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ORIGINAL ARTICLE

Cosleeping and sleep problems in children: a systematic review and meta-analysis

Xiaojing Peng[1] · Gangxuan Yuan[1] · Ning Ma[1]

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Abstract

There exist inconsistent findings about the relation between cosleeping and sleep problems in children. We conducted a meta-analysis to assess these relations and compared their cross-cultural differences. We searched the EMBASE, PsycARTICLES, PsycINFO, PubMed, ScienceDirect, and Web of Science databases. A random effect model was used, and subgroup analysis by culture group was performed. By including fifteen qualified studies, this meta-analysis revealed that increased bedtime resistance, sleep anxiety, night waking, and parasomnia were shown from children cosleeping with others. Cosleeping children from the West performed more bedtime resistance and night waking, while those children from the East showed more parasomnia. In general, cosleeping is associated with several sleep disturbances for children, including bedtime resistance, sleep anxiety, night waking, and parasomnia, and the cultural differences do exist between the West and East. The findings provide initial evidence of the influence of cosleeping on children's sleep problems. More studies on the related topic are needed from diverse cultures in the future.

Keywords Cosleeping · Sleep problems · Meta-analysis

Introduction

Over the past three decades, sleep problems in children have been a global health issue. Due to their prevalence and severity, sleep problems have received increasing attention from medical professionals and researchers [1, 2]. To date, sleep disturbances, including inadequate sleep duration and poor sleep quality, are proved to correlate with a great deal of damage which may adversely affect the long-term development of children, such as obesity [3–5], autism spectrum disorder [6], and emotional and behavioral difficulties [7].

A number of substantial factors may cause sleep problems in children, from macro level (social culture, economic level, etc.) to micro level (parenting styles, individual variances, etc.) [8–13]. Recently, much concerns have been focused on sociocultural factors [14], which may result in more specific strategies for sleep health care on children with different sociocultural backgrounds [15]. Cosleeping, a universal family practice of sleeping arrangement for children [16], has attracted the interest of researchers gradually.

Cosleeping generally means bed sharing with others (including parents, siblings, and any other person), as well as in the current study. Although the global prevalence of children's cosleeping is not known certainly, investigations of various studies have shown rates varying from 10 to 70% [17–25]. In addition, cosleeping is a culturally diverse practice. For example, compared with Western societies, where the individualism prevails, the prevalence of children's bed sharing is higher in Eastern societies, where great emphasis is laid on collectivism [1, 26, 27]. By coincidence, the proportion of Western children exposed to various sleep problems ranges from 20 to 45% [28–37], while it might be even higher in those children form Eastern countries [15]. Whether cosleeping creates an increased risk for sleep problems in child population, actually, it still remains controversial [38]. Numerous studies support the presence of positive correlations between cosleeping and sleep disturbances in children, for instance, more difficult to fall asleep

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✉ Ning Ma
maning@m.scnu.edu.cn

[1] Center for Sleep Research, School of Psychology, Center for Studies of Psychological Application, Guangdong Key Laboratory of Mental Health & Cognitive Science, South China Normal University, Guangzhou 510631, China

by themselves [22, 39], more times of nocturnal waking [19], and more interfered with parasomnia [40]. On the other hand, some studies of different populations failed to detect such similar relations [1, 18, 21].

Therefore, it might be well accepted that bed sharing is one of the crucial risks for increased sleep problems of children; however, there still exist some issues as follows: (a) what specific aspects of sleep problems does cosleeping correlate with and (b) is there any stable effect of cosleeping correlating with other sleep problems in different groups (e.g., the West and the East)? Accordingly, the specific aims of this meta-analysis are (a) to carry out a retrospection on relevant studies; (b) to assess quantitatively whether existing studies support the universal associations between cosleeping and various children's sleep problems; and (c) to compare tentatively the effects of cosleeping on different sleep problems between Western and Eastern countries.

Methods

Literature search

In most of the previous studies on children's sleep, cosleeping means that "bed sharing with caregivers (e.g., parents)", and a few studies consider that bed sharing with any other person (e.g., siblings) is also a practice of cosleeping. In the current meta-analysis, cosleeping is defined as "bed sharing with others". Sleep problems in children are commonly examined both behaviorally based and medical sleep disorders [41], and therefore, it involves many sleep problems or disorders such as high sleep anxiety, insufficient sleep duration, and obstructive sleep apnea.

Using the EMBASE, PsycARTICLES, PsycINFO, PubMed, ScienceDirect, and Web of Science databases (from 2000 to 31st Aug 2018), we conducted a systematic review for publications concerned about the relation between cosleeping and sleep problems. Without language restrictions, search strategies used the key words "sleep pattern terms" (cosleep OR cosleeping OR bed sharing) in combination with "sleep problem terms" (sleep problem OR sleep behavior OR sleep disorder OR sleep disturbance OR sleep habit). Owing to a wide application of the Children's Sleep Habits Questionnaire (CSHQ) [41] for evaluating children's sleep problems from eight aspects, "CSHQ" was also one of the "sleep problem terms" in our literature search.

Eligibility criteria

Studies were excluded if (a) it was not a cross-sectional design; (b) it did not focus on the links between cosleeping and sleep problems in children, such as the links between cosleeping and cognitive outcomes [42]; (c) the age range of children who were assessed was not 0–12 years; (d) the individuals had other diseases irrelevant to sleep disorders like cerebral palsy [43] or autism spectrum disorders [44]; and (e) it used unsuitable analysis or defined unsuitable outcome which made data difficult to be extracted or to be compared with most studies, such as determining whether a child had night waking or not, rather than reporting how many times he/she woke [45]. When some descriptive results were not available from published reports, we sent our request for raw data to the authors and included the studies that the authors replied to us.

Data extraction

The retrieval of studies was processed based on the PRISMA scheme (Fig. 1). The detailed information of included studies was listed as shown below (Table 1): first author name, published year, country of origin, sample size of independent sample, male percentage, age, quality of study, and outcome of sleep problem (with its assessment tool). For each study, we extracted the sample size (Total) of the group "Cosleeping" and group "Non-cosleeping", as well as the mean value (M) and the standard deviation (SD) of various sleep problems in each group, respectively (see Supp Figure S1a–S8a, S1b–S8b). The results were categorized into eight aspects (bedtime resistance, sleep anxiety, parasomnia, sleep disordered breathing, daytime sleepiness, sleep onset delay, sleep duration, and night waking) according to the eight subscales defined by CSHQ. Independent samples from the same publication were coded independently. Therefore, for different sleep problems, the number of samples included was not exactly the same, as well as the means of measuring approaches. In addition, to compare the cultural differences, we differentiated the group "the Western country" and group "the Eastern country". The division was mainly based on the geographical location of the country (https://www.who.int/countries/en/), where each sample came from simultaneously with reference to the cultural background of the country [46].

Quality assessment

The Downs & Black Quality Index score system was used to assess the quality of included studies, which was appropriate for evaluating both randomized and non-randomized studies [47]. The checklist consists of 27 items organized into five subscales: (1) reporting (10 items); (2) external validity (3 items); (3) bias (7 items); (4) confounding (6 items); and (5) power (1 item). Except for the single item on power, which is scored 0 to 5, and 1 item on reporting, which is scored 0 to 2, the other items of the checklist are scored 0 or 1. For the evaluation of non-randomized studies, the maximum score is 20 [5]. All published studies included in the meta-analysis

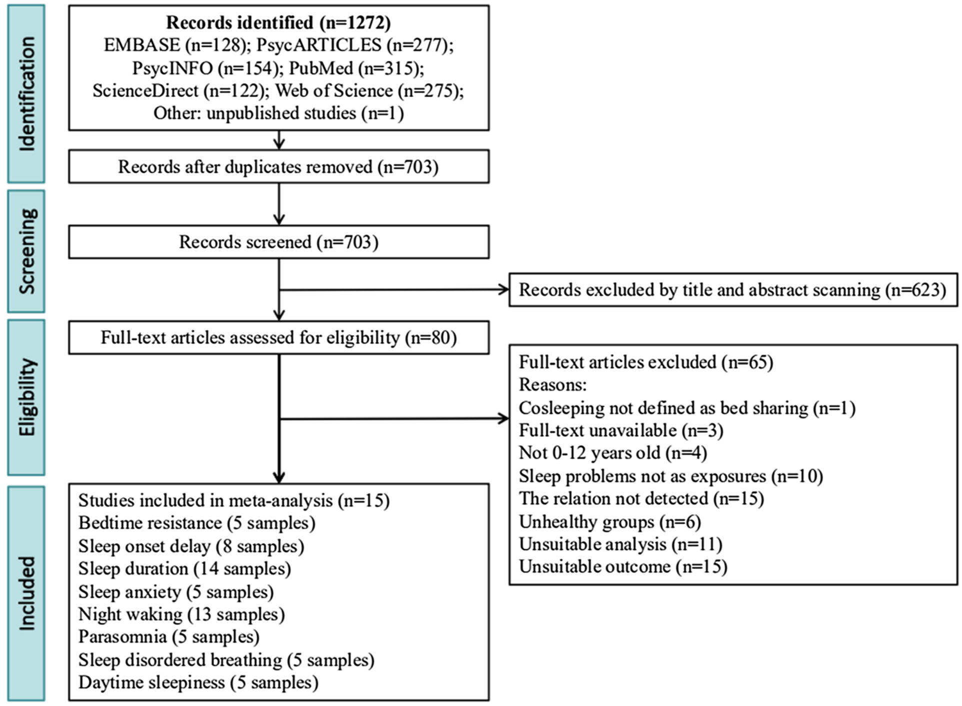

Fig. 1 Flow chart based on the PRISMA scheme

were with a score of 13 or higher, and the unpublished one was left out of quality assessment.

Statistical analysis

We calculated the unadjusted mean difference (MD) to evaluate the correlations between cosleeping and sleep problems. When the measuring approaches used in studies differ with each other, the MD is supposed to be standardized before being pooled, to eliminate the effect caused by inconsistent rating scales. Here, we chose the Cohen's d formula to obtain the standardized mean difference (SMD). We used a random effect model with DerSimonian–Laird method [48] to estimate pooled effects of SMD in different sleep problems. The heterogeneity among studies was quantified by I^2-statistic, which ranged from 0 to 100%, and the value of 25%, 50%, and 75% was considered as low, medium, and high heterogeneity [49]. The publication bias was detected by Egger's regression test [50]. In addition, subgroup analysis by culture group was conducted to present the effects of cosleeping on sleep problems in Western countries and Eastern countries separately. We estimated the change of pooled effect size by omitting one study at a time to evaluate the influence of individual study on the integral inferences (one of the common methods of sensitivity analysis) [5]. Furthermore, we could use this method to find the heterogeneity among studies, and we would report which study omitted from a particular subscale minimizes the heterogeneity of the effect size of that subscale. Subgroup analysis by age group was also performed to detect possible sources of heterogeneity. The statistical analysis was carried through Stata (version 12), and the forest plots (see Supp Figure S1a–S8a, S1b–S8b) were designed by R Statistical Software (version 3.4.1).

Results

The overall effect and subgroup analysis by culture group

Totally, there were fifteen qualified studies included in the current meta-analysis (Fig. 1), with five samples at least for each sleep problem (5 for bedtime resistance, sleep anxiety, parasomnia, sleep disordered breathing, and daytime sleepiness; 8 for sleep onset delay; 14 for sleep duration; and 13 for night waking).

For bedtime resistance, sleep anxiety, parasomnia, sleep disordered breathing, and daytime sleepiness (Supp Figure S1a, S4a, S6a–S8a), five samples from five studies were included. Three samples were from Western countries (Italy [18], Russia [51], and America [40]) and two samples were from Eastern countries (China [1]). To avoid repetition, it was not described in the relevant sections below.

Bedtime resistance and sleep anxiety

All the five studies reported that children who shared the bed with others performed stronger bedtime resistance and

Table 1 Details of qualified studies included in the present meta-analysis

1st author	Year	Country	Sample size (male %)	Age	Quality score	Outcome *assessment tool
Baddock	2006	New Zealand	80 **(56.25%)**	5–27 weeks	18	Total sleep time (h) ***Video recording**
BaHammam	2008	Saudi Arabia	977 **(50.50%)**	9.5 ± 1.9 years	14	Total sleep time (h & min) ***Questionnaire**
Cortesi	2008	Italy	148 **(52.70%)**	6.3 ± 1.11 years	18	Sleep onset latency (min) Total sleep time (min) ***Sleep diary** CSHQ for other six scales ***Questionnaire**
Iwata	2013	Japan	41 **(57.45%)**	M = 5 years	16	Sleep onset delay (min) Sleep duration weekday (h) ***Actigraphy**
Kelmanson	2010	Russia	112 **(42.86%)**	M = 2 months	19	CSHQ for eight scales ***Questionnaire**
Kim	2017	America	48 **unreported**	5.55 ± 1.59 years	13	CSHQ for eight scales ***Questionnaire**
Li	2008	China	13,602 **(49.70%)**	9 ± 1.61 years	17	Sleep duration weekday (h) ***Questionnaire**
Liu	2003	China	422 **(47.40%)**	M = 10.5 years	17	CSHQ for eight scales ***Questionnaire**
Mao	2004	"Caucasian"	18 **(77.78%)**	3–15 months	14	Night waking (numbers) ***Video recording**
Mileva-Seitz	2016	Netherlands	374 **(52.14%)**	M = 2 months	16	Night waking (frequency) ***Questionnaire**
Mindell_a	2017	America	4278 **(52.90%)**	6–12 months	16	Sleep onset delay (min) Night waking (numbers) Total sleep time (h) ***Questionnaire**
Mindell_b	2017	"International"	2556 **(53.10%)**	6–12 months	16	Sleep onset delay (min) Night waking (numbers) Total sleep time (h) ***Questionnaire**
Mindell_a	2010	"predominantly Caucasian"	6359 **(48.10%)**	0–36 months	19	Night waking (numbers) Total sleep time (h) ***Questionnaire**
Mindell_b	2010	"predominantly Asian"	15,901 **(48.10%)**	0–36 months	19	Night waking (numbers) Total sleep time (h) ***Questionnaire**
Santos	2008	Brazil	3907 **(51.80%)**	M = 12 months	19	Night waking (numbers) ***Questionnaire**
Yu	2017	China	547 **(53.20%)**	0–36 months	19	Night waking (numbers) Total sleep time (h) ***Questionnaire**
Ma	2018	China	281 **(49.47%)**	3–7 years	–	CSHQ for eight scales ***Questionnaire**

The concrete location in some studies

Mindell_b-2017: Australia, Brazil, Canada, United Kingdom, New Zealand;

Mindell_a-2010: Australia, Canada, New Zealand, United Kingdom, America;

Mindell_b-2010: China, India, Indonesia, Japan, Korea, Singapore, Malaysia, Philippines, etc

The more detailed definition of cosleeping announced in some studies

Baddock-2006: bed sharing with parents for a minimum of 5 h per night

BaHammam-2008: all night sharing of a bed or room with a parent

Cortesi-2008: bed sharing with parents, more than five nights a week, for at least 1 year

Kim-2017: bed sharing with parents sometimes and usually

Li-2008: bed sharing with parents 5–7 nights per week

Santos-2008: habitual sharing of a bed with any other person during part or all of the night higher sleep anxiety significantly than those who slept alone, irrespective of cultural difference.

For bedtime resistance (Table 2), the overall SMD was 2.35 (95% CI 1.24–3.46) with significant heterogeneity among studies ($I^2=97.3\%$, $p<0.001$), and publication bias was not detected by the Egger's regression test ($p=0.068$). With the decrease of heterogeneity, subgroup analysis indicated that cultural difference might be one of the causes to high heterogeneity and that bed sharing had a greater effect on bedtime resistance of Western children than of Eastern children (SMD = 3.29 vs. 1.04).

For sleep anxiety (Table 2), the overall SMD was 1.22 (95% CI 0.53–1.91) with evidence of heterogeneity ($I^2=94.4\%$, $p<0.001$), and publication bias was not inspected (Egger's regression test $p=0.231$). Subgroup analysis suggested that between the West (SMD = 1.67, 95% CI 0.54–2.80) and the East (SMD = 0.61, 95% CI 0.39–0.83), there might exist no significant difference in degree of associations between cosleeping and sleep anxiety.

Parasomnia

For parasomnia (Table 2), the overall SMD was 0.72 (95% CI 0.01–1.44) with high heterogeneity ($I^2=95.2\%$, $p<0.001$). There was no evidence of publication bias (Egger's regression test $p=0.258$). In general, children who shared the bed with others were more likely to be disturbed by parasomnia; however, subgroup analysis pointed out a possibility that it might only exist within the children in the East (SMD = 0.23, 95% CI 0.06–0.41), rather than those children in the West (SMD = 1.09, 95% CI − 0.63 to 2.82).

Sleep disordered breathing and daytime sleepiness

Overall estimates provided evidence of a significant relation neither between cosleeping and sleep disordered breathing (Table 2, Supp Figure S7a), nor between cosleeping and daytime sleepiness (Table 2, Supp Figure S8a). For sleep disordered breathing, the overall SMD was 0.66 (95% CI − 0.06 to 1.38), and publication bias was not inspected by the Egger's regression test ($p=0.178$). For daytime sleepiness, the overall SMD was 0.63 (95% CI − 0.10 to 1.35) without proof of publication bias (Egger's regression test $p=0.380$). The results of heterogeneity test and subgroup analysis are also presented in Table 2.

Sleep onset delay and sleep duration

Eight samples from seven studies were included for sleep onset delay (Table 2, Supp Figure S2a). Five samples were from the West (Italy [18], Russia [51], and America [40, 52], "International" region [52]) and three samples were from the East (Japan [53] and China [1]). The overall SMD was 0.10 (95% CI − 0.13 to 0.32). With great heterogeneity ($I^2=91.5\%$, $p<0.001$), publication bias failed to be detected (Egger's regression test $p=0.207$). Cosleeping was not correlated with sleep onset delay significantly, both in the West (SMD = 0.15, 95% CI − 0.13 to 0.43) and in the East (SMD = − 0.03, 95% CI − 0.19 to 0.14).

The findings were similar for sleep duration (Table 2, Supp Figure S3a) compared to sleep onset delay. There were 14 samples from 12 studies included for sleep duration, with seven samples from Western countries (New Zealand [54], Italy [18], Russia [51], America [40, 52], "International" region [52], and "predominantly Caucasian" region [46]) and the rest from Eastern countries (Saudi Arabia [55], Japan [53], China [1, 56, 57], and "predominantly Asian" region [46]). In addition, the subtotal SMD statistics were 0.08 (95% CI − 0.18 to 0.35) and − 0.69 (95% CI − 2.84 to 1.46), respectively. Publication bias was insignificant (Egger's regression test $p=0.762$) in pooled analysis, along with proof of high heterogeneity.

Night waking

For night waking (Table 2, Supp Figure S5a), 13 samples from 11 studies were included. Nine samples were from the West (Italy [18], Russia [51], America [40, 52], "Caucasian" region [58], Netherlands [59], "International" region [52], "predominantly Caucasian" region [46], and Brazil [60]) and four samples were from the East (China [1, 57], "predominantly Asian" region [46]). With no evidence of publication bias (Egger's regression test $p=0.235$), the heterogeneity test was significant ($I^2=97.8\%$, $p<0.001$). In overall analysis, cosleeping was associated with increased night waking significantly (SMD = 0.64, 95% CI 0.43–0.85). In subgroup analysis, it suggested that Western children who shared the bed with others woke up at night with more times than those children in Eastern countries (SMD = 0.97 vs. 0.11).

Sensitivity analysis

For bedtime resistance, sleep duration, sleep anxiety, night waking, parasomnia, sleep disordered breathing, and daytime sleepiness (Supp Figure S1c, S3c–S8c), sensitivity analysis by omitting one study at a time showed no biased inferences that depended on a particular study. By the removal of the study of Cortesi et al. [18], the heterogeneity reduced to 95.4% in overall effect for bedtime resistance. For sleep duration, in the group from Eastern country, the heterogeneity reduced to 14.6% by the removal of the study of Li et al. [56]. For sleep anxiety, in group the Western country, the heterogeneity reduced to 0.0% by the removal of the study of Cortesi et al. [18]. For night waking, parasomnia, sleep disordered breathing, and daytime sleepiness, in group the Western country, the heterogeneity reduced to

Table 2 Subtotal and overall effect size, test of effect, and test of heterogeneity

	Bedtime resistance	Sleep onset delay	Sleep duration	Sleep anxiety	Night waking	Parasomnias	Sleep disordered breathing	Daytime sleepiness
Country								
The Western country								
Subtotal effect:	3.29	0.15	0.08	1.67	0.97	1.09	1.11	0.95
SMD (95% CI)	(2.13, 4.45)	(−0.13, 0.43)	(−0.18, 0.35)	(0.54, 2.80)	(0.69, 1.24)	(−0.63, 2.82)	(−0.51, 2.74)	(−0.81, 2.71)
Test of subtotal effect:	5.56	1.04	0.62	2.90	6.83	1.24	1.34	1.06
Z (p value)	($p<0.001$)	($p=0.300$)	($p=0.533$)	($p<0.01$)	($p<0.001$)	($p=0.214$)	($p<0.179$)	($p<0.291$)
Heterogeneity:	89.7%	93.6%	96.3%	93.3%	97.8%	97.3%	97.0%	97.4%
I^2-statistic (p value)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)
The Eastern country								
Subtotal effect:	1.04	−0.03	−0.69	0.61	0.11	0.23	0.06	0.22
SMD (95% CI)	(0.84, 1.24)	(−0.19, 0.14)	(−2.84, 1.46)	(0.39, 0.83)	(0.04, 0.19)	(0.06, 0.41)	(−0.11, 0.24)	(−0.04, 0.47)
Test of subtotal effect:	10.21	0.29	0.63	5.32	3.05	2.58	0.72	1.65
Z (p value)	($p<0.001$)	($p=0.768$)	($p=0.531$)	($p<0.001$)	($p<0.001$)	($p<0.05$)	($p=0.469$)	($p=0.100$)
Heterogeneity	14.0%	0.0%	100.0%	35.7%	19.0%	0.0%	0.0%	52.3%
I^2-statistic (p value)	($p=0.281$)	($p=0.426$)	($p<0.001$)	($p=0.212$)	($p=0.295$)	($p=0.971$)	($p=0.543$)	($p=0.147$)
Age								
<3 years old								
Subtotal effect:	–	0.08	0.14	–	0.79	–	–	–
SMD (95% CI)		(−0.27, 0.44)	(−0.10, 0.38)		(0.53, 1.04)	–		
Test of subtotal effect:	–	0.47	1.13	–	6.09	–	–	–
Z (p value)		($p=0.640$)	($p=0.258$)		($p<0.001$)			
Heterogeneity	–	96.8%	97.9%	–	98.5%	–	–	–
I^2-statistic (p value)		($p<0.00$ 1)	($p<0.001$)		($p<0.001$)			
4–6 years old								
Subtotal effect:	2.35	0.16	−0.17	1.48	0.38	0.18	0.11	0.03
SMD (95% CI)	(0.34, 4.35)	(−0.03, 0.35)	(−0.56, 0.22)	(0.02, 2.94)	(−0.20, 0.96)	(−0.02, 0.38)	(−0.16, 0.38)	(−0.17, 0.23)
Test of subtotal effect:	2.30	1.60	0.87	1.99	1.28	1.75	0.82	0.28
Z (p value)	($p<0.05$)	($p=0.109$)	($p=0.387$)	($p<0.05$)	($p=0.200$)	($p=0.080$)	($p=0.413$)	($p=0.783$)
Heterogeneity	97.8%	0.0%	70.0%	97.0%	85.2%	0.0%	35.0%	0.0%

Table 2 (continued)

	Bedtime resistance	Sleep onset delay	Sleep duration	Sleep anxiety	Night waking	Parasomnias	Sleep disordered breathing	Daytime sleepiness
I^2-statistic (p value)	($p<0.001$)	($p=0.865$)	($p=0.019$)	($p<0.001$)	($p<0.01$)	($p=0.517$)	($p=0.215$)	($p=0.796$)
7–12 years old								
Subtotal effect:	–	–	− 1.57	–	–	–	–	–
SMD (95% CI)			(− 5.57, 2.42)					
Test of subtotal effect:	–	–	0.77	–	–	–	–	–
Z (p value)			($p=0.440$)					
Heterogeneity	–	–	100.0%	–	–	–	–	–
I^2-statistic (p value)			($p<0.001$)					
Total								
Subtotal effect:	2.35	0.10	− 0.19	1.22	0.64	0.72	0.66	0.63
SMD (95% CI)	(1.24, 3.46)	(− 0.13, 0.32)	(− 1.20, 0.82)	(0.53, 1.91)	(0.43, 0.85)	(0.01, 1.44)	(− 0.06, 1.38)	(− 0.10, 1.35)
Test of subtotal effect:	4.16	0.81	0.37	3.48	5.92	1.98	1.80	1.70
Z (p value)	($p<0.001$)	($p=0.410$)	($p=0.709$)	($p<0.001$)	($p<0.001$)	($p<0.05$)	($p=0.072$)	($p=0.089$)
Heterogeneity	97.3%	91.5%	99.9%	.4%	97.8%	95.2%	95.3%	95.3%
I^2-statistic (p value)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)	($p<0.001$)

97.1%, 0.0%, 56.8%, and 0.0% by the removal of the study of Kelmanson et al. [51].

For sleep onset delay (Supp Figure S2c), by deleting the study of Kelmanson et al. [51], the test of overall SMD changed to a significant level, which inferred that cosleeping correlated with more sleep onset delay (SMD = 0.23, 95% CI 0.03–0.42). By the removal of this study, in group, the Western country, the heterogeneity reduced to 88.8%. However, subgroup analysis suggested that the relationship between cosleeping and sleep onset delay might only exist in the West (SMD = 0.37, 95% CI 0.16–0.59).

Subgroup analysis by age group

Because age is a major factor related to both cosleeping and sleep problems, a separated analysis by age group (group < 3 years, group 4–6 years, and group 7–12 years) was also conducted to test whether the associations varied by age and age was one of the possible sources of heterogeneity or not (Table 2, Supp Figure S1b–S8b).

For bedtime resistance, sleep anxiety, parasomnia, sleep disordered breathing, and daytime sleepiness, there were three samples included in group 4–6 years. However, there was only one sample in the other groups, which was hard to constitute a subgroup. In addition, therefore, a good comparison of the association between cosleeping and sleep problems among three age groups was limited in these subscales. For sleep onset delay, sleep duration, and night waking, the subtotal SMD of each age group was not different from each other significantly due to the overlap of their confidence interval. For most of the eight subscales (except bedtime resistance and sleep anxiety), remarkable decrease was shown in heterogeneity from overall effect to the subtotal effect of group 4–6 years (Table 2), which inferred that age may be one of the possible sources of high heterogeneity in the current meta-analysis.

The findings of longitudinal studies

As with any cross-sectional association, it is hard to determine the direction of causality between cosleeping and sleep problems, longitudinal findings, or intervention studies may shed light on the direction of causality between them. However, the number of longitudinal studies testing cosleeping and sleep problems was very limited to date, which is very difficult to conduct a meta-analysis. We described the longitudinal studies [61–65] in Table 3 according to what we could retrieve. In general, the results of longitudinal studies were inconsistent. For example, Teti et al. [64] found that mothers reported more night wakings of consistent cosleeping infants, while the association was not detected in the study of Volkovich et al. [65]. Nevertheless, some longitudinal studies found that cosleeping did increase the incidence of some sleep problems, which could provide stronger support for the association found in cross-sectional studies.

Discussion

To our knowledge, this meta-analysis is the first to evaluate the cross-sectional links between cosleeping and various sleep problems in children, as well as the cross-cultural differences of the above associations. The current meta-analysis revealed the crucial findings as below: (a) cosleeping correlated with an increased risk for children's sleep problems, for example, stronger bedtime resistance, higher sleep anxiety, worse parasomnia, and more night waking and (b) there might not exist significant relations of cosleeping and sleep onset delay, as well as inadequate sleep duration, sleep disordered breathing, and daytime sleepiness. In addition, in subgroup analysis by culture group, we obtained the following results: (c) children cosleeping with others in Western countries performed more bedtime resistance and night waking, while those children in the East were more likely to be disturbed by parasomnia instead; (d) for sleep anxiety, there was no significant difference of the effect between the West and the East; and (e) it was consistent that bed sharing had no effect on some sleep disturbances both in the West and in the East, which were mentioned in (b).

In the present study, there existed stronger associations between cosleeping and some sleep disturbances in the West than in the East. First, it is not in conflict with the previous findings that a higher detection rate of children with sleep problems is reported in Eastern countries, where cosleeping is more popular because of different baselines for various sleep problems between their control groups (i.e., non-cosleeping groups). What presented by subgroup analysis was the effects of cosleeping on various sleep problems in the context of Western countries and Eastern countries, respectively. We failed to obtain the direct results that whose sleep problems were more serious between children cosleeping with others in Western countries and those children in Eastern countries. Second, it has been suggested that parental involvement (parental perception, the interaction before sleep onset, etc.) leads to such differences [46]. As mentioned in the beginning, it is more common in the East than in the West that children sleep together with others, which can be accounted for the cultural variance in value cultivation [1, 56]. In Eastern countries, rearing practices in children focus on interdependence and family closeness, so it may be considered as a traditional custom that children sleep with caregivers [16]. On the contrary, it highlights the autonomy and independence of individuals in Western countries, and therefore, children are encouraged to sleep alone in most situations. Thus, when Western children have a request for bed sharing with others, parents may pay more attention to children's sleep performances or take more inappropriate measures in interactive behaviors before bedtime. It inspires us that cosleeping might not increase sleep problems in child population per se and that cultural background should be taken into consideration when parents make sleeping strategies for children [55].

Due to the limited number and methodology of the publications concerning children cosleeping with others, it is difficult to explain why cosleeping is associated with some sleep problems in the current meta-analysis. However, some suggestions could be put forward based on the previous studies. Some suspect that it might be attributed to a possibility that parents are more easily to be aware of children's sleep behaviors when cosleeping than when they sleep alone [40, 55, 64]. Others believe that it may be owing to the fact that children who share the bed with others are more likely to be disturbed by the environment during sleep than children sleeping alone, such as head covered by blankets more frequently which is found in the study of Baddock et al. [54]. In addition, there exists a more common hypothesis called reactive bed sharing [16]. It holds that cosleeping often takes place in early stage and persists through the whole childhood as a parental response to sleep problems in child group [18]. In other words, cosleeping is a result of sleep disturbances but not a cause to them. In general, the mechanism of these links is not understood well, which should be further explored or explained by new control studies or cohort studies.

Limitations and implications for future study

There are some certain limitations in the current meta-analysis. First, we fail to test the causal relationship between cosleeping and sleep disturbances, because all studies included are cross-sectional design. However, according to what we can retrieve, there are little longitudinal studies at present for carrying out a good meta-analysis [61–65]. In addition, their findings of the relationship between cosleeping and sleep problems are inconsistent, which may be attributed to the differences in origin of

Table 3 Details of longitudinal studies included in this study

1st author	Year	Country	Sample size (male %)	Age at baseline	Age at retest	Findings *assessment tool	Adjusted variables
Huang	2015	China	524 **(50.2%)**	1 month	Every week in 1 month, and every month from 2 to 8 months	Compared to cosleeping, sleeping alone was associated with greater nocturnal sleep percentage by 3.6% (equivalent of 26 min more per 24 h), but this difference decreased over time ***Sleep diary**	Parental age, parental education level, household income, supplementation of complementary food, and infant birth weight and length
Hunsley	2002	America	101 **(44.55%)**	5 weeks	6 months	Compared to the long-term non-cosleepers, the long-term cosleeping infants showed more quite sleep, and longer quite sleep bout length as well as less active sleep, fewer arousal in active sleep, and less wakefulness ***Motility monitoring system**	–
Okami	2002	America	205 **unreported**	5 months	2, 3, and 6 years	Cosleeping at 5 months did not predict any sleep problems at age 2 and 3 years. At age 6 years, cosleeping in infancy and early childhood was not associated with sleep problems ***Questionnaire**	Gender and socioeconomic status (SES)
Teti	2016	America	149 **(46.31%)**	1 month	3, 6, 9, and 12 months	The sleep quality of persistent cosleeping infant did not differ from those slept alone persistently ***Actigraphy** Mothers of infants in consistent cosleeping arrangements reported more infant night wakings than mothers of infants in consistent solitary sleep arrangement ***Sleep diary**	–
Volkovich	2015	Israel	128 **(46.00%)**	3 months	6 months	There were no cross-lagged associations between infant night waking and sleep arrangement ***Actigraphy**	Feeding techniques (i.e., fully, partial, or bottle feeding)

country, age at baseline and retest, assessment tool, and adjusted variables and so on. Second, the pooled analysis of such observational studies that confounding variables (gender, age, region, etc.) are out of exact control may lead to biased estimates. Moreover, these variables may cause the high heterogeneity in the current meta-analysis. Subgroup analysis indicates that origin of country and age of children may be the possible sources of heterogeneity. In addition, heterogeneity can be derived from the male percentage, year of study, assessment tool, and quality of study and so on. However, due to limited by the numbers of studies (only 1–2 samples for some subgroups), a good separated analysis by these groups or meta-regression fails to be conducted. Third, the outcome data of sleep problems in children are mostly provided by parents' judgement, which is subjective and may not really accurate.

Nevertheless, the findings from the previous studies have provided initial evidence of the influence of cosleeping on children's sleep problems, and indicate the directions for sleep health on children. Sleep health in early childhood may affect people's development and performance later in their life [66]. Further investigation concerning cosleeping or other related factors influencing children's sleep health is necessary, using different study designs (both cross-sectional and longitudinal design) and diverse methods for measuring children's sleep performances (either by subjective reports from parents or by objective measures such as video recording and actigraphy). The future findings may be protective in preventing children's problems, not only for their sleep health, but also for their physical and psychological health and development.

Conclusions

Our study suggests that cosleeping correlates with more bedtime resistance, sleep anxiety, night waking, and parasomnia on the whole. However, children cosleeping with others in the West show stronger bedtime resistance and more times of night waking, while those children in the East perform more parasomnia instead. In general, cosleeping with others may be an important factor for children's sleep health, further studies are necessary to investigate on this topic.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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