Breastfeeding and risk of habitual snoring in children: A meta-analysis

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Abstract

Research regarding the effects of breastfeeding on habitual snoring in children has yielded conflicting results. Therefore, a meta-analysis was carried out to evaluate the effect of breastfeeding on the risk of habitual snoring in children. Relevant studies published in English or Chinese were identified by a search of PubMed, Embase, Web of Science, Chinese National Knowledge Infrastructure, China Biology Medical literature, and Wanfang databases up to October 2018. Random effects model was used to pool the findings, and results were expressed as odds ratios (OR) with 95% CIs. Eleven studies with 71,622 participants were included in the present meta-analysis. The pooled OR of habitual snoring for more versus less breastfeeding (duration) was 0.74 (95% CI [0.62, 0.90]), and the result remained significant in cohort studies (OR, 0.74; 95%CI [0.66, 0.84]). We found no evidence of publication bias. This meta-analysis of observational studies indicates that breastfeeding for a long time is associated with reduced risk of habitual snoring in children. The finding needs to be investigated in well-designed prospective studies.

KEYWORDS

breastfeeding, children, meta-analysis, snoring

1 | INTRODUCTION

Snoring is a common and early symptom of sleep-disordered breathing that refers to a spectrum of diseases with severity ranging from primary snoring, featured by snoring with no evidence of ventilation abnormalities or increased sleep fragmentation, to obstructive sleep apnea syndrome, featured by intermittent partial or complete obstruction of the upper airways (Ng et al., 2006; Ponce-Garcia, Hernandez, Major, & Flores-Mir, 2017). Habitual snoring (HS) affects about 10% of the children and has been associated with stroke (M. Li, Li, Zhang, Hou, & Tang, 2015), diabetes mellitus (Xiong, Zhong, Xu, & Wang, 2016), and coronary heart disease (D. Li, Liu, Wang, & He, 2014).

HS is caused by interactions between genetic and environmental factors such as family history of snoring, adenotonsillar hypertrophy, passive smoking, and overweight or obese status (Kent & Soose, 2014; Schwengel, Dalesio, & Stierer, 2014; Sun, Zhang, Tian, & Jiang, 2018). Many investigators have researched varieties of possible

factors associated with HS. Among these, breastfeeding may influence the risk of HS. Breastfeeding is the optimal form of human nutrition in the early period of life, and it has many benefits for the child and mother (Gartner et al., 2005; Labbok, 2001). Breastmilk contributes to the development of sensory and cognitive, as well as protects the infant from infectious and chronic diseases. Meta-analyses showed that breastfeeding was associated with childhood obesity (Yan, Liu, Zhu, Huang, & Wang, 2014), acute otitis media (Bowatte et al., 2015), and asthma (Lodge et al., 2015).

A growing number of researches have been performed to investigate the relationship between breastfeeding and childhood HS. Breastfeeding has been identified as a protective factor for HS in many studies (Galbally, Lewis, McEgan, Scalzo, & Islam, 2013; Kuehni, Strippoli, Chauliac, & Silverman, 2008; Li, Au, et al., 2010), whereas other studies have found non-significant association (Brew et al., 2014; Li, Au, et al., 2010), or even an increased risk of HS (Chng, Goh, Wang, Tan, & Ong, 2004). Therefore, we performed a systematic

meta-analysis by combining all available data of observational studies to assess the association between breastfeeding and risk of HS in children.

2 | METHODS

2.1 | Search strategy

The PRISMA guidelines were consulted in the current analysis (Moher, Liberati, Tetzlaff, & Altman, 2009). We performed a computer-based search up to October 2018 from six databases: PubMed, Embase, Web of Science, Chinese National Knowledge Infrastructure, China Biology Medical literature, and Wanfang databases using the following search terms: (breastfeeding OR breast-feeding OR breast feeding OR breast fed OR weaning) and (snoring OR snorer). Moreover, the reference lists of retrieved articles were reviewed to identify further undiscovered relevant articles. The detailed information is shown in Figure 1.

2.2 | Inclusion criteria and exclusion criteria

Studies were included if they met the following criteria: (a) observational study designs (cohort, case-control, cross-sectional); (b) the exposure of interest was breastfeeding; (c) the outcome of interest was HS; (d) odds ratio (OR) or relative risk (RR) with corresponding 95% CI (or data available to calculate them) were provided; (e) studies

Key messages

- Breastfeeding is the optimal form of human nutrition in the early period of life and it has many benefits for the child and mother.
- A growing number of researches have been conducted to assess the association between breastfeeding and habitual snoring in children. However, the results remain inconsistent.
- We used random effects model to pool the findings quantitatively, and came to the conclusion that breastfeeding for a long time (e.g., 6 months) is associated with reduced risk of habitual snoring in children.
- Future research should record breastfeeding in a uniform manner using validated questions and definitions.

were reported in English or Chinese; (f) the majority of subjects were 0–18 years old. Studies were excluded in the light of the following criteria: (a) were not original study or full text; (b) did not report OR or RR with 95% CI (or data available to calculate them) for the relationship between breastfeeding and HS; (c) randomized controlled trial. If data from the same population had been published in more than one study, the most recent study was chosen.

FIGURE 1 Flowchart of the selection of studies included in the meta-analysis

All identified studies were carefully reviewed independently by two investigators. If a discrepancy occurred regarding article selection, it was resolved by consensus with a third investigator.

2.3 | Data extraction

Two investigators independently extracted the following data: (a) the first author's name; (b) publication year; (c) country and continent where the study was conducted; (d) age (mean age); (e) study design; (f) sample size; (g) definition of snoring; (h) feeding patterns; (i) the ORs (we presented all results with OR for simplicity) with corresponding 95% CIs for more versus less breastfeeding and (j) adjusted covariates. The ORs adjusted with the most confounders in the original studies were extracted, if not available, the unadjusted ORs. The Newcastle–Ottawa quality assessment scale was used to assess the overall quality and risk of bias (Stang, 2010). Quality of selection, comparability, and outcome (exposure) of study participants are three major parameters. Two investigators (YG and YZ) independently assessed study quality, and the third investigator (XJ) made a final decision if consensus was not reached by the first two investigators.

One breastfeeding category was identified as important group to be meta-analysed: more versus less breastfeeding. This category was created to include all studies, which compared groups with relatively more (longer duration of breastfeeding) and relatively less breast milk exposure (shorter duration). When studies reported effect estimates of multiple breastfeeding groups, the priority was given to exclusive breastfeeding or, if not available, any breastfeeding. Second, the estimate comparing the longest duration with the shortest was selected. If there were multiple ages of outcome within the particular group, then we chose the oldest age reported. HS was defined by the original study.

2.4 | Statistical analysis

Pooled values were calculated as the inverse variance-weighted mean of the logarithm of OR with 95% CI to assess the strength of association between breastfeeding and risk of HS. The I^2 was adopted to assess the heterogeneity between studies (I^2 values of 0%, 25%, 50%, and 75% represented no, low, moderate, and high heterogeneity, respectively; Higgins, Thompson, Deeks, & Altman, 2003). The random effects model was used as the pooled method. The leave-one-out sensitivity analysis was carried out to evaluate the key studies that have a substantial impact on the between-study heterogeneity (Patsopoulos, Evangelou, & Ioannidis, 2008). Influence analysis was conducted to describe whether or not an individual study affected the pooled estimator. If the main estimate of an individual study's omitted analysis lay outside the 95% CIs of the combined analysis, it was suspected of excessive influence. Publication bias was evaluated by visual inspection of the funnel plot and Egger's test (Egger, Davey Smith, Schneider, & Minder, 1997). Subgroup analysis was performed by study design, outcome definition, mean age, duration of breastfeeding, and the status of adjusting for passive smoking.

All statistical analyses were carried out with STATA version 12.0. All reported P values were two-sided, with P value less than 0.05 considered statistically significant.

3 | RESULTS

3.1 | Study selection and study characteristics

The detailed steps of our literature search are shown in Figure 1. We identified 11 published articles eligible for this meta-analysis on the relationship of breastfeeding and HS risk, and three of the 11 studies were identified from reference lists. All of the included studies assessed breastfeeding using questionnaires. The publication dates for these studies ranged from 2004 to 2014. Study quality was assessed with the Newcastle–Ottawa scale (Table S1).

Among the included studies, there were four cohort studies, and seven cross-sectional studies, which were conducted in Asia, Europe, Oceania, and North America. HS was defined as snoring ≥ 3 nights per week in three studies, ≥ 4 nights per week in five studies, and cases in the other included studies were defined in different ways. The major adjustment confounding factors included age, race, gender, weight, and passive smoking. The baseline characteristics of the included studies are shown in Table 1 (Beebe, Rausch, Byars, Lanphear, & Yolton, 2012; Bonuck et al., 2011; Brew et al., 2014; Chng et al., 2004; Galbally et al., 2013; Huang et al., 2008; Kuehni et al., 2008; Li, Au, et al., 2010; Li, Jin, et al., 2010; Li, Sadeh, Au, Goh, & Mindell, 2013; Piteo et al., 2011).

3.2 | Quantitative synthesis

Four cohort studies (Beebe et al., 2012; Bonuck et al., 2011; Brew et al., 2014; Galbally et al., 2013) and seven cross-sectional studies (Chng et al., 2004; Huang et al., 2008; Kuehni et al., 2008; Li et al., 2013; Li, Au, et al., 2010; Li, Jin, et al., 2010; Piteo et al., 2011) involving 71,622 participants reported ORs for the association between children who exposed to more versus less breastfeeding and risk of HS. Among the 11 studies, seven revealed a significantly reduced risk (of $P < 0.05$), one indicated an increased risk, and three indicated a non-significant association. The pooled OR was 0.74 (95% CI [0.62, 0.90]; $I^2 = 80.2\%$; $P_{\text{heterogeneity}} = 0.000$; Figure 2).

Subgroup analysis by study design suggested that there was a significant inverse association between breastfeeding and risk of HS in the cohort studies (OR = 0.74, 95% CI [0.66, 0.84]). With regard to duration of breastfeeding, the pooled OR was 0.70 (95% CI [0.58, 0.86]) in the ≥ 6 –7 months subgroup, 0.60 (95% CI [0.36, 1.01]) in the ever versus never subgroup, and 0.80 (95% CI [0.69, 0.92]) among the other studies. The detailed results of subgroup analysis are shown in Table 2.

3.3 | Sensitivity analysis

Three studies (Chng et al., 2004; Li, Jin, et al., 2010; Piteo et al., 2011) were found to contribute towards between-study heterogeneity by

TABLE 1 Characteristics of included studies in the meta-analysis

Reference	Country, continent	Age (mean age)	Study design	Sample size	HS definition	Feeding patterns	Adjusted OR (95% CI)	Adjusted covariates
Chng et al. (2004)	Singapore, Asia	4–7 years (5.8 years)	Cross-sectional	10,279	≥4 nights per week	Breastfeeding: Ever vs. never	1.49 (1.11–1.98)	Obesity, allergic rhinitis, atopic dermatitis, maternal smoking
Beebe et al. (2012)	USA, North America	2–3 years (2.5 years)	Cohort	249	Scored ≥2 times/week at both ages 2 and 3	Breastfeeding for longer periods vs. absent or shorter duration	0.73 (0.61–0.87)	Gender, race, socio-economic status, birth weight, prenatal (maternal) cotinine, preschool cotinine, preschool BMI z score
Galbally et al. (2013)	Australia, Oceania	3–19 months (9.3 months)	Cohort	4,507	≥4 nights per week	Breastfeeding ≥6 months vs. < 6 months	0.59 (0.41–0.87)	Sleep problems, indigenous community, ethnicity, maternal age, marital status, education, employment, smoking status, mental health, gestational age and baby's birthweight
Piteo et al. (2011)	Australia, Oceania	1–13.9 weeks (4.6 weeks)	Cross-sectional	269	≥3 nights per week	Breastfeeding: Ever vs. never	0.03 (0.01–0.17)	Maternal concern, restless sleep
Brew et al. (2014)	Australia, Oceania	0–8 years (4 years)	Cohort	450	≥4 nights per week	Full breastfeeding ≥3 months vs. <3 months	0.61 (0.33–1.14)	BMI, environmental tobacco smoke at 7.5 years, current asthma, birth weight, sex, smoking in pregnancy, rhinitis at 8 years
Li et al. (2013)	14 Asia Pacific countries	0–36 months (18 months)	Cross-sectional	9,568	≥3 nights per week	Breastfeeding: Ever vs. never	0.69 (0.54–0.88)	No
Li, Jin, et al. (2010)	China, Asia	5.08–11.99 years (9.0 years)	Cross-sectional	20,152	≥2 nights per week	Breastfeeding vs. mixed/bottle feeding	0.86(0.79–0.94)	Age and gender
Bonuck et al. (2011)	UK, Europe	0.5–6.75 years (3.4 years)	Cohort	12,447	≥4 nights per week	Breastfeeding: Ever vs. never	0.83(0.68–1.01)	Maternal smoking, race, housing inadequacy, paternal employment, maternal education, other child, gestational age, gender, adenoids removed, wheezing days
Li, Au, et al. (2010)	China, Asia	5–14 years (9.2 years)	Cross-sectional	6,349	≥3 nights per week	Breastfeeding ≥6 months vs. < 6 months	0.96(0.49–1.87)	Age, gender and BMI z score, clinical features, environmental and socio-economic factors (not include passive smoking)
Kuehni et al. (2008)	UK, Europe	1–4 years (1.8 years)	Cross-sectional	6,742	≥4 nights per week	Breastfeeding > 6 months vs. ≤ 6 months	0.73(0.57–0.95)	Age, sex, and ethnic group
Huang et al. (2008)	China, Asia	0–6 months (3.0 months)	Cross-sectional	610	Not available	Breastfeeding: Ever vs. never	0.41(0.20–0.84)	No

Note. BMI: body mass index; CI: confidence interval; HS: habitual snoring; OR: odds ratio.

FIGURE 2 Forest plot of the odds ratio (ORs) with corresponding 95% confidence intervals (CIs) of the associations between breastfeeding (more versus less) and risk of HS

TABLE 2 Subgroup analysis: Breastfeeding and risk of HS

Stratification	No. of studies	OR	95% CI	I ² (%)	P _{heterogeneity}
More versus less	11	0.74	0.62, 0.90	80.2	0.000
Study design					
Cross-sectional	7	0.73	0.53, 0.99	86.4	0.000
Cohort	4	0.74	0.66, 0.84	2.4	0.380
Outcome definition					
≥3 nights per week	3	0.35	0.10, 1.16	89.8	0.000
≥4 nights per week	5	0.82	0.60, 1.13	80.6	0.000
Other definitions	3	0.76	0.61, 0.94	68.5	0.042
Mean age					
<1 years	3	0.24	0.07, 0.81	87.5	0.000
1–4 years	5	0.74	0.67, 0.83	0.0	0.736
>4 years	3	1.07	0.70, 1.64	84.3	0.002
Duration of breastfeeding					
Ever vs. never	5	0.60	0.36, 1.01	90.6	0.000
≥6–7 months	3	0.70	0.58, 0.86	0.0	0.417
Others	3	0.80	0.69, 0.92	44.4	0.165
Adjustment for passive smoking					
Yes	5	0.82	0.61, 1.10	81.7	0.000
No	6	0.64	0.46, 0.87	82.5	0.000

Note. CI: confidence interval; HS: habitual snoring; OR: odds ratio.

the leave-one-out sensitivity analysis. After further excluding these three studies, the result was also statistically significant and the pooled OR was 0.73 (95% CI [0.66, 0.80]), indicating that our result was robust.

3.4 | Influence analysis and small-study effect

Influence analysis showed that no individual study had an excessive influence on the pooled OR. Visual inspection of the funnel plot and Egger's test suggested there was no evidence of significant small-study effects in the analysis between HS risk and breastfeeding ($P = 0.135$).

4 | DISCUSSION

Before focusing in on HS, it is widely recognized that breastfeeding has numerous beneficial effects. Current WHO breastfeeding guidelines recommend that infants should be exclusively breastfed for the first 6 months and complementary foods should then be introduced with continued breastfeeding for the first 2 years or older (World Health Organization. Nutrition. WHO guideline development group meeting on breastfeeding counselling, 2018a). Exclusive breastfeeding reduces infant mortality as a result of common childhood illnesses such as diarrhoea or pneumonia and contributes to a quicker recovery during illness (World Health Organization. Maternal, newborn, child and adolescent health. Breastfeeding, 2018b).

The meta-analysis of all available observational studies including 71,622 participants revealed that breastfeeding for a long time (e.g., 6 months) was associated with a statistically significant reduced risk of HS in children, and the result remained significant in cohort studies. The finding is similar to the WHO breastfeeding guidelines. There was no evidence of publication bias.

There are two potential explanations underlying the impact of breastfeeding on risk of HS. On the one hand, oral cavity features such as high palates, retruded chin, and narrow dental arches all are additional risk factors for snoring in children (Kushida, Efron, & Guilleminault, 1997). Breastfeeding has a beneficial effect on the development of mandible, thereby preventing the occurrence of many

of these anatomic issues (Charchut, Allred, & Needleman, 2003; Palmer, 2006). On the other hand, breastfeeding could provide immunoglobulins that help prevent infection from respiratory viruses therefore decreasing potential inflammation that may lead to adenotonsillar hypertrophy that may facilitate snoring (Montgomery-Downs, Crabtree, Sans Capdevila, & Gozal, 2007).

Between-study heterogeneity is common in meta-analysis, and it is essential to explore the potential sources of heterogeneity among studies (Munafo & Flint, 2004). Our meta-analysis showed high heterogeneity. Although most studies in this meta-analysis used multivariate regression to adjust confounders, other indeterminate characteristics that varied among studies, such as study design, age, and outcome definition, might be the causes of between-study heterogeneity. Hence, we used both subgroup analyses and the leave-one-out sensitive analysis that aimed to explore the potential important sources. Nevertheless, the between-study heterogeneity persisted in subgroups, indicating the presence of other unknown confounding factors. Three studies were found to contribute towards between-study heterogeneity by the leave-one-out sensitivity analysis. After excluding these three articles, the pooled OR was 0.73 (95% CI [0.66, 0.80]), indicating that our result was steady and reliable. It is interesting that Piteo et al. (2011) regarded restless sleep and maternal concern about the child's breathing during sleep as baseline covariates rather than alternative outcome measures. The unadjusted odds ratio was 0.16 (95% CI [0.05, 0.53]).

This meta-analysis has several advantages. First of all, our study included a relatively large number of participants, reducing sampling error to a great extent and allowing a much greater possibility to reach reasonable conclusions. Second, almost all included studies had adjusted for confounders, improving the credibility of the results. Third, we found no evidence of publication bias in this meta-analysis. In addition, the subgroup analysis by study design strongly identified the effect of breastfeeding on HS, and the pooled OR of cohort studies was 0.74 (95% CI [0.66, 0.84]).

Nevertheless, the limitations of our study should also be considered. First, confounders adjusted of each study were different, which could affect the results to some extent. Second, the definition of HS was different among studies. Third, we could not conduct dose-response relationship between breastfeeding and risk of HS because of the limited data.

A systematic review of the association between breastfeeding and sleep-disordered breathing written by Cecilia was published in 2017 (Ponce-Garcia et al., 2017). Compared with this review, our article included more studies to quantitatively analyse the relationship between breastfeeding and HS and came to the conclusion that breastfeeding for a long time (e.g., 6 months) is associated with reduced risk of HS in children (OR, 0.74; 95% CI [0.62, 0.90]). On the one hand, a uniform data screening strategy was used to extract data, and each article extracted only one OR with regard to the association between breastfeeding and snoring. On the other hand, based on high heterogeneity, we used random effect model to pool the findings quantitatively, and used both subgroup analyses and the leave-one-out sensitive analysis to explore the potential sources of heterogeneity.

5 | CONCLUSION

In summary, results from this meta-analysis indicated that breastfeeding for a long time (e.g., 6 months) is associated with reduced risk of HS in children. This article may provide evidence to support and promote breastfeeding. Future research should record breastfeeding in a uniform manner using validated questions and definitions.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

KS conceptualized and designed the study, assisted in data collection, and drafted the initial manuscript; YG and YZ assisted in data collection, carried out the initial analyses, and reviewed and revised the manuscript; XJ conceptualized and designed the study, coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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