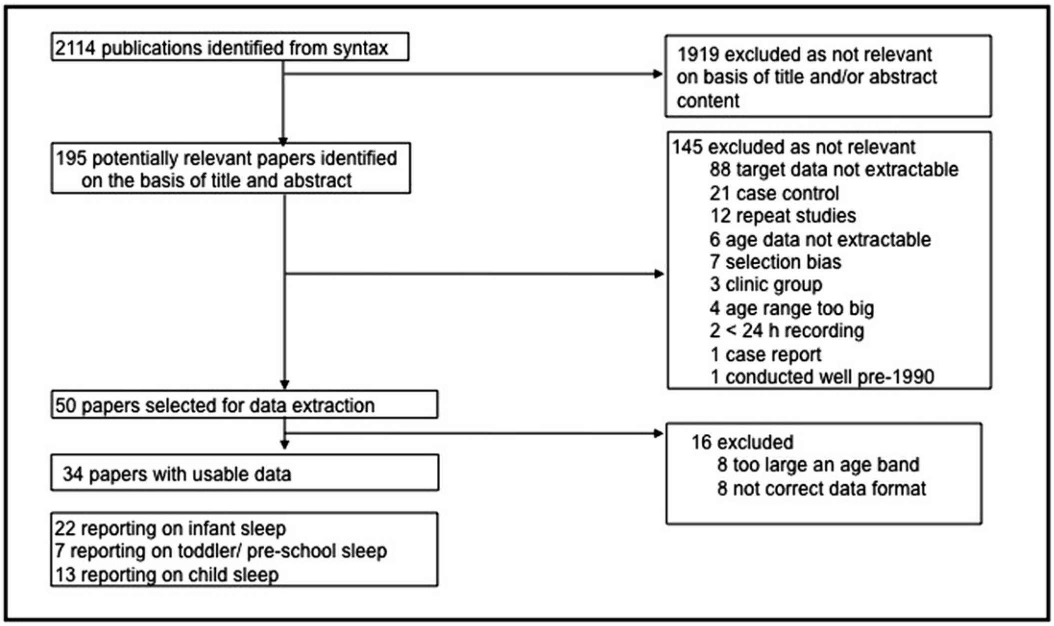

Fig. 2. Flow chart indicating the results of the systematic review with inclusions and exclusions.

polynomial regression model. The best-fit equation shown, calculates the decline in sleep duration at approximately 10.5 min per month between 1 and 6 months of age, slowing to 5.4 min per month between 7 and 12 months. Between 1 and 4 years, sleep duration declines at the rate of 7.8 min per year, and from 5 years to 12 years, at the rate of approximately 5.9 min per year.

Meta-regression analysis for sleep duration by year of publication produced no significant results, whereas cross-cultural analyses using country of origin did; sleep duration of children over the 0–12 year age range was shorter in the studies from predominantly Asian countries/regions (38 data points) compared to predominantly Caucasian/non-Asian countries (53 data points) by 59.4 min [95% CI, 7–111 min ($p = 0.025$)].

Number of night wakings

The number of night wakings was extracted from the "infant only" data in age-bands of 0–2 months, 3–6 months, 7–11 months and 1–2 years (Table 3). Ten studies contributed to the 21 strong dataset with all except one from cross-sectional studies. There was not enough data to combine beyond age 2. The best-fit equation for the number of night wakings over the first 24 months is given in Fig. 4b showing a decline in frequency from 1 month to 6 months at the rate of 0.33 wakes per month; 0.04 per month from 7 to 12 months, and 0.01 night wakings per month from 13 to 24 months. Data were highly variable but nevertheless showed an inverse relationship with age.

Sleep latency

Data were summarized according to infant category (Table 3) producing an average value of 19 min, but because only 2 studies contributed data beyond this age, values for toddler and child categories were not analysed. Individual studies reported mean sleep latencies for age 3–4 years[55] (17 min), 3–5 years[38] (17.4 min) and 5–6 years[55] (16 min).

Longest sleep period overnight

Data were available only across the infant age-bands of 0–5 months, and 6–24 months. Of all the sleep measures, this yielded the least amount of data, but nevertheless showed a trend for sleep to become consolidated with increasing age. Reference values for the longest sleep period increased from 5.8 to 8.4 h across these 2 age-bands (Table 3). The best-fit equation for the longest sleep period (LSP; h) over the first 24 months is shown in Fig. 4c. The longest sleep period increased from 1 month to 6 months at the rate of 39 min per month, slowing to 9.9 min per month from 7 to 12 months, and 5.1 min per month from 13 to 24 months.

Number of daytime naps

These data were confined to the infant age group producing age-bands for 0–5 months, 6–11 months and 1–2 years of age (Table 3). Three studies contributed to the full dataset with mainly cross-sectional data. The best-fit equation for the number of daytime naps over the first 24 months is illustrated in Fig. 4d. The number of naps from 1 month to 6 months decreased at the rate of 0.28 per month, from 7 to 12 months, 0.1 per month, and from 13 to 24 months, 0.09 per month.

Discussion

The main purpose of this systematic review was to provide mean reference values for normative sleep patterns in children from 0 to 12 years. Because the meta-analysis combined data from different countries and cultures, the reference values should be considered as international norms, rather than culture-specific norms. The quality of the data reported here cannot go beyond the quality of the individual studies included, and therefore cannot fully represent all studies published, as many did not reach our inclusion criteria. The results, we believe, will be useful in guiding an assessment of what is the normal range for each of the sleep measures at any given age. The line equations provide a summary of the age-related trends.

Sleep measures were assessed at one time point in the majority of studies. Although single measures of exposure may not accurately capture the changing patterns over time, developmental patterns were strongly evident. Large longitudinal studies provide the richest source of data for describing the evolution of normative sleep patterns within one population; 10 were included in this

Table 1
Description of the studies included for each age range and quality index score.

First author, reference number	Year	Country	Study numbers	M:F	Age			Measure	Design	Variables	Quality index score[a]
					0–23 months	2–5 years	6–12 years				
Walker[54]	1994	Australia	21	1.1	1 week, 8 weeks			D	L	SD	4
Ottaviano[55]	1996	Italy	2889	1.11	1–5 months, 6–12 months, 1–2 years			Q	X	SD, SL	6
Matthey[56]	2001	Australia	≈158	–	6 weeks, 6 months			Q	L	NW,DN	7
Iglowstein[3]	2003	Switzerland	493	1.13	6 months, 9 months, 1 year, 1.5 years	3,4 years	6,7,8,9,10, 11,12 years	Q	L	SD	7
Liu[57]	2003	China	517	0.89			7,8,9,10,11 years	Q	X	SD	8
Harrison[58]	2004	U.K.	56	0.87	6 weeks, 9 weeks, 12 weeks			D	L	SD	6
Spilsbury[59]	2004	U.S.A	755	1.01			8,9,10–11 years	Q	X	SD	10
Ng[60]	2005	Hong Kong	3047	0.99			6,7,8,9,10, 11,12 years	Q	X	SD	7
Fazzi[61]	2006	Italy	50	1.17	10–39 months (1.9 years)			Q	X	NW, SL	5
Montgomery-Downs[62]	2006	U.S.A	944	1.13	<1,1,2,6,9,12, 18 months			Q	X	SD, NW, DN	9
BaHammam[63]	2006	Saudi Arabia	1012	1.02			5–6,7,8,9 10,11 years	Q	X	SD	7
Sampei[64]	2006	Japan	117	0.48			5–6 years	Q	X	SD	5
Chaput[48]	2007	Canada	422	1.0			6.6 years	Q	X	SD	6
Chou[65]	2007	Taiwan	506	1.17	0–6,7–12, 13–24 months			Q	X	SD	7
De Leon[66]	2007	U.S.A.	41	1.73	9 months			D	X	SD, NW	6
Dollman[11]	2007	Australia	510	1.04			10–12 years	Q	X	SD	7
Li[67]	2007	China	19,299	0.94			5–6,7,8,9, 10,11 years	Q	X	SD	9
Meijer[68]	2007	Netherlands	107	1.06	2,7 weeks			Q	L	NW	8
O'Connor[69]	2007	U.K.	11,490	≈1.0	6,18 months			Q	L	SD, NW	10
Russo[70]	2007	Italy	1073	1.03			8,9,10,11,12 years	Q	X	SD	7
Kelmanson[71]	2008	Russia	114	0.78	2,8 months			Q	L	SD	8
Spruyt[72]	2008	Australia	20	1.86	3,6,12 months			D	L	SD	6
Werner[73]	2008	U.S.A.	50	1.27			5.9 years	Q, D	X	SD	7
Mindell[74]	2009A	U.S.A.	206	0.84	7–18 months	18–36 months		Q, D	X	NW, LSP, SL	7
Mindell[38]	2009	U.S.A.	1473	1.04	0–11 months	1–3 years, 3–5 years		Q	X	SL	7
Sadeh[49]	2009	U.S.A./Canada	5006	1.07	0–2,3–5,6–8, 9–11,12–17, 18–23 months	2–3 years		Q	X	SD, NW, LSP, DN	7
Thomas[75]	2009	U.S.A.	20	1.85	4–10 weeks			D	X	SD, LSP	6
Tikotzky[18]	2009	Israel	85	1.5	6 months			Q, D	L	SD, NW, SL	7
Xiao-Na[76]	2009	China	14,883	1.1	<1,2,3,6,9, 12,18 months,	2,3,4,5 years		Q	X	SD	8
Tikotzky[19]	2010	Israel	96	1.82	1,6,12 months			D	X	NW	8
Iwasaki[77]	2010	Japan	47	1.35		5 years		Q, D	X	SD, NW, SL	6
Canet[78]	2010	Spain	321	1.13			7–8 years, 9–10 years, 11–12 years	D	X	SD	7
Seo[79]	2010	Korea	3639	1.01			7,8,9,10, 11,12 years	Q, D	X	SD	8
Henderson[8]	2010	New Zealand	75	1.32	1,2,3,4,5,6,7,8,9,10, 11,12 months			D	L	LSP	6

D, diary; DN, daytime naps; L, longitudinal study design; LSP, longest sleep period; NW, night waking; Q, questionnaire; SD, sleep duration; SL, sleep latency; X, cross-sectional design.
[a] Quality index score was based on a scale of 0–12; see text for explanation.

report. However we could not combine longitudinal data within a single meta-analysis because the studies add bias by representing data from the same population at different time-points. Three of the five measures extracted mainly pertained to infant sleep, so not surprisingly the articles covering this age category were strongly represented (21 of the 34 articles). Reference values provided here combine studies covering large sectors of healthy populations. Though the majority will represent infants and children with non-problematic sleep, the prevalence of sleep problems (as assessed by parents) can be up to 30% in these age groups.[16,17] Two infant studies screened out sleep-related breathing problems.[18,19]

Sleep duration

The variability of reported sleep duration in the young is seen in the wide range of values in infancy. A strong inverse relationship with age was evident with the fastest rate of decline seen over the first 6 months of life. Most studies presented sleep duration as the

Table 2
Summary data for sleep duration (hours/24 h) across age-bands and age category.

Age-band or category	Reference number	Mean	Lower limit	Upper limit
0–2 months	54, 62, 76, 49, 18, 58, 75, 54*, 63, 71, 76	14.6	9.3	20.0
≈3 months	58*, 72, 49, 76	13.6	9.4	17.8
≈6 months	3, 62, 69, 72, 49, 76, 19	12.9	8.8	17.0
≈9 months	55, 62, 65, 66, 71*, 49, 76	12.6	9.4	15.8
≈12 months	3*, 62, 72, 49, 76, 19	12.9	10.1	15.8
1–2 years	55, 3*, 62, 65, 69*, 49, 76, 62, 76	12.6	10.0	15.2
All infants	All above excluding *	12.7	9.0	16.3
2–3 years	3, 62, 76, 65, 69, 49, 3, 76	12.0	9.7	14.2
4–5 years	3*, 76, 76	11.5	9.1	13.9
All toddlers	All above excluding *	11.9	9.9	13.8
≈6 years	3, 60, 63, 64, 48, 67	9.7	8.1	11.4
≈7 years	3*, 57, 60, 63, 67, 79	9.4	7.9	10.9
≈8 years	78, 3*, 57, 59, 60, 63, 67, 70, 79	9.3	7.8	10.8
≈9 years	3*, 57, 59, 60, 63, 67, 70, 79	9.3	7.8	10.8
≈10 years	78, 3*, 57, 59, 60, 63, 67, 70, 79	9.1	7.6	10.7
≈11 years	3*, 57, 60, 63, 11, 67, 70, 79	9.0	7.3	10.6
≈12 years	78, 3*, 60, 63, 70, 79	8.9	7.3	10.4
All children	All above excluding *	9.2	7.6	10.8

*Datasets not included in the "All" age category meta-analysis because the data came from longitudinal studies. See text for explanation.

number of hours over a 24-h period, with only 2 studies presenting the data as a percentage. Disappointingly, many research articles collected sleep duration data, but were excluded because the values were not reported numerically. For example, sleep duration was often subdivided categorically and some articles were rejected because they reported data by education grade rather than age.

Sleep duration in school-aged children is influenced by the start of the school day.[20] Weekday data were used for consistency, rather than the weekend data that includes variable "catch-up" sleep. Weekend/weekday differences however are more evident in adolescence where a strong preference for staying up later in the evening occurs as a function of both biology and environment, particularly so for males.[21] Bedtimes and wake up times would be useful for cross-cultural analyses as predominantly Asian countries have been shown to have shorter sleep duration due to later bedtimes.[22] Ethnic differences in relation to sleep duration are discussed later. Sleep duration data came from parental sleep diaries and questionnaires and therefore the data are subjective. More objective measures of sleep duration from actigraphy report variations of between 14 and 50 min less sleep compared with parental report (in children and infants respectively).[23,24]

The importance of measuring sleep duration and indicators for disrupted sleep is reflected in the literature. Cross-sectional studies show that inadequate quality or quantity of sleep in children can have negative impacts on daytime function with respect to behaviour,[25] cognitive development[26] and academic performance,[27] and can predispose children to more accidental injury.[28] Developmental trajectories link sleep problems at early ages with later behavioural and emotional problems[29] and some aspects of poorer neuropsychological functioning in adolescence.[30,31] Several cross-sectional and longitudinal studies have linked short sleep duration and sleeping problems with obesity[23,32,33] including a recent longitudinal study from this laboratory that has shown that children who do not get enough sleep (measured objectively) are at increased risk of becoming overweight, even after adjusting for multiple confounders.[34] Furthermore, during 6 years of observing 156 school children, investigators found that blood pressure was elevated in those who regularly had a shorter-than-average sleep duration compared with those who regularly had longer sleep.[35] However recent studies have provided evidence showing no link between short sleep duration and obesity.[36,37]

Night wakings

Night wakings and prolonged sleep onset impair sleep consolidation and shorten sleep. A developmental trend towards reduced night waking from birth to 2 years of age was shown but night waking produced the most variable data of all measures. Mindell et al.[22] report no differences between predominantly Asian and predominantly Caucasian cultures in relation to night waking, but show a developmental trend of reduced night waking from 0 to 3 years. Their data were collated from a large cross-cultural survey. We were unable to incorporate their data into our meta-analysis due to the lack of detailed information around study numbers for the smaller age groups. A clear omission from nearly all the datasets on night waking in infants was a breakdown by type of feeding. Breastfeeding has been associated with a higher frequency of awakenings.[38,39] Place of sleep was also omitted. Bedsharing has been linked to poorer infant sleep patterns when practiced sporadically,[4] however other studies have found bedsharing does not influence the quality or quantity of infant or maternal sleep when practiced habitually.[40–42] A more robust measure of night waking is derived from actigraphy as parental report may not identify some night waking. The values in this report derive purely from parental report.

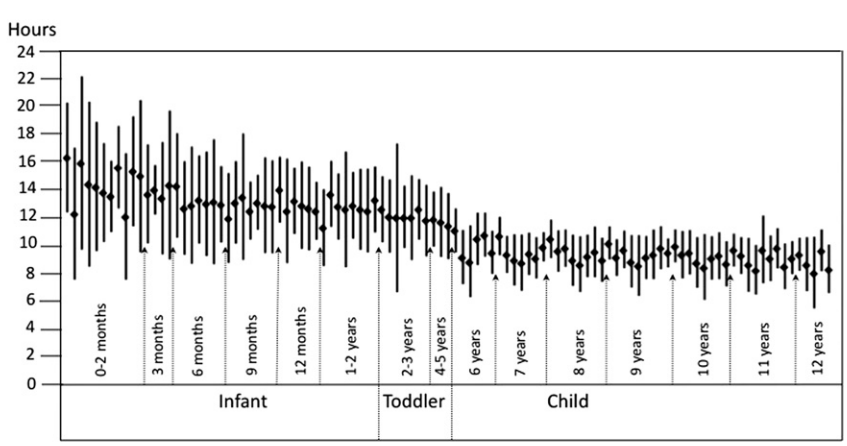

Fig. 3. Plot of the sleep duration data across age categories from all the studies reviewed for this variable. Data are presented as the mean ± 1.96 SD.

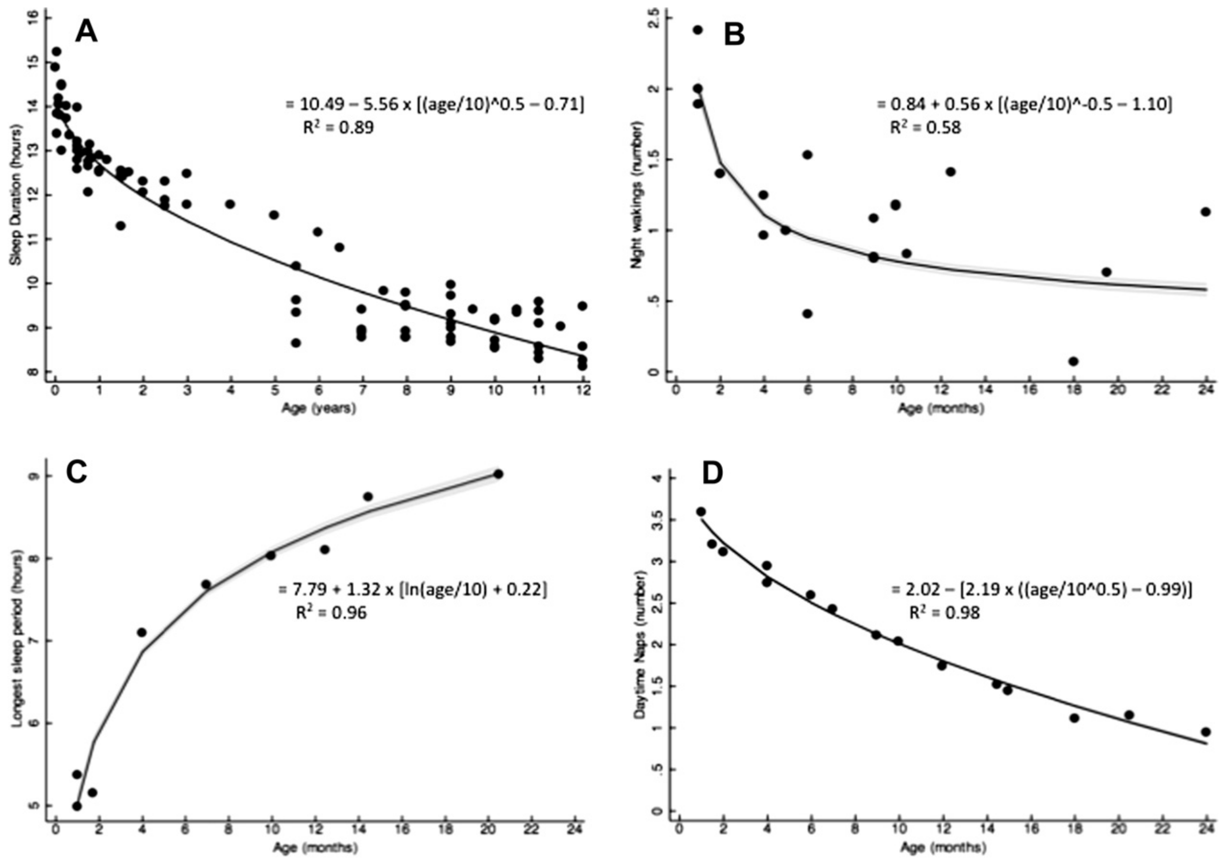

Fig. 4. Scatterplots of sleep duration (A) and age (0–12 years), the number of night wakings (B), longest sleep period (C), the number of daytime naps (D) and age (0–24 months), with the fitted best estimate equations for each sleep variable.

Sleep latency

We found sleep latency was on average, 19 min in infants aged 0–2 years and 17 min in 3–12 year-olds. Two studies covering toddler and early child age groups reported similar sleep latencies.[38,55] Unlike other variables, an age trend was not expected.

Table 3
Summary data for four sleep variables across age-bands and by age category in infants.

Variable	Age-band or category	Reference number	Mean	Lower limit	Upper limit
Night wakings (#)	0–2 months	56, 62, 68, 49, 76, 18	1.7	0	3.4
	3–6 months	56*,62, 69, 49, 76, 19	0.8	0	3.0
	7–11 months	25, 62, 66, 49, 76	1.1	0	3.1
	1–2 years	61, 62, 69*, 74, 49, 76	0.7	0	2.5
	All infants	All above excluding *	0.8	0	2.9
Sleep latency (min)	All infants (0–2 years)	19, 55, 19, 38, 55, 19, 74, 55, 61	19	0	43
Longest sleep period (h)	0–5 months	49, 75, 49, 8	5.7	1.8	9.6
	6–24 months	49, 49, 74, 49, 49, 8*	8.3	3.0	13.7
	All infants	All above	7.1	2.3	11.8
Daytime naps (#)	0–5 months	56, 49, 62, 62, 49	3.1	1.2	5.0
	6–11 months	56*, 62, 49, 62, 49	2.2	0.9	3.5
	1–2 years	62, 62, 49, 62, 49, 63	1.2	0.4	2.1
	All infants	All above excluding *	1.7	0.6	2.8

*Datasets not included in the "All" age category meta-analysis because the data came from longitudinal studies. See text for explanation.

Ohayon et al.[12] report slightly shorter average times through meta-analysis of objective measures, with no change in sleep latency between child and adolescent age groups. Sleep latency is an important measure because up to 16% of parents of school-aged children report their child has difficulty falling asleep and this will shorten sleep duration, because for most children wake up times are governed by the start of the school day. Sleep latency is strongly related to the homeostatic sleep pressure that has built since the last sleep period, and is influenced by many factors including the level of daytime exercise in children.[43] However sleep latency is a difficult measure to obtain reliably because it is over a short percentage of the 24-h day, and requires objective measures to record accurately as the difference between the exact time of going to bed (or more precisely, settling for sleep) and exact time of sleep onset. Parental reports tend to overestimate true sleep latency compared to objective measures of polysomnography.[44]

Longest sleep period

The longest sleep period measure yielded the least amount of data (4 studies, 10 datasets) but developmental trends moving towards lengthier "longest sleep periods" with age were evident. Within the first six months postpartum, most infants develop the ability to sustain longer episodes of sleep and begin to consolidate sleep towards the nighttime, taking on a sleep pattern similar to adults.[45] To define sleep consolidation, Henderson et al.[46] consider the longest sleep period as a measure of an infant's physiological capacity to sustain a long period of unbroken sleep. They recently introduced a new definition referring to the longest self-regulated sleep period (LSRSP) i.e., the longest period of behavioural quietude that includes the longest sleep period together with periods of nocturnal wakings where the infant transitions back to sleep without assistance. The LSRSP can only be obtained reliably with objective measures but has more scope for defining an infant's self-regulation of sleep-wake transition. The longest sleep period is not a variable of interest once nighttime consolidation has been reached; thus data beyond 2 years of age were rare. Again the lack of data on type of feeding is an important omission in these studies because breastfeeding has been linked to impaired sleep consolidation.[19,47,4]

Number of daytime naps

The number of daytime naps showed developmental trends up to the age of two. Like the longest sleep period, data were rare beyond the infant age range but most children discontinue daytime napping between 3 and 5 years of age.[45] In comparison with the survey results of Mindell et al.,[22] the current review found a mean of 1.7 naps per day (SD = 0.6) in 0–2 year-olds, compared with 1.83 naps per day (SD = 1.08) in the survey results. The cross-cultural study reports no difference in the number of naps across cultures, suggesting this sleep measure has a more biological than cultural basis. There are more data available before 1990 for this sleep measure, but to be consistent across all ages, only data covering modern-day practices were included. The number of daytime sleeps, for example, may be prescribed by routine practices incorporated in early child daycare centres. These are considered modern-day practices.

Gender and ethnic differences

Gender differences were not considered as separate analyses because of the lack of data. Three studies did consider gender,[48,10,49] all showing no significant difference in the sleep measures studied. One study excluded in the final selection, found no gender differences in sleep duration in children aged 5–12 years as measured by actigraphy.[50] Gender differences in sleep timing are more apparent once children reach puberty.[21] Ethnic differences were considered for sleep duration only in the context of the predominant culture of the study. In support of what some other studies have shown,[22,50] sleep duration of predominantly Asian cultures was shorter over the 0–12 year age range (1 h less). A comparison of school-aged children between China and the USA found parents reported children in China went to bed later and woke up earlier and their sleep duration was 1 h shorter than children from the USA.[50] We cannot ascertain if the difference we found relates more to one age category than another because the number of studies was not large enough to tease this out without losing statistical power. Furthermore, to look for any interaction effect requires linear data, which clearly the data are not. In the cross-cultural survey of 0–3 year-olds, Mindell et al.[22] reported the widest difference in sleep duration between predominantly Asian and predominantly Caucasian cultures was 101 min shorter in the former (mean differences estimated at 42 min). These differences were related to later bedtimes rather than daytime sleep and they suggest a strong culturally based influence to nighttime sleep behaviours. Interestingly, their nighttime waking data, when broken down into small age groups, graphically displays more nighttime waking in Asian cultures within each age group, inferring less consolidated sleep in addition to shorter sleep overall. If this trend is real, it makes the link between shorter sleep within Asian cultures more interesting in terms of why? One would expect more consolidated sleep to be associated with shorter sleep. Is there perhaps also a biological need for less sleep within Asian cultures? Or are the differences purely culturally based, resulting in more problematic sleep within Asian children as some studies seem to suggest?[22,50] Only in depth cross-cultural studies will be able to answer these questions. Our cultural findings are limited by not being able to include and control for demographic information, particularly socio-economic status (SES) within the analyses. One study has shown that race and SES of 2–7 year old children have independent relationships with sleep behaviour; independent of SES, African-American children slept less due to later bedtimes, but SES did play a role in reported sleep-related behaviour problems.[51] As well as ethnic differences in sleep patterns, the influence of the dominant culture on sleep practices of immigrants also needs consideration.[5]

Limitations

There were some limitations to this review. The first was the balance in age categories and participant numbers. There were small numbers in the toddler/preschool age category which limited the strength of data for this age group. The numbers of participants included in each study was variable, but the meta-analysis controlled for this by applying a weighting in calculation of the estimated mean. Secondly, the measures were from subjective data. Reliance on parental reports has both strengths and inherent limitations. The strength is that these normal values are what parents will report and enquire as to whether they are "normal" or not. However, we know that parents' awareness of night wakings is largely influenced by the child's inclination to signal this (as in crying or calling for attention) and parents have been reported to overestimate sleep duration tending to report times for going to bed and rising, rather than times for going to sleep and waking.[23,52] Thus, the biological significance of the findings of this review need to be validated against objective measures of the same sleep variables with actigraphy being the most likely tool to provide that measure in future studies. Thirdly, sometimes only a small number of studies could be included in the meta-analysis e.g., 4 studies were available for measures of the longest sleep period (0–5 months). A recent study discussed the numbers of studies required before a meta-analysis for an outcome in a systematic review settles down around a final value reporting that it takes a median of 4 studies to get within 10% of the final point estimate.[53] Finally, we were not in a position to make statements in regard to ethnic/cultural differences encountered in measures other than sleep duration in relation to country of origin.

Conclusions

In conclusion, normative data across the infant/child lifespan is important to collate to know what is outside of normal; to assess sleep complaints, to deal accurately with sleep problems, or provide preventive advice. Furthermore, knowledge of the wide variation in normal, particularly in the very young is important for dealing with infant/child sleep problems. Knowledge of the differences between Asian and non-Asian cultures regarding 24 h sleep duration is also important. The upper and lower limits of the ranges for sleep variables given in Tables 2 and 3, represent cut-offs that would be useful in clinical practice. The data were collated from parental reports about their child, therefore do not represent the more accurate physiological measures of sleep obtained by polysomnography, actigraphy or videosomnography. The subjective measures were obtained from: 1) sleep questionnaires that provided information about one point in time, or gave historical data, or 2) sleep diaries that, if maintained for a few weeks, can aid investigations of a child's sleep problem by studying longitudinal sleep patterns, and can be used for assessing before- and aftertreatment effects. We re-iterate that the reference values should be considered as international norms, rather than culture-specific norms.

Practice points

1) Sleep patterns show developmental trends for sleep duration (decrease 0–12 years), number of night wakings (decrease from 0 to 2 years), longest sleep period (increase from 0 to 2 years), and number of daytime naps (decreasing up to age 2).
2) Sleep duration is the most commonly reported sleep variable. It has a wide range in infancy with the greatest rate of change occurring within the first 6 months of life. Predominantly Asian countries report less sleep duration than non-Asian countries.
3) A clear omission from nearly all the infant studies is a breakdown to breast or bottle-feeding, well known to influence sleep patterns.
4) There are several aspects of sleep that have limited documentation; normal sleep patterns in the toddler age group, gender and ethnic differences, and weekday versus weekend differences across all age groups.
5) Studies publishing information on sleep patterns should present numerical data with measures of central tendency and variability so data can be incorporated into meta-analysis.

Research agenda

1) The findings of this review need to be validated against parental reports matched to objective measures of the same sleep variables.
2) More prospective large-scale longitudinal studies, rather than cross-sectional studies, are required to provide richer sources of data to document developmental patterns of sleep.
3) Research around cultural practices influencing sleep development is needed to provide culture-specific data.
4) The gap in the literature around the toddler age group, suggests this age needs to be targeted to better document normal sleep patterns before children's daytime routine is changed to fit school schedules.
5) The significance of the lower and upper limits of our data as cut-offs for problematic sleep need to be assessed for clinical application.

Acknowledgements

The Accident Compensation Corporation (ACC) of New Zealand funded the research. The funders had no role in the study design other than to specify the systematic nature and standard of the review. They had no role in data collection, data analysis, data interpretation or writing of the report. BG had full access to all the data in the study and had final responsibility for the decision to submit for publication. Views and/or conclusions in this article are those of the authors and may not reflect the position of ACC. The authors would like to thank the valuable input of Research Assistant Carmen Lobb (CL) into database entry and crosschecking final articles for the study, and Sue Weddell from the University of Otago Medical Library, for her assistance with developing the database search strategies for the scientific literature.

References

1. Davis KF, Parker KP, Montgomery GL. Sleep in infants and young children: part one: normal sleep. *J Pediatr Health Care* 2004;**18**:65–71.
2. Sheldon SH. Sleep in infants and children. In: Lee-Chiong T, Sateia MJ, Carskadon MA, editors. *Sleep medicine*; 2002. p. 99–103.
*3. Iglowstein I, Jenni OG, Molinari L, Largo RH. Sleep duration from infancy to adolescence: reference values and generational trends. *Pediatrics* 2003;**111**:302–7.
4. Touchette E, Petit D, Paquet J, Boivin M, Japel C, Tremblay RE, et al. Factors associated with fragmented sleep at night across early childhood. *Arch Pediatr Adolesc Med* 2005;**159**:242–9.
5. Palmstierna P, Sepa A, Ludvigsson J. Parent perceptions of child sleep: a study of 10 000 Swedish children. *Acta Paediatr* 2008;**97**:1631–9.
6. Richman N. A community survey of characteristics of one- to two- year-olds with sleep disruptions. *J Am Acad Child Psychiatry* 1981;**20**:281–91.
7. Barnard KE. *Nursing child assessment sleep activity manual*. Seattle, WA: NCAST Publications, University of Washington; 1979.
8. Henderson JM, France KG, Owens JL, Blampied NM. Sleeping through the night: the consolidation of self-regulated sleep across the first year of life. *Pediatrics* 2010;**126**:e1081–7.
9. Sadeh A. A brief screening questionnaire for infant sleep problems: validation and findings for an internet sample. *Pediatrics* 2004;**113**:e570–7.
10. Dollman J, Ridley K, Olds T, Lowe E. Trends in the duration of school-day sleep among 10- to 15-year-old South Australians between 1985 and 2004. *Acta Paediatr* 2007;**96**:1011–4.
11. Mattriciani L, Olds T, Willams M. A review of evidence for the claim that children are sleeping less than in the past. *Sleep* 2011;**34**:651–9.
*12. Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. *Sleep* 2004;**27**:1255–73.
13. PRISMA statement; 2010. Available from: http://www.prisma-statement.org/.
14. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998;**52**:377–84.
15. Iglowstein I, Hajnal BL, Molinari L, Largo RH, Jenni OG. Sleep behaviour in preterm children from birth to age 10 years: A longitudinal study. *Acta Paediatr* 2006;**95**:1691–3.
16. Bayer JK, Hiscock H, Hampton A, Wake M. Sleep problems in young infants and maternal mental and physical health. *J Paediatr Child Health* 2007;**43**:66–73.
17. Blader JC, Koplewicz HS, Abikoff H, Foley C. Sleep problems of elementary school children. A community survey. *Arch Pediatr Adolesc Med* 1997;**151**:473–80.
*18. Tikotzky L, Sadeh A. Maternal sleep-related cognitions and infant sleep: a longitudinal study from pregnancy through the 1st year. *Child Dev* 2009;**80**:860–74.
19. Tikotzky L, De Marcus G, Har-Toov J, Dollberg S, Bar-Haim Y, Sadeh A. Sleep and physical growth in infants during the first 6 months. *J Sleep Res* 2010;**19**:103–10.
20. Epstein R, Chillag N, Lavie P. Starting times of school: effects on daytime functioning of fifth-grade children in Israel. *Sleep* 1998;**21**:250–6.
21. Roenneberg T, Kuehnle T, Pramstaller PP, Ricken J, Havel M, Guth A, et al. A marker for the end of adolescence. *Curr Biol* 2004;**14**:R1038–9.
22. Mindell JA, Sadeh A, Wiegand B, How TH, Goh DY. Cross-cultural differences in infant and toddler sleep. *Sleep Med* 2010;**11**:274–80.
23. Nixon GM, Thompson JMD, Han DY, Becroft DM, Clark PM, Robinson E, et al. Short sleep duration in middle childhood: risk factors and consequences. *Sleep* 2008;**31**:71–8.
24. Sadeh A. Evaluating night wakings in sleep-disturbed infants: a methodological study of parental reports and actigraphy. *Sleep* 1996;**19**:757–62.
25. Scher A. Infant sleep at 10 months of age as a window to cognitive development. *Early Hum Dev* 2005;**81**:289–92.
26. Touchette E, Petit D, Seguin JR, Boivin M, Tremblay RE, Montplaisir JY. Associations between sleep duration patterns and behavioral/cognitive functioning at school entry. *Sleep* 2007;**30**:1213–9.
27. Curcio G, Ferrara M, De Gennaro L. Sleep loss, learning capacity and academic performance. *Sleep Med Rev* 2006;**10**:323–37.
28. Koulouglioti C, Cole R, Kitzman H. Inadequate sleep and unintentional injuries in young children. *Public Health Nurs* 2008;**25**:106–14.
29. Gregory AM, O'Connor TG. Sleep problems in childhood: a longitudinal study of developmental change and association with behavioral problems. *J Am Acad Child Adolesc Psychiatry* 2002;**41**:964–71.
30. Gregory AM, Caspi A, Moffitt TE, Poulton R. Sleep problems in childhood predict neuropsychological functioning in adolescence. *Pediatrics* 2009;**123**:1171–6.
31. Friedman NP, Corley RP, Hewitt JK, Wright KP. Individual differences in childhood sleep problems predict later cognitive executive control. *Sleep* 2009;**32**:323–33.

* The most important references are denoted by an asterisk.

32. Montplaisir J, Touchette E, Petit D, Boivin M, Tremblay R. Short sleep duration and risk of obesity in early childhood – a longitudinal study. *Sleep* 2007;**30**:A101–2.
33. Al Mamun A, Lawlor DA, Cramb S, O'Callaghan M, Williams G, Najman J. Do childhood sleeping problems predict obesity in young adulthood? Evidence from a prospective birth cohort study. *Am J Epidemiol* 2007;**166**:1368–73.
34. Carter PJ, Taylor BJ, Williams SM, Taylor RW. Longitudinal analysis of sleep in relation to BMI and body fat in children: the FLAME study. *BMJ* 2011;**342**:d2712.
35. Tonai S, Arakawa Y, Yanagisawa TM. Blood pressure in childhood and lifestyle. *J Pediatr Pract* 1995;**58**:1961–7.
36. Hassan F, Davis MM, Chervin RD. No independent association between insufficient sleep and childhood obesity in the National Survey of Children's Health. *J Clin Sleep Med* 2011;**7**:153–7.
37. Wake M, Price A, Clifford S, Ukoumunne OC, Hiscock H. Does an intervention that improves infant sleep also improve overweight at age 6? Follow-up of a randomised trial. *Arch Dis Child* 2011;**96**:526–32.
*38. Mindell JA, Meltzer LJ, Carskadon MA, Chervin RD. Developmental aspects of sleep hygiene: findings from the 2004 National Sleep Foundation Sleep in America Poll. *Sleep Med* 2009;**10**:771–9.
39. Quillin SI. Infant and mother sleep patterns during 4th postpartum week. *Issues Compr Pediatr Nurs* 1997;**20**:115–23.
40. Baddock SA, Galland BC, Bolton DPG, Williams SM, Taylor BJ. Differences in infant and parent behaviors during routine bed sharing compared with cot sleeping in the home setting. *Pediatrics* 2006;**117**:1599–607.
41. Quillin SI, Glenn LL. Interaction between feeding method and co-sleeping on maternal–newborn sleep. *J Obstet Gynecol Neonatal Nurs* 2004;**33**:580–8.
42. Mosko S, Richard C, McKenna J. Maternal sleep and arousals during bed-sharing with infants. *Sleep* 1997;**20**:142–50.
43. Nixon GM, Thompson JM, Han DY, Becroft DM, Clark PM, Robinson E, et al. Falling asleep: the determinants of sleep latency. *Arch Dis Child* 2009;**94**:686–9.
44. Goodwin JL, Silva GE, Kaemingk KL, Sherrill DL, Morgan WJ, Quan SF. Comparison between reported and recorded total sleep time and sleep latency in 6- to 11-year-old children: the Tucson Children's Assessment of Sleep Apnea Study (TuCASA). *Sleep Breath* 2007;**11**:85–92.
*45. Jenni OG, Carskadon MA. Normal human sleep at different ages: infants to adolescents. In: Sleep Research Society, editor. *SRS basics of sleep guide*. Westchester, IL: Sleep Research Society; 2005. p. 11–9.
46. Henderson JM, France KG, Blampied NM. The consolidation of infants' nocturnal sleep across the first year of life. *Sleep Med Rev* 2011;**15**:211–20.
47. Touchette E, Cote SM, Petit D, Liu X, Boivin M, Falissard B, et al. Short nighttime sleep-duration and hyperactivity trajectories in early childhood. *Pediatrics* 2009;**124**:e985–93.
48. Chaput JP, Tremblay A. Does short sleep duration favor abdominal adiposity in children? *Int J Pediatr Obes* 2007;**2**:188–91.
*49. Sadeh A, Mindell JA, Luedtke K, Wiegand B. Sleep and sleep ecology in the first 3 years: a web-based study. *J Sleep Res* 2009;**18**:60–73.
50. Liu X, Liu L, Owens JA, Kaplan DL. Sleep patterns and sleep problems among schoolchildren in the United States and China. *Pediatrics* 2005;**115**:241–9.
51. Crabtree VM, Korhonen JB, Montgomery-Downs HE, Jones VF, O'Brien LM, Gozal D. Cultural influences on the bedtime behaviors of young children. *Sleep Med* 2005;**6**:319–24.
52. Acebo C, Sadeh A, Seifer R, Tzischinsky O, Hafer A, Carskadon MA. Sleep/wake patterns derived from activity monitoring and maternal report for healthy 1- to 5-year-old children. *Sleep* 2005;**28**:1568–77.
53. Herbison P, Hay-Smith J, Gillespie WJ. Meta-analyses of small numbers of trials often agree with longer-term results. *J Clin Epidemiol* 2011;**64**:145–53.
54. Walker AM, Menahem S. Normal early infant behaviour patterns. *J Paediatr Child Health* 1994;**30**:260–2.
*55. Ottaviano S, Giannotti F, Cortesi F, Bruni O, Ottaviano C. Sleep characteristics in healthy children from birth to 6 years of age in the urban area of Rome. *Sleep* 1996;**19**:1–3.
56. Matthey S. The sleep and settle questionnaire for parents of infants: psychometric properties. *J Paediatr Child Health* 2001;**37**:470–5.
57. Liu X, Liu L, Wang R. Bed sharing, sleep habits, and sleep problems among Chinese school-aged children. *Sleep* 2003;**26**:839–44.
58. Harrison Y. The relationship between daytime exposure to light and night-time sleep in 6–12-week-old infants. *J Sleep Res* 2004;**13**:345–52.
59. Spilsbury JC, Storfer-Isser A, Drotar D, Rosen CL, Kirchner LH, Benham H, et al. Sleep behavior in an urban US sample of school-aged children. *Arch Pediatr Adolesc Med* 2004;**158**:988–94.
60. Ng DK, Kwok KL, Cheung JM, Leung SY, Chow PY, Wong WH, et al. Prevalence of sleep problems in Hong Kong primary school children: a community-based telephone survey. *Chest* 2005;**128**:1315–23.
61. Fazzi E, Zaccagnino M, Capsoni C, Orcesi S, Spada G, Cavallini A, et al. A questionnaire on sleep behaviour in the first years of life: preliminary results from a normative sample. *Funct Neurol* 2006;**21**:151–8.
*62. Montgomery-Downs HE, Gozal D. Sleep habits and risk factors for sleep-disordered breathing in infants and young toddlers in Louisville, Kentucky. *Sleep Med* 2006;**7**:211–9.
63. BaHammam A, Bin Saeed A, Al-Faris E, Shaikh S. Sleep duration and its correlates in a sample of Saudi elementary school children. *Singapore Med J* 2006;**47**:875–81.
64. Sampei M, Dakeishi M, Wood DC, Murata K. Impact of total sleep duration on blood pressure in preschool children. *Biomed Res* 2006;**27**:111–5.
65. Chou YH. Survey of sleep in infants and young children in northern Taiwan. *Sleep Biol Rhythms* 2007;**5**:40–9.
66. DeLeon CW, Karraker KH. Intrinsic and extrinsic factors associated with night waking in 9-month-old infants. *Infant Behav Dev* 2007;**30**:596–605.
67. Li S, Jin X, Wu S, Jiang F, Yan C, Shen X. The impact of media use on sleep patterns and sleep disorders among school-aged children in China. *Sleep* 2007;**30**:361–7.
68. Meijer AM, van den Wittenboer GL. Contribution of infants' sleep and crying to marital relationship of first-time parent couples in the 1st year after childbirth. *J Fam Psychol* 2007;**21**:49–57.
*69. O'Connor TG, Caprariello P, Blackmore ER, Gregory AM, Glover V, Fleming P. Prenatal mood disturbance predicts sleep problems in infancy and toddlerhood. *Early Hum Dev* 2007;**83**:451–8.
70. Russo PM, Bruni O, Lucidi F, Ferri R, Violani C. Sleep habits and circadian preference in Italian children and adolescents. *J Sleep Res* 2007;**16**:163–9.
71. Kelmanson IA. Infant sleep disturbances at two and eight months of age. *Somnologie* 2008;**12**:220–5.
72. Spruyt K, Aitken RJ, So K, Charlton M, Adamson TM, Horne RS. Relationship between sleep/wake patterns, temperament and overall development in term infants over the first year of life. *Early Hum Dev* 2008;**84**:289–96.
73. Werner H, Molinari L, Guyer C, Jenni OG. Agreement rates between actigraphy, diary, and questionnaire for children's sleep patterns. *Arch Pediatr Adolesc Med* 2008;**162**:350–8.
74. Mindell JA, Telofski LS, Wiegand B, Kurtz ES. A nightly bedtime routine: impact on sleep in young children and maternal mood. *Sleep* 2009;**32**:599–606.
75. Thomas KA, Burr RL. Accurate assessment of mother & infant sleep: how many diary days are required? *MCN Am J Matern Child Nurs* 2009;**34**:256–60.
*76. Xiao-Na H, Hui-Shan W, Jing-Xiong J, Yu-Yan M, Lin A, Xi-Cheng L. The epidemiology of sleep and its disorder in Chinese children aged 0–5 years. *Biol Rhythm Res* 2009;**40**:399–411.
77. Iwasaki M, Iwata S, Iemura A, Yamashita N, Tomino Y, Anme T, et al. Utility of subjective sleep assessment tools for healthy preschool children: a comparative study between sleep logs, questionnaires, and actigraphy. *J Epidemiol* 2010;**20**:143–9.
78. Canet T. Sleep–wake habits in Spanish primary school children. *Sleep Med* 2010;**11**:917–21.
*79. Seo WS, Sung HM, Lee JH, Koo BH, Kim MJ, Kim SY, et al. Sleep patterns and their age-related changes in elementary-school children. *Sleep Med* 2010;**11**:569–75.