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ORIGINAL ARTICLE

Prevalence of habitual snoring and its correlates in young children across the Asia Pacific

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Aims: To evaluate: (i) the prevalence of habitual snoring (HS) in a large sample of children aged from birth to 36 months in 14 countries across Asia Pacific; and (ii) the different correlates associated with HS in Caucasians, Chinese and non-Chinese, non-Caucasian Asians.

Methods: This was a multi-centre, cross-sectional survey conducted across Asia Pacific. Parents/caregivers of 23 481 infants and toddlers completed an expanded version of the Brief Infant Sleep Questionnaire. We defined HS as snoring more than three nights per week.

Results: Chinese and non-Caucasian non-Chinese (NCNC) children had a lower prevalence of HS across the age range from birth to 3 years than their Caucasian counterparts (6.2% and 5.1% vs. 11%, $P < 0.01$). Boys had a higher prevalence of HS compared to girls ($\chi^2 = 98.5$, $P < 0.0001$). History of prematurity (OR = 1.37–1.56, CI (1.1–2.17), $P < 0.01$) and gender (OR = 1.53–1.54, CI (1.26–1.85), $P < 0.0001$) were found to be significant predictors for HS. Current breastfeeding (OR = 0.69, CI (0.54–0.88), $P < 0.005$) and greater parental age (OR = 0.86, CI (0.78–0.96), $P < 0.01$) were protective against HS among NCNC children. HS was less prevalent in younger Chinese subjects (OR = 0.88, CI (0.84–0.93), $P < 0.0001$). In Caucasians, parents' education (OR = 0.78, CI (0.67–0.91), $P < 0.005$) and their not sleeping in the same room as their child (OR = 0.62, CI (0.45–0.86), $P < 0.005$) were negatively associated with parental report of HS.

Conclusions: Prevalence of HS shows racial differences among countries across Asia Pacific. Future studies should assess craniofacial structure and body fat distribution as contributory factors for this differential prevalence.

Key words: Asia Pacific; habitual snoring; infants; racial difference; toddlers.

What is already known on this topic

1 Previous studies on the prevalence of habitual snoring have focused on school-aged children, and the rate varies between 2.4% and 34.5%.
2 Most studies have been conducted in Western countries.

What this paper adds

1 Chinese and non-Caucasian, non-Chinese (NCNC) children have a lower prevalence of habitual snoring than Caucasian children.
2 Habitual snoring in different ethnic groups is associated with different predictors.

Snoring is the most important and common manifestation related to obstructive sleep apnoea (OSA) and may cause gaseous exchange abnormalities due to partial obstruction of the upper airway during sleep.[1] In adults, habitual snoring (HS), which is defined as snoring more than three nights per week, is associated with hypertension,[2] cardio/cerebrovascular disease[3] and daytime sleepiness.[4] In children, higher blood pressure has been found in children with HS compared with healthy controls.[5] Impaired neuropsychological functioning has also been documented in children with a history of snoring.[6] Furthermore, children with primary snoring initially may develop OSA later, and there is robust evidence to show that OSA can result in serious cardiovascular and metabolic consequences.[7] Therefore, the clinical importance of HS as a potential marker of morbidity and even mortality is increasingly being recognised.

Reported studies on the prevalence of HS have concentrated on school-aged children, and the rate varies between 2.4% and 34.5%.[8] Such a wide range may be attributed to discrepancies in the definition of HS, differences in age group, different methods of sampling and possible cultural differences in what the term 'snoring' really means. Furthermore, most studies examining the prevalence of HS and associated risk factors have been carried out in populations from Western countries.[8]

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Conflict of interest: Jodi A Mindell is both a speaker and a consultant for Johnson & Johnson. Avi Sadeh has served as a consultant for Johnson & Johnson. Albert M Li and Daniel YT Goh are members of APPSA, which receives financial support from Johnson & Johnson to carry out regional research work and establish sleep-related educational materials for use in Asia Pacific.

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The primary objectives of this study were to evaluate: (i) the prevalence of HS in a large sample of children of ages birth to 36 months in multiple countries across Asia Pacific; and (ii) the different correlates associated with HS in Caucasians, Chinese and non-Chinese non-Caucasians.

Methods

Subjects

Parents/caregivers (hereon referred to as 'parents') of 23 481 infants and toddlers in 14 Asia Pacific countries (Australia (1073), China (7505), Hong Kong (1049), India (3982), Indonesia (967), South Korea (1036), Japan (872), Malaysia (997), New Zealand (1081), Philippines (1034), Singapore (1001), Taiwan (896), Thailand (988) and Vietnam (1000)) participated in this study. Depending on racial origin, each subject was allocated to one of three groups, namely Caucasian (CA, n = 1948), Chinese (CH, n = 11 965) or non-Caucasian non-Chinese (NCNC, n = 9568).

Children's ages ranged from birth to 36 months. Sample sizes within each country were evenly distributed across age. The final recruited sample sizes were based on urban population, with a target of 1000 subjects for each country with <100 million urban inhabitants, 5000 subjects for urban populations between 100 and 500 million, and 7500 for those >500 million.

Survey questionnaire

Parents of recruited subjects completed an expanded version of the Brief Infant Sleep Questionnaire (BISQ).[9] The BISQ has been validated against actigraphy and daily logs, and its sensitivity in documenting expected developmental changes in infant sleep and the effects of environmental factors has been established. The expanded version included specific questions on infant daytime and night-time sleep patterns, as well as on sleep-related behaviours. The question on snoring was 'Does your child snore when he/she is asleep?' and the options given were 'never', 'only when he/she suffers from influenza or allergy', 'sometimes' and 'almost always'. For participants who chose the latter two options, a drop-down list of frequencies was then provided. We defined occasional and habitual snoring as snoring one night per week or less and at least three nights per week, respectively. The respondents were asked to describe their child's behaviour during the last two weeks. The questionnaire was translated into each respective language and back-translated to ensure appropriate translation.

All data were collected online except for Thailand and Vietnam, where a paper-based version was completed face-to-face with a researcher. The online questionnaire and face-to-face interview were implemented at the same time in autumn 2007. Full details of the methodology can be obtained in our previous publication.[10] Completion of the questionnaire was voluntary and parents were not given any feedback. In addition to the BISQ, demographic information including parental age, education, race, employment status and child's birth order position was also collected.

Statistical analyses

Means and frequencies were used for demographic information. Predictors for HS were examined using the PROC LOGISTIC procedure (logistic regression based on analysis of maximum likelihood estimates) in SAS (SAS Institute, Cary, NC, USA). In these logistic regressions, habitual snoring (yes/no) was used as the criterion and background variables were used as predictors. Chi-square analyses were used to compare group differences in frequencies of dichotomous variables (gender, birth order, age groups, education level and employment level).

Results

Across the entire sample, there were 11 310 boys (48.2%) and 12 171 girls (51.8%), and the gender distribution across the three racial groups was 48.7% boys among CA, 47.8% among CH and 48.5% among NCNC (χ^2 = 1.47, not significant). There were fewer children defined as the only child in the family in the CA group (45.4%) than in CH and NCNC samples (49.4% and 49.1%, respectively) (χ^2 = 10.7, P < 005). The majority of the respondents were mothers (87.9%), with 10.6% being fathers and the remaining 1.5% grandparents and others. More mothers completed the survey in the CA group (96.7%) compared with the other two groups (86.8% of CH and 87.4% of NCNC) (χ^2 = 278.8, P < .0001). The majority of the respondents (78.5%) were between 25 and 35 years of age, and most had some college education (83.0%). Respondents in the CA group were older (χ^2 = 544.8; P < .0001). Parents in the NCNC group had higher education (χ^2 = 2553, P < .0001). Across all respondents, 56.1% were employed full-time and 6.24% were working part-time, and respondents in the CH group were more likely to be working full-time (χ^2 = 2527, P < .0001).

Figure 1 shows prevalence of HS for all 14 countries across Asia Pacific. Australia, New Zealand and the Philippines had prevalence ratings for HS of >10%, while the remaining countries had ratings of <10%. Of all the countries, Korea had the lowest parent-reported rate of HS: only 2.4%. The prevalence rates for Caucasians, Chinese and non-Caucasian non-Chinese were 11.0%, 6.2% and 5.1%, respectively. The HS prevalence among Caucasians was higher than in the other two racial groups across the whole age range from birth to three years (χ^2 = 306.8, P < .0001; Fig. 2). Similarly, boys were found to have a higher prevalence of HS than girls across age (Fig. 2; χ^2 = 98.5, P < .0001).

In the logistic regression, history of prematurity and gender were found to be significant predictors for HS (Table 1). Current breastfeeding and greater parental age were protective against HS. However, this was valid only among the NCNC group. Snoring was significantly less likely in older Chinese subjects. In Caucasians, parents' education and their not sleeping in the same room as their child were associated with decreased HS.

Discussion

This is the largest epidemiologic study utilising a standardised instrument yet carried out in Asia Pacific to examine the prevalence of HS among infants and toddlers up to the age of three years. We found significant racial differences in the prevalence

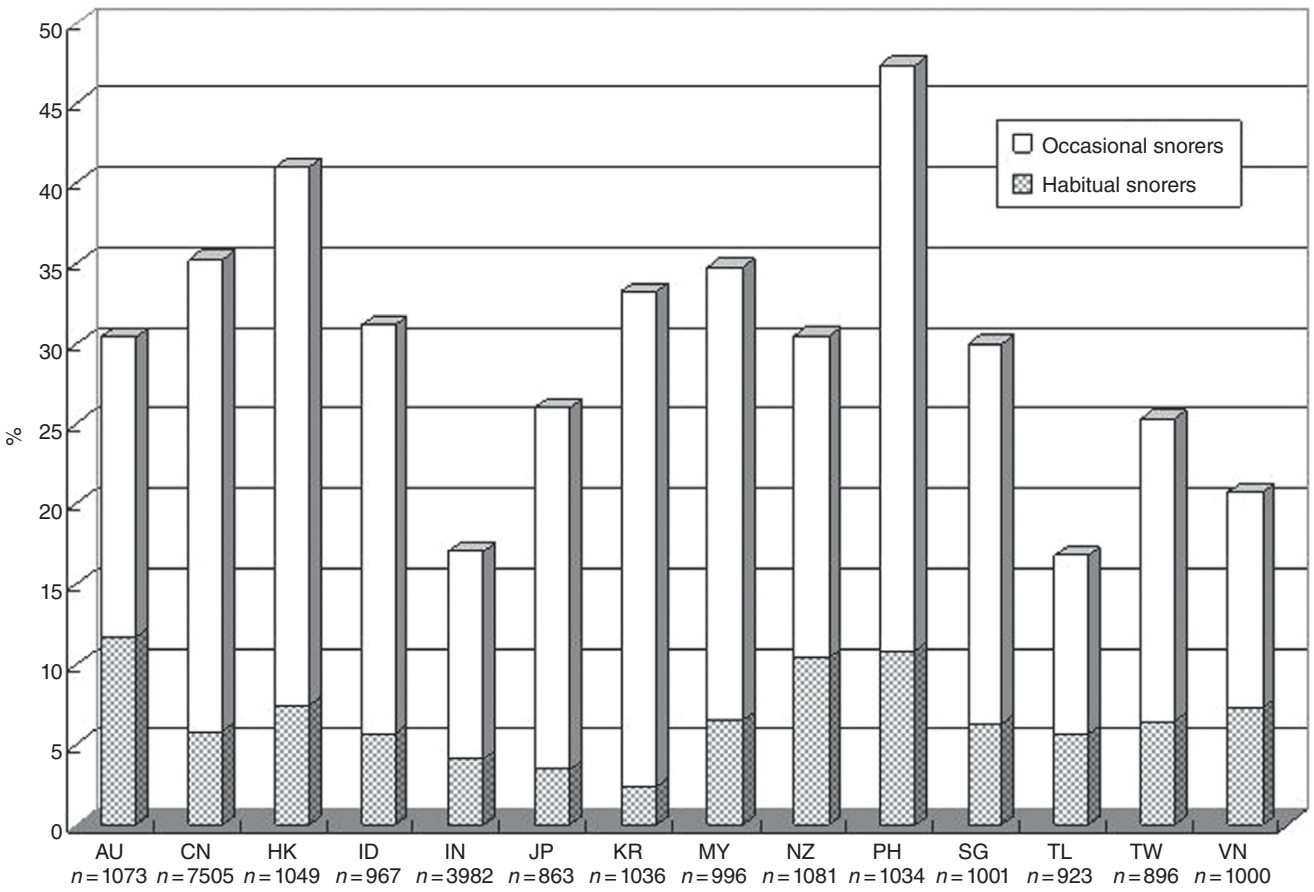

Fig. 1 Prevalence of HS for all 14 countries. AU, Australia; CN, China; HK, Hong Kong; ID, India; IN, Indonesia; JP, Japan; KR, Korea; MY, Malaysia; NZ, New Zealand; PH, Philippines; SG, Singapore; TL, Thailand; TW, Taiwan; VN, Vietnam. Occasional snorer, ≤1 night/week. Habitual snorer, >3 nights/week.

of HS, with Caucasians having the highest rate compared with Chinese and non-Chinese non-Caucasians. Our results are in agreement with published data, which demonstrate a higher prevalence of HS among Caucasians. Table 2 shows published studies on HS prevalence among children of similar age groups to those examined in our current study. The reported rates vary widely and are most likely a result of different diagnostic cutoffs used for defining HS.[11–25] There is only one study on Asia Pacific. The researchers from China reported a prevalence of between 5.2% and 5.5%,[16] which is much lower compared with rates amongst Caucasians and similar to the 6.2% reported in this study. Our study findings agree with what has been reported in the literature, in that the prevalence of HS is greater in Caucasians than Chinese.

Snoring is the cardinal symptom of OSA, which is a complex chronic clinical syndrome. Racial studies and chromosomal mapping as well as familial and twin studies have provided robust evidence for a significant role played by genetics in OSA. Furthermore, most of the risk factors involved in the pathogenesis of OSA are largely genetically determined. It is therefore likely that genetic factors associated with craniofacial structure, body fat distribution and neural control of the upper airway muscle interact to produce the OSA phenotype. Inter-ethnic differences have been demonstrated in craniofacial morphology, head posture and nasal respiratory resistance in a study comparing OSA subjects with different disease severity from three races, namely Malay, Indian and Chinese.[26] Genetic influence may also apply to snoring, giving rise to different prevalence across races.

In our study, HS was more prevalent in boys across the whole age range from birth to three years. The issue of gender difference in the prevalence of HS is controversial, and has only been reported in a few published studies.[13,16,20,22] In adults, among whom HS is more common in men, sex hormones and their influence on respiratory control and/or body fat distribution have been suggested to play a crucial role.[27] Clearly, these factors would be much less important in prepubertal children. Boys are known to have smaller airways and therefore reduced forced expiratory volume in the first second compared with girls.[28] The same may hold true for their oropharyngeal diameter, which could explain why boys are more likely to have snoring.

Prematurely born children may be at increased risk for snoring and sleep-disordered breathing as a result of their limited exposure to the perinatal environment, which significantly influences the development of respiratory control and/or upper airway size.[29] Another possible explanation for prematurity being a risk factor for snoring is the higher incidence of

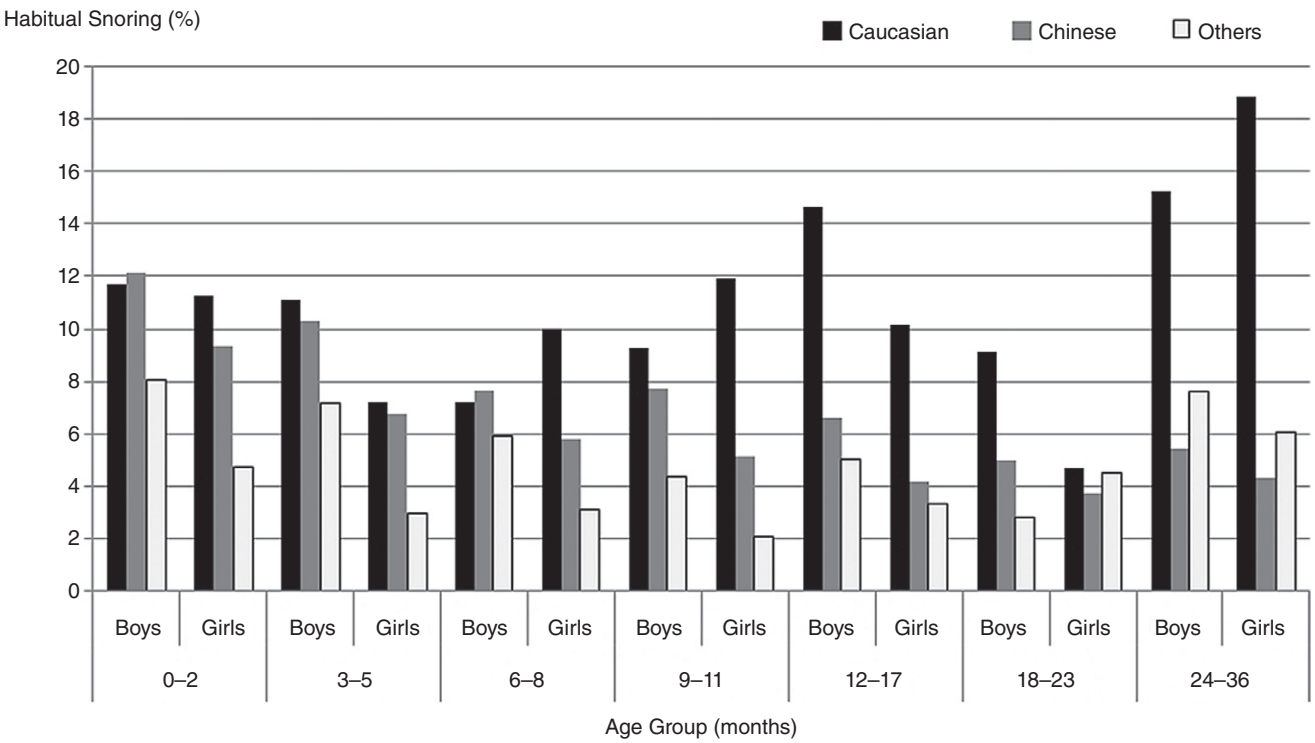

Fig. 2 Prevalence of HS across age and gender for each of the three racial groups.

Table 1 Predictors for HS for each of the three racial groups

Predictor	Wald χ^2	*P*<	Odds Ratio	95% CI
Caucasians				
Parent's education	10.70	0.005	0.78	0.67–0.91
Parent not in room	8.10	0.005	0.62	0.45–0.86
Preterm	6.85	0.01	1.56	1.12–2.17
Chinese				
Sex	29.50	0.0001	1.54	1.32–1.80
Age	27.87	0.0001	0.88	0.84–0.93
Preterm	7.77	0.01	1.37	1.10–1.71
Non-Caucasian non-Chinese				
Sex	18.66	0.0001	1.53	1.26–1.85
Current breastfeeding	9.03	0.005	0.69	0.54–0.88

muscle hypotonicity, which is more frequent in infants who were born preterm.

It has been hypothesised that breastfeeding can provide immunologic protection against early viral infections that could result in chronic inflammation of the upper airway and hypertrophy of the upper airway lymphoid tissues. One study showed that children with HS who had been breastfed for at least two months in their early infancy had significantly lower sleep-disordered breathing severity compared with those who had never been breastfed.[30] However, because all of the children in their sample were habitual snorers, the authors did not measure differences in snoring prevalence between formerly breastfed and formula-fed infants. However, another study showed that breastfeeding did not reduce the risk of HS but, on the contrary, increased the risk of it.[31] The authors suggested that the increased risk of HS was owing to the increased risk of atopy associated with breastfeeding, as supported by a previous large-scale study.[32] Therefore, the relationship between breastfeeding and HS is still controversial, and the mechanisms behind all the aforementioned findings remain unclear.

There were certain limitations to our study. Firstly, as expected from a primarily Internet-based study, the cohort in this study was skewed towards higher educational background. However, this bias was likely consistent across all countries, as

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Table 2 Published studies on prevalence and risk factors of HS

First author/Year of publication	Definition of habitual snoring	N	Location	Age	Prevalence, %	Risk factors for habitual snoring											
						Male	Obesity	Parental snoring	History of allergy	Rhinitis	Asthma	Eczema	URTI	Recurrent otitis media	Parental smoking	Adeno-tonsillar hypertrophy	African-American	Low socio-economic status
Gislason / Chest 1995[10]	Often	454	Iceland	Six months to six years	3.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kelmanson / Eur J Pediatr 2000[11]	Yes/no	200	Russia	Two to four months	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Montgomery-Downs / Sleep Med 2006[12]	≥3x/wk	944	United States	Two weeks to two years	5.3	NA	NA	+	NA	NA	NA	NA	NA	NA	+	NA	NA	NA
Kaditis / Pediatr Pulmonol 2004[13]	Always	3680	Greece	One to 18 years	5.3 (for children aged one to six years)	+	NA	+	NA	NA	NA	NA	NA	NA	+	NA	NA	NA
Liu / Pediatrics 2005[14]	NA	5979	China	Two to 12 years	5.5 (for children aged two years) 5.2 (for children aged three to five years)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Liukkonen / Int J Pediatr Otorhinolaryngol 2008[15]	≥3x/wk	1471	Finland	One to six years	6.3	NA	NA	+	NA	+	NA	NA	+	+	+	+	NA	NA
Kuehni / Eur Respir J 2008[16]	Almost always	6742	United Kingdom	One to four years	7.9	+	NA	NA	+	NA	NA	NA	NA	+	+	NA	NA	+
Lu / Chest 2003[17]	≥4x/wk	974	Australia	Two to five years	10.5	NA	NA	NA	NA	NA	+	NA	NA	NA	NA	NA	NA	NA
Weissbluth / J Pediatr 1984[18]	Yes/no (last 2 wk)	141	United States	Four to eight months	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kalra / Chest 2006[19]	≥3x/wk	681	United States	One year	15	NA	NA	+	+	NA	NA	NA	NA	NA	NA	NA	+	NA
Valery / J Pediatr Child Health 2004[20]	≥2x/wk	1650	Australia	Birth to 17 years	15.4 (for children aged birth to four years)	+	+	NA	NA	NA	+	NA	NA	NA	NA	NA	NA	NA
Montgomery-Downs / Clin Pediatr 2003[21]	≥3x/wk	1010	United States	Three to 5.3 years	22	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	+	+
Mitchell / Acta Paediatr 2003[22]	Yes/no (last 2 wk)	1585	New Zealand	One to six months	26.1	+	NA	NA	NA	NA	NA	NA	+	NA	+	NA	NA	NA
Owen / Clin Otolaryngol Allied Sci 1996[23]	Sometimes	245	United Kingdom	Birth to 10 years	27	NA	NA	NA	NA	NA	NA	+	+	NA	+	NA	NA	NA
Montgomery-Downs / Pediatrics 2006[24]	PSG-defined snoring-related arousals	35	United States	7.2 to 9.5 months	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	+	NA	NA	NA

we obtained similar segments of the population within each country, allowing meaningful comparison between different racial populations. However, it is important to note that our findings cannot be applied to all infants and young children within each country. Nonetheless, our obtained prevalence rates are very similar to the results of other studies that had utilised traditional (non-computerised) surveys. Secondly, the survey questionnaires were completed by parents; very often, they did not sleep in the same room as their child and therefore would not know their child's actual sleep behavior. Interestingly, among Caucasians, parents' not sleeping in the same room as their child was found to be negatively associated with HS. This may simply reflect parents not hearing their child's snoring because they are in a separate room. Noises at night from this age group of children are common, and without audio feedback to the parents who completed the online questionnaire, there was a chance of their misclassifying other noises as snoring. This issue of accuracy in reporting is a known intrinsic problem associated with the use of questionnaire surveys. Nonetheless, a recent publication on pre-school children showed a significant and independent association between parentally reported and objectively measured HS.[33] Lastly, the atopic status and body weight of each participant were not obtained. This information may be important in explaining the differences in HS prevalence across the region.

In this largest epidemiological study yet on HS prevalence among infants and children in the Asia Pacific region, we documented significant differences in prevalence across different countries. Future studies that assess craniofacial structure, body fat distribution and atopy will be useful to determine the underlying mechanisms accounting for these racial differences.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Expanded version of Brief Infant Sleep Questionnaire (BISQ).