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Title: Napping, development and health from 0-5 years: A systematic review

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ABSTRACT

Background Duration and quality of sleep affects child development and health.

Encouragement of napping in preschool children has been suggested as a health-promoting strategy.

Objectives To assess evidence regarding the effects of napping on measures of child development and health

Design A systematic review of published, original research articles of any design.

Subjects Children aged 0 to 5 years

Method Electronic data base search following PRISMA guidelines and assessment of research quality following a GRADE protocol.

Results Twenty-six articles met inclusion criteria. These were of heterogeneous quality; all had observational designs (GRADE-low). Development and health outcomes included salivary cortisol, night-sleep, cognition, behaviour, obesity and accidents. The findings regarding cognition, behaviour and health impacts were inconsistent, probably due to variation in age and habitual napping status of the samples. The most consistent finding was an association between napping and later onset, shorter duration and poorer quality of night sleep, with evidence strongest beyond age 2.

Limitations Studies were not randomised. Most did not obtain data on the children's habitual napping status or the context of napping. Many were reliant on parent report rather than direct observation or physiological measurement of sleep behaviour.

Conclusions The evidence indicates that beyond age 2 napping is associated with later night sleep onset and both reduced sleep quality and duration. The evidence regarding behaviour, health and cognition is less certain. There is a need for more systematic studies that employ stronger designs. In preschool children presenting with sleep problems clinicians should investigate napping patterns.

INTRODUCTION

The duration and quality of sleep has immediate, ongoing and long-term consequences for child development and health.[1,2] During early childhood, sleep patterns not only impact upon the individual child but can also have a profound effect on family functioning and parent well-being.[3] There is continuing emotive debate about what is optimal parenting practice with regard to sleep during early childhood.[4] While this controversy is not new, recent evidence on the significance of sleep for long-term child health has intensified this debate. Evidence linking sleep duration to health outcomes derives predominantly from studies of night sleep or total sleep in a 24-hour period. The findings have been extrapolated to infer the value of promoting napping, both in home and childcare contexts.[5] We sought to understand how well this assumption was founded. The purpose of the current review was to examine the state of evidence and current findings regarding the independent effects of napping on children's night sleep, behaviour, cognitive functioning and physical health from birth to 5 years.

Early childhood is a particularly important period in sleep development. From birth to 5 years is a time of normative transition in sleep patterns during which sleep gradually consolidates into the nighttime hours and daytime naps cease.[6] This is also a sensitive period in which children's sleep patterns are increasingly responsive to environmental modification.[7] The presence of napping across this transition might therefore reflect ongoing natural biphasic sleep patterns, or alternative mechanisms such as opportunistic sleep or compensation for inadequate night sleep.[5] A further complexity is that sleep achieved during a daytime nap may not be equivalent to that achieved at night, with reports of differences in sleep architecture,[9,10], circadian timing,[8] and developmental salience.[11]

Understanding the independent contribution of napping within the range of sleep factors influencing child development and health is significant to inform parents, non-parental carers and health professionals about optimal sleep practices. The current systematic review was therefore undertaken to assess the evidence regarding costs and benefits of napping for the development and health of children aged 0-5 years.

METHODS

A review protocol was developed by the authors using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Guidelines.[12]

Search strategy

An extensive search for relevant studies was carried out on the 8th of January 2014 using the following electronic databases; Medline (via Ebscohost), PsycINFO (via Ebscohost), CINAHL (via Ebscohost), Web of Science, Scopus and ERIC (via Ebscohost). Searches were conducted to identify papers that contained the following key words: ("daytime sleep" OR nap* OR "day?sleep" OR "sleep consolidation") AND (cognition OR behavior OR "physical Health" OR "night sleep") AND (child* OR infant OR bab*). The search strategies were developed in consultation with a Health Liaison Librarian.

The exact search terms and limiters used for each database are listed in the online supplementary material Table S1. Reference lists from papers identified by searches were also examined to identify potential papers for inclusion.

Inclusion criteria

All published, original research articles that examined the independent effects of napping on night sleep, behaviour, cognition, and physical health, in children aged 0-5 years were included for review. Napping was defined as periods of sleep, measured using observational, parent/carer or self-report, or physiological measurement that occurs during daytime hours. Studies that included napping as part of total or 24-hour sleep measurement were included

only if the effects of the napping component could be reasonably differentiated from the effects of night-time sleep, or if napping was indicated by a ratio of day-to-night-time sleep (an index of sleep consolidation).

Selection of studies

A three step approach to the selection of studies was undertaken. First, two review authors (ES and SSt) independently examined the title and abstract of all records identified via searches to determine if they met the inclusion criteria. Second, full-text versions of relevant studies were obtained and the same review authors independently examined the details of each to determine if they meet the pre-determined criteria. The rationale for inclusion or exclusion of a study was documented by each review author. Finally, decisions for inclusion and exclusion of full-text articles were discussed with additional members of the research team (KT, SSm, CP) and a consensus method used to resolve any disagreements.

Grading of study quality

To assess the quality of each article we employed a GRADE system.[13,14] GRADE first assigns a quality score for study design. Randomised control trials are scored as high quality, and observational studies, including longitudinal, quasi-experimental and correlational designs, are scored as low quality. In the study of napping, experimental designs that manipulate napping and longitudinal studies that provide detail of the sequencing of effect of night and day sleep are significant in showing direction of effect. For this reason we increased GRADE score by 1 point for design when studies were experimental or longitudinal. Additionally, GRADE deducts or adds points if aspects of the methodology increase or decrease the certainty of the result. In assessing the quality of research for this study, we reduced scores if key methodological features decreased certainty of the findings regarding sleep in early childhood (low objectivity of the sleep measure, low quality data on habitual napping). We also reduced scores if there were general methodological features that

reduced certainty (reporting bias, poor control of confounders, low levels of observation). GRADE also makes provision for increasing scores if high effect size is found, however, as the outcomes and their measurement were diverse, comparison and grading would be arbitrary and was not undertaken and precluded meta-analyses. Instead, for this review we were dependent on consistency of direction of result only. The GRADE criteria for this review are documented in online supplementary material Table S2. Using these criteria two authors (KT, ES) each graded the studies. The authorship team undertook a final review to ensure consensus.

RESULTS

Database search and data extraction

Figure 1 presents the data extraction records for each stage of the search. Of the initial 781 papers identified after exclusion of duplicates, 26 met the criteria for inclusion. Most papers reported on a single outcome, but 2 report on more than one outcome. An overview of the key details of the 26 papers arranged by outcome measure is presented in Table 1.

Designs and Methodologies

There were no randomised control trials within the corpus of studies. There was a heterogeneous group of observational studies that included experimental ($n=5$), quasi-experimental ($n=6$), longitudinal ($n=6$), and cross-sectional designs ($n=9$). The description of each study and their findings are summarised in Table 1 and summary of quality and GRADE score in Table 2. It should be noted that the sample sizes are generally small and therefore present challenges for generalizability. In addition, the studies using correlational designs had varying levels of statistical control. Where such factors present a major concern for interpretation this is noted in Table 2.

Table 1. Summary of papers

Author	Year	Country	Design	Sample N	Age (months)	Findings
NIGHT SLEEP						
Fukuda[15]	2002	Japan	Quasi-experimental	441	42-72	Later night sleep onset time occurs following a day nap. Napping does not occur as a response to loss of night sleep
Ward[16]	2008	USA	Cross-sectional	52	36-60	Napping was associated with, more night awakenings and reduced night sleep duration but not reduced total sleep
Yokomaku*[17]	2008	Japan	Quasi-experimental	135	48-72	Children in families with late evening schedules had longer nap duration and less night sleep
Komada[18]	2012	Japan	Longitudinal	967	0-60	Duration of napping and later end of nap time was associated with later bedtime on the corresponding night and
Iwata[19]	2011	Japan	Cross-sectional	48	60	Nappers had later sleep onset, longer sleep latency , later sleep end time and more parent reported sleep problems
Lam*[20]	2011	USA	Cross-sectional	59	36-60	Increased nap duration associated with decreased night sleep duration
El-Sheikh[21]	2013	USA	Cross-sectional	63	36-60	Poor quality of sleep in the day associated with poor quality night sleep. Quality defined by number of wake minutes, sleep efficiency and sleep activity. No association between duration of day and night sleep
Jones[5]	2013	UK	Cross-sectional	84	36	Greater napping duration associated with decreased night sleep but not total sleep duration.
Cairns[22]	2014	USA	Longitudinal	34	60	Reduced napping was associated an increase in night time sleep and a reduction in total weekday sleep.

BEHAVIOUR						
Spruyt[23]	2008	Australia	Longitudinal	20	0-12	At 12 months decreased daytime sleep associated with higher emotional regulation and total behavioral development scores BSID-II
Yokomaku*[17]	2008	Japan	Quasi-experimental	135	48-72	Longer nap duration was associated with higher scores on the withdrawn, anxious/depressed and thought problems subscales of the CBCL
Lam*[20]	2011	USA	Cross-sectional	59	36-60	Napping not associated with behavior BASC-II
Berger[24]	2012	USA	Experimental	10	30-36	Nap restriction affects emotional response-children more negative and confused in face of negative stimuli, and less able to respond positively to positive stimuli
Hall[25]	2012	Canada	Cross-sectional	58	12-36	Reported problems with napping at home and daycare associated with increased emotional problems and poorer adaptation to preschool
COGNITION						
Gómez[26]	2006	USA	Quasi-experimental	48	15	Napping after a language learning task improved language abstraction
Hupbach[27]	2009	USA	Quasi-experimental	24	15	Infants who napped had better performance on language abstraction 24 hours later
Dionne[28]	2011	Canada	Longitudinal	1029	6-60	Poor sleep consolidation associated with poorer language development
Lam*[20]	2011	USA	Cross-sectional	59	36-60	Napping negatively associated with cognitive function
Kurdziel[10]	2013	USA	Quasi-Experimental	40	36-66	Naps support memory among habitual nappers only– polysomnography suggests a role of sleep spindles in memory
Lukowski[29]	2013	USA	Quasi-	21	10	Nap related to encoding and generalisation at 2 hours but

Werchan[30]	2014	USA	experimental Experimental	27	24-60	not delayed recall Non-nappers perform better on word generalisation
HEALTH						
Valent[31]	2001	Italy	Cross-sectional	113	0-60	In males accidents associated with less sleep including nap. Independent effect of nap not certain
Touchette[32]	2008	Canada	Longitudinal	2223	6-72	Nap duration at 2.5 years was not significantly associated with odds of being overweight/obesity at 6 years.
Jiang[33]	2009	China	Cross-sectional	1311	36-48	Nap duration not associated with odds of obesity.
Bell[34]	2010	USA	Longitudinal	882	0-60	Napping was not associated with BMI.
Boto[35]	2012	Portugal	Quasi- experimental	413	12-60	Children who nap had significantly less risk of accidents
CORTISOL						
Larson[36]	1991	USA	Quasi- experimental	24	8-11	Naps temporarily reduced cortisol levels but rose to pre- nap level after 45 minutes
Watamura[37]	2002	USA	Cross-sectional	35	34-51	No napping variables related to cortisol rise/no diff between home and ECEC
Gribbin[38]	2011	USA	Experimental	7	30-48	Cortisol Awakening Response occurred after morning and afternoon napping but was diminished following an evening nap

*Papers appear multiple times in table.

Table 2: Quality of papers

Author	Nap Measurement	Certainty of habitual/non-habitual napping status	Certainty of finding	Other comments on quality	GRADE Score
Fukuda[15]	Standard report measure	Yes	Other concern	<7 days sleep data	0
Ward[16]	Objective, Standard report measure	Probable	Other concern	<7 days sleep data	0
Yokomaku[17]	Standard report measure	Probable	No concern	Group comparison but with check for group confounders	0
Komada[18]	Standard report measure	Yes	No concern	Detailed analysis of day/night correspondence, large sample looks across ages 1-5 years	1
Iwata[19]	Objective, Standard report measure	Yes	No concern	Provides data on non-routine and late-onset naps	2
Lam[20]	Objective, Standard report measure	Yes	No concern	Take account of weekend variation Detailed measurement	2
El-Sheikh[21]	Objective, Standard report measure	Probable	Other concern	<7 days sleep data	0
Jones[5]	Standard report measure	Probable	Other concern	<7 days sleep data	0
Cairns[22]	Objective, Standard report measure	Yes	No concern	Detailed longitudinal tracking across the transition from kindergarten to school	3
Spruyt[23]	Objective, Standard report measure	Yes	No concern	Sleep assessed 3 consecutive days every month for 12 consecutive months	3
Berger[24]	Objective, Standard report measure	Yes	No concern	Well controlled study	3

Hall[25]	Standard report measure	Probable	Insufficient control of confounders	No information on family background variables	0
Gómez[26]	Standard report measure	Probable	No concern	Appears napping behaviour is mother report	1
Hupbach[27]	Objective	Probable	No concern	Small experimental study with adequate control	2
Dionne[28]	Standard report measure	Yes	No concern	Sample of 1029 twins studied over 5 years with focus on sleep consolidation. Uses standardised measures of language development	2
Kurdziel[10]	Objective	Yes	No concern	Detailed study including polysomnography	2
Lukowski[29]	Standard report measure	Yes	No concern	Study is limited to habitual nappers only	1
Werchan[30]	Nap (yes/no)	Yes	No concern	Outcome focus learning generalisation	1
Valent[31]	Standard report measure	No	Probability of reporting bias	Retrospective recall following accident	0
Touchette[32]	Standard report measure	No	Other concern	Napping is an indirect focus with insufficient detail	0
Jiang[33]	Standard report measure	No	No concern	Total populations (no refusals)	0
Bell[34]	Standard report measure	Yes	No concern	Statistically controlled for a large number of relevant child and family characteristics	1
Boto[35]	Standard report measure	No	Probability of reporting bias; insufficient control of confounders	Retrospective recall following accident; Comparison groups: accident and emergency centre with child centre	0

Outcomes

The consistency of benefit or cost to the child was examined with reference to study quality. Three studies examining the association of napping with changes in salivary cortisol were not included in this process because the meaning of the outcomes could not be interpreted in terms of benefit or cost to the child. A summary of the direction of findings for all other outcomes are presented in Figure 2.

The most consistent finding was an association between napping and night sleep. Table 3 provides a summary of the magnitude of findings and documents a moderate association of napping with night sleep patterns including later sleep onset,[15,18,19] reduced duration,[16,17,20,5] and quality indices [16,19,20]. Three studies examine differences in total 24-hour sleep duration and report no difference between those who do and do not nap, indicating that daytime napping changes the distribution, rather than the duration, of sleep in a 24 hour period.[5,16,20] However, Cairns and Harsh[22] in a study of transition to school report reduction in total sleep duration which they attribute to loss of naps. Notably, eight of the studies of nighttime sleep were of children beyond the age of 2 years, a point at which there is a significant decline in habitual napping.[6] Three papers provide evidence of direction of association. Komada *et al*[18] presents evidence of the direction of the relationship through a detailed study of nine consecutive 24-hour periods in a sample of 967 children aged 0-5 years. The study reports that there were not significant differences in night sleep associated with duration of napping in children younger than 2. Beyond 2, however decreased sleep duration and later bedtime occurred on nights following napping. Fukuda and Sakashita[15] report that among children attending Kindergarten, where napping is optional, the onset of night sleep was later on evenings following a nap compared with onset on days in which the same children had not napped. Napping was not found to be a response to shorter sleep duration on the night preceding a nap. Iwata *et al*[39] presents data on children

who are non-habitual nappers attending nursery during weekdays, where naptime is compulsory, and compares their weekday and weekend sleep. During weekends most children did not nap and had earlier sleep onset, and shorter sleep latency. A subgroup of children, however, had late unplanned naps that increased the onset and decreased the quality of their nighttime sleep. A likely explanation for these findings is that napping acts to dissipate homeostatic sleep pressure,[8] with this mechanism evidence by increased sleep latency and later sleep onset. Together the evidence suggests that, beyond age 2 napping can influence night sleep patterning.[15,18,39] The meaning of these affects, however, remains uncertain.

Table 3. Summary of the magnitude of significant findings regarding napping and child outcomes.

Author	Outcome and analysis	Outcome magnitude
<i>Night Sleep</i>		
Fukuda[15]	<i>Sleep onset time</i> Within subject comparison – same child on napping and non-napping days	Mean 28 minutes later sleep onset following daytime nap.
Ward[16]	<i>Duration of night sleep and number of night awakenings</i> Group comparison – nappers and non-nappers	Mean 48 minutes shorter duration of night sleep for napping children. Mean 0.8 more awakenings for napping children.
Yokomaku[17]	<i>Duration of night sleep</i> Group comparison – late versus early family schedule	Children with late family schedule had mean of 24 minutes more nap duration and mean of 80 minutes less night sleep and 57 minutes less total sleep per day.
Komada[18]	<i>Bedtime on corresponding night</i> Group comparisons across 4 napping duration groups (no nap, <1 hr, <2 hrs, ≥ 2 hrs) and group differences in relationship to nap start and end time.	Mean between 10-40 minutes later bedtime across groups on night following a nap. Later bedtime when nap has later end-time for 3 and 4-year-olds (figures not provided).
Iwata[19]	<i>Night sleep latency, onset time, end time and parent reported sleep problems</i> Correlation with incidence of napping	Incidence of napping associated with increased night sleep latency: $r = .47$ moderate effect. Trend towards later night sleep onset time, end time and increased parent reported sleep problems (figures not provided).
Lam[20]	<i>Duration of night sleep</i> Correlation with duration of napping	$r = -.51$ moderate effect
El-Sheikh[21]	<i>Quality* of night sleep</i> Partial correlation with quality of day sleep - controlling for age gender, ethnicity and BMI.	Poor sleep quality during the day associated with poor sleep quality at night – significant correlations ranging from $r = .30$ to $r = .60$ moderate effect
Jones[5]	<i>Duration of night sleep</i> Correlation with duration of napping	$r = -.25$ small effect
Cairns[22]	<i>Duration of night and total weekday sleep</i> Group (preschool or not) by time (before and after entry to school) comparison	Reduced reduction in total weekday sleep. Attributed by authors to loss of napping (figures not provided).

Behavior		
Spruyt[23]	Emotional regulation and behavioral development Correlation with diurnal sleep duration	At 12 months reduced diurnal sleep duration associated with higher emotional regulation, $r=.77$ large effect, and higher behavioral development $r=.68$ moderate effect.
Yokomaku [17]	Behavior problems <i>Correlations with nap duration</i>	Increased nap duration associated with increased withdrawal $r=.18$ small effect, anxious/depressed $r=.21$ small effect thought problems $r=.19$ small effect
Berger[24]	Emotion responses <i>Pairwise between nap and no-nap condition</i>	Following no-condition children showed a 31% increase in worry/anxiety (Cohan's $d=0.60$ medium effect) and 34% decrease in positive emotion (Cohan's $d=0.98$ large effect).
Hall[25]	Behavior Problems and preschool adjustment <i>Correlation with parent reported difficulty settling for naps</i> <i>Number of naps per day</i>	Increased difficulty settling for naps associated with higher anxious/depressed $r=.32$ moderate effect, withdrawn $r=.34$ moderate effect total internalizing problems $r=.30$ moderate effect. Increased number of naps associated with teacher reported decreased ego-strength $r=-.29$ small effect and pro-social behavior $r=-.33$
Cognition		
Gómez[26]	Abstraction in language learning <i>Between group comparison; nap versus no-nap condition</i>	Language abstraction was significantly greater for the nap compared the no-nap condition, $d=.38$ small effect
Hupbach[27]	Abstraction in language learning <i>Between group comparison; nap versus no-nap condition</i>	Children who napped following a language learning task compared with those who did not nap had an average of 24 second faster recognition response 24hrs latter.
Dionne[28]	Language development <i>Association with ratio of consecutive day to night sleep</i>	Higher ratio of day to night sleep at 6 and 18-months associated with poorer language outcomes at 30 and 60-months. $r= .14-.16$ small effect.
Lam [20]	Language and Number Recall Partial correlation with duration of weekday napping controlling for age	Longer duration of napping associated with lower scores for language $r=-.33$ moderate effect and lower scores for number recall $r= -.27$ small effect.
Kurdziel[10]	Delayed and 24hr recall accuracy Children who did and did not nap.	10% drop in accuracy for children who did not nap across a 24hr period. 15% drop for habitual nappers, no significant drop for non-habitual nappers (2%).

Lukowski[29]	<i>Elicited imitation scores</i> Correlation with day sleep duration	Children who napped for longer had higher scores on imitate imitation $r = .66$ large effect and generalization $r = .50$ large effect.
Werchan[30]	<i>Generalization of word learning</i> Between group comparison (nap versus no-nap)	Children in no-nap group had increased scores for generalization task, $r = .97$ large effect.
Health		
Valent[31]	<i>Accidents</i> <i>Comparison of children who did and did not sleep within the 8 hours preceding accident (only those presenting between 4pm and midnight).</i>	3-5 year old males who did not sleep in preceding 8 hours had a 5-fold increase in risk of accident.
Boto[35]	<i>Accidental falls</i> <i>Differences napping (yes/no) in previous 24 hours.</i>	Among 1-2 year old there was 22% higher incident of accidental fall in children who had not napped and among 3-5 year old a 12.2% higher incident of accidental fall in children who had not napped.

*Quality defined as number of wake minutes, sleep efficiency and sleep activity
Note. Effect Size Cut-offs; Cohen's d Small = 0.3, Medium = 0.5, Large = 0.8;
 Correlation coefficient r Small = 0.1, Moderate = 0.3, Large = 0.5.

Behavioural outcomes were examined by four studies. Berger *et al*[24] report an experimental study of sleep restriction among children, age 30-36 months, trained to a nap schedule. Under these conditions a reduction in positive facial emotional responses and increase in negative facial emotional responses to visual stimuli and problem solving were found. Three studies are non-experimental. Spruyt *et al*[23] in a detailed 12 month longitudinal study reports that children with easier temperament napped more readily but, at 12 months decreased daytime sleep was associated with better emotional regulation as measured by the Bayley Scales of Infant Development (BSID-II). Two studies report association with internalising behavioural problems using the parent-form of the Child Behaviour Check List.[17,25] Yokomaku *et al*[17] found longer nap duration among 4- to 6-year-olds was associated with greater anxiety/depression, withdrawal and thought problems, while Hall *et al*,[25] found that among 1- to 3-year-olds difficulty settling for naps at home

was associated with anxiety, depression, withdrawal and internalising behaviour. Additionally, Hall *et al*[25] obtained teacher report using the Preschool Adjustment Questionnaire and Preschool Behaviour Questionnaire. There were inconsistent outcomes; higher daily frequency of napping was associated with less prosocial behaviour and reduced ability to deal with challenges, while difficulty settling for naps was associated with poorer behaviour and poorer adjustment at preschool. The difference between the experimental study and non-experimental studies are most likely explained by two processes. First, while the experimental study focuses on disruption of habitual napping,[24] the non-experimental studies focus on normally occurring nap behaviours.[17,23,25] Second, two of the non-experimental studies were of children who attended preschool settings.[17,25] The preschool setting may be a factor explaining the association of problems settling for naps and behavioural difficulties because these contexts often mandate naptime and may not be environmentally conducive to napping.[40] Both the stage in developmental sleep transition and the environmental context of napping are significant factors in interpretation of results.

Studies of cognitive outcomes also present a mixed picture. Three studies report that language learning is improved following a nap,[10,26,27] while another reports being awake rather than napping improves language generalisation.[30]. The age of children and the task used to assess learning may be implicated in these findings but there is currently insufficient evidence to speculate on cause of this inconsistency. An important factor in interpretation of effect, however, is the habitual napping status of the children. Kurdziel, Duclos and Spencer[10] report a positive effect of napping on learning and memory consolidation in preschool aged children, but with benefit only for habitual nappers. Two further studies suggest that sleep consolidation (ratio of night to day sleep) is a key marker of cognitive maturity.[20,28] Dionne *et al*,[28] using a longitudinal twin design, mapped the association of sleep consolidation from 6 to 30 months on language development at 60 months. They

report that later sleep consolidation is a risk factor for language delay while more rapid sleep consolidation positively predicts language learning.[28] Similarly, Lam *et al*[20] report that daytime napping was associated with poorer neurocognitive function in children aged 3-5 years and suggest cessation of napping may be a marker of brain maturation. The corpus of cognition studies directs attention to both the benefits of napping for learning and memory, especially among younger children,[26,27] but also the changing value of napping across time.[20] Sleep consolidation may be a global marker of neurological maturity.

Evidence on the implications of napping for physical health was poor. Two studies report that, among preschoolers, napping serves to protect against accidental injury.[31,35] Both studies, however, have the serious limitation of dependence on retrospective recall at the time of attending accident and emergency departments.[31,35] The only other published studies pertaining to napping and health were three reporting on the association with childhood obesity.[32–34] All reported shorter sleep duration as a predictor of excessive weight or obesity, but no independent effect for napping. These findings suggest that the function of napping with regard to weight status is potentially different from that of night sleep. Considerably more research is required before there can be any certainty about the effects of napping on children's physical health.

In summary, there is currently a low volume of evidence regarding the impacts of napping on children's development and health. Extant literature covers a range of outcomes with few using standard, comparable measures. The quality of studies reflects the relatively new focus of research on the independent effects of napping. There is an imperative for increased understanding about individual differences in napping trajectories and indeed sleep needs within this age group. Future studies should address the dual complexities of sleep transition across early childhood and the impacts of environmental manipulations at home and in the non-parental care context and should consider multiple child outcomes.

CONCLUSION

There is consistent, though low quality, evidence that night sleep onset, duration and quality are influenced by napping, particularly beyond age 2 as sleep consolidates into the nighttime. The relationship between napping and other child development and health outcomes are less clear. Greater certainty about the nature and direction of effect would be provided by stronger study designs, with attention to population representation in sampling. These should include collection of data about habitual napping status and the stability of napping across home and childcare context. Studies should employ independent physiological measurement of sleep. The impact of night sleep on children's development and health is increasingly documented, but to date there is not sufficient evidence to indicate the value of prolonging napping, whether at home or in childcare contexts, once sleep has consolidated into the night. For clinicians treating sleep problems, particularly among preschool aged children, the investigation of napping patterns is indicated.

What is already known on this topic?

- Early childhood is an important period in sleep development in which sleep consolidates into the night and napping ceases.
- The total duration and quality of sleep in a 24-hour period is a predictor of child health and development.
- In early childhood, children's sleep patterns can disrupt family functioning and parent well-being.

What this study adds?

- Our review identifies consistent reports that, beyond age 2, napping is increasingly associated with delayed night sleep onset and disrupted night sleep.

- Our review identifies the need for more extensive and higher quality studies of the effects of napping on multiple outcomes, including learning, behavior and health.
- Extant evidence does not support the practice of prolonging napping behaviour once sleep consolidates into the night.

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FIGURE LEGENDS

Figure 1. Systematic review search flow diagram based on Prisma[10]

Figure 2. Number of articles reporting health and development benefits or costs of napping.

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Contributor's Statement

Professor Thorpe conceptualized and designed the study, supervised database searches and screening, analysed and interpreted the data, and drafted the final manuscript; Ms Staton conceptualized and designed the study, developed the review protocol, undertook database searches and screening, contributed to interpretation of data, contributed to drafting of the manuscript and critically reviewed the manuscript; Ms Sawyer undertook database searches and screening, assisted in the analysis and interpretation of the data and critically reviewed the manuscript. Ms Pattinson conceptualized and designed the study, contributed to interpretation of the data and critically reviewed the manuscript; Ms Haden assisted in the development of search protocols, undertook database searches and contributed to drafting of the manuscript. Dr Smith conceptualized and designed the study, supervised data collection, contributed to interpretation of data and critically reviewed the manuscript. All authors approved the final manuscript as submitted.

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