



All snoring is not adenoids in young children

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KEYWORDS

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Summary

Objective: To determine the prevalence of snoring in young children and to assess age, growth, previous surgery therapy, respiratory problems and sleep-related symptoms in relation to child's snoring, and to evaluate the relationship between child's snoring and parents' snoring and smoking.

Children and methods: A cross-sectional study evaluated 2100 children 1–6 years of age in Helsinki, Finland. Child's frequency of snoring on a five-point scale (never to every night) and age, height, weight and body mass index, previous adenotonsillectomies, tympanostomies, allergic rhinitis and respiratory infections were determined as was frequency of parental snoring and smoking. Sleep problems were determined based on Finnish or Swedish modified version of the sleep disturbance scale for Children.

Results: Of the 2100 eligible children, 1471 (71%) returned questionnaires. Children always or often snoring numbered 92 (6.3%), sometimes snoring, 183 (12.4%), and never or occasionally snoring, 1196 (81.3%). No difference in age ($p = 0.06$) or gender ($p = 0.39$) existed between snorers and non-snorers. History of previous adenotonsillectomies ($p < 0.001$), allergic rhinitis ($p < 0.001$), recurrent respiratory infections ($p < 0.001$), and otitis media ($p < 0.001$) were more common among snorers than among occasional or never-snorers. Nocturnal symptoms such as breathing problems, sleep hyperhydrosis, sleep-wake transition disorders, and daytime somnolence were associated with children's snoring. Frequency of children's snoring was also associated with parental snoring ($p < 0.001$) and smoking ($p < 0.001$).

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Conclusions: Snoring is common among young children and is associated with previous adenotonsillectomy, allergic rhinitis, respiratory infections, nocturnal symptoms, and parents' snoring and smoking. The high prevalence of snoring among children with adenotonsillectomy raises the question whether adenotonsillectomy alone is adequate treatment for snoring in young children.

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1. Introduction

Snoring has been considered relatively common in young children, with the prevalence ranging from 5% up to 20% [1–3]. Snoring frequency varies slightly among different age groups, being more common among preschool-age children than during older ones [4,5]. Occurrence of snoring is difficult to interpret because the criteria and definition of snoring vary markedly. Snoring associates with daytime symptoms such as behavioral problems and anxious and depressive symptoms and tiredness, as well as with night-time problems such as restless sleep, nocturnal sweating, teeth-grinding, sleep-talking and nightmares [6–8].

Hypertrophy of adenotonsillar tissue is an important risk factor for snoring in childhood [9]. Adenotonsillectomy is by far the most widely performed procedure for snoring in young children, and in most of the cases symptomatic improvement is rapid after adenotonsillectomy, but improvement after adenoidectomy without tonsillectomy is minor [10]. Small upper airways and mucosal inflammation may also be important risk factors [11]. Many have reported an association between snoring and allergic rhinitis [9], recurrent upper respiratory infections [1,12], passive smoking [13], and parents' snoring [14].

The aim of the present study was to assess the prevalence of snoring in young children in Finland and to evaluate the child's age and growth, previous upper respiratory surgery therapy, respiratory problems with child's snoring as well as sleep-related symptoms and relationship between child's snoring and parental snoring and smoking.

2. Children and methods

This study is a part of larger epidemiological study of child's sleep-related breathing disorders in Finland. A random sample of 2100 children born between 1 September 1998 and 31 August 2005 was collected from the Population Register Center, Helsinki, Finland. The children came from both Finnish- and Swedish-speaking families. The sample accounted for 7% of the city population 1–6 years of age. The questionnaires were mailed to the children's

parents periodically from January 2005 to September 2006, starting with the oldest age group (5–6 years old). Each questionnaire included a prepaid return envelope. Families who failed to return it were re-contacted with a new questionnaire twice. Of the 2100 questionnaires, 12 did not reach the subject, 21 were completed for the wrong child, e.g., a sibling. Overall, 1494 questionnaires (72%) came back. Information on snoring frequency was available for 1471 (71%) children and was further analyzed.

Children considered to snore were identified based on parents' response to the item "How often does your child snore?" "Symptoms during the past 6 months were described. Children were classified as snorers if they were reported to snore always, often, or sometimes (scores 3–5) or non-snorers if the answer was occasionally or never (scores 1–2). Child's age, height and weight, previous surgery, and upper respiratory and middle ear infections were recorded. History of allergic rhinitis was assessed with the answer: "Does your child have allergic rhinitis?" "Respiratory infections were assessed to the question": "Does your child have upper respiratory infection episodes?" (common colds, cough, or sore throat during the last 6 months). A response of often or always (scores 4–5) was defined as having recurrent respiratory infections. The amount of acute otitis media was determined with the options none, one, two, three, or over four episodes during the past 6 months. Children having four or more episodes of acute otitis media during the past 6 months were classified as having recurrent otitis media.

Snoring and sleep problems were evaluated more extensively by a Finnish or Swedish modified version of the sleep disturbance scale for children (SDSC), an instrument for assessing the frequency of sleep problems on a five-point scale (1 = never, 2 = occasionally (1–2 times/month), 3 = sometimes (1–2 times/week), 4 = often (3–5 times/week) 5 = always (every day/night)) [15]. The SDSC consists of 26 items grouped into six subscales: (1) disorders of initiating and maintaining sleep (sleep latency, going to bed reluctantly, difficulty falling asleep, falling-asleep anxiety, night awakenings, difficulty in falling asleep after awakenings), (2) sleep-breathing disorders (breathing problems,

sleep apnea), (3) disorders of arousal/nightmares (sleepwalking, sleep terrors, nightmares), (4) sleep–wake transition disorders (hypnic jerks, rhythmic movement disorders, hypnagogic hallucinations, nocturnal hyperkinesia, sleep talking, bruxism), (5) disorders of excessive somnolence (difficulty in waking up, tiredness when waking up, daytime somnolence, sleep paralysis, bed-wetting) and (6) sleep hyperhydrosis (night sweating, falling asleep sweating). Parents' snoring frequency was classified on a five-point scale (non-snorers: scales 1–2, snorers: scales 3–5), and smoking was assessed as only "yes/no".

The study was approved by the Ethics Committee, Helsinki University Hospital, and informed written consent was provided by the children's care-givers.

2.1. Statistical analysis

Results were expressed as means ($\pm$ S.D.) for continuous data. Independent *t*-tests or Pearson's Chi-square tests were used to assess group differences in demographic variables. Age variables were tested by the Mann–Whitney *U*-test, and Spearman rank correlation coefficients served to evaluate nocturnal symptoms of snoring and non-snoring children. All analyses were done with statistical software (NCSS and PASS 2004. Number Cruncher Statistical Systems, Kaysville, UT). *p*-Value less than 0.01 were considered to indicate statistical significance.

3. Results

The always or often snoring, 92 (6.3%) and sometimes snoring, 183 (12.4%) children were classified as snorers ($n = 275$, 18.7%). Never or occasionally snoring children numbered 1196 (81.3%). Ages ranged from 12 to 84 months (mean 46 months), and 719 (48.1%) were boys. No differences were apparent between snorers and non-snorers regarding age or gender (Table 1). Snoring prevalence did not differ between age groups (Fig. 1).

Of the 1471 analyzed, 214 (15%) children had undergone adenoidectomy and 51 (3.7%) tonsillectomy. The number of adenoidectomies and tympanostomies was significantly higher in the snoring than in the non-snoring group: 63; 24% vs. 151; 13%, and 61; 22% vs. 154; 13% ($p < 0.001$) (Table 1).

Allergic rhinitis was more common in the snoring group (65; 24% vs. 171; 14%, $p < 0.001$). In the previous 6 months, 28% of children have had over four episodes of acute otitis media. Recurrent respiratory infections (58; 21% vs. 109; 9.3%, $p < 0.001$) and otitis media (105; 38% vs. 307; 26%, $p < 0.001$) were more common among snorers (Table 1).

Sleep hyperhydrosis (night sweating, falling asleep sweating), sleep–wake transition disorders (hypnic jerks, rhythmic movement disorders, hypnagogic hallucinations, nocturnal hyperkinesia, sleep talking, bruxism) and daytime somnolence

Table 1 Demographic and epidemiologic data from snoring (snoring frequency at least once a week) and non-snoring (never or less than once a week) children

	Snorers ($n = 275$)	Non-snorers ($n = 1196$)	<i>p</i>
Male gender (%)	141 (51)	578 (48)	0.39
Age (months, median)	48.2	45.9	0.06
Mean height (m, S.D.)	1.03 (± 0.14)	1.01 (± 0.14)	0.03
Mean weight (kg, S.D.)	17.4 (± 4.9)	16.6 (± 4.7)	0.01
Adenoidectomy (%)	63 (24)	151 (13)	<0.001
Tympanostomy (%)	61 (22)	154 (13)	<0.001
Tonsillectomy (%)	16 (6)	35 (3)	0.01
Allergic rhinitis (%)	65 (24)	171 (14)	<0.001
Recurrent respiratory infections ^a (%)	58 (21)	109 (9)	<0.001
Acute otitis media ^b (%)	105 (38)	307 (26)	<0.001
Snoring ^c (%)			
Mother	103 (37)	235 (20)	<0.001
Father	201 (73)	701 (59)	<0.001
Smoking (%)			
Mother	27 (14)	71 (8)	<0.01
Father	42 (20)	202 (20)	0.03
Both	40 (20)	96 (10)	<0.001

^a Recurrent upper respiratory infections often or always in the previous 6 months (scores 4–5).

^b Four or more episodes of acute otitis media in the previous 6 months.

^c Parents snoring sometimes, often, or always (scores 3–5).

correlated with snoring frequency, with no correlation between snoring frequency and disorders of initiating or maintaining sleep (Table 2).

Smoking was reported in 32.5% of families for either or both parents. Among snoring children, parental smoking, especially maternal smoking, was more common than among the non-snorers (40; 20% vs. 96; 10%, $p < 0.001$). Parental snoring was significantly higher in the snoring group than in the non-snoring group ($p < 0.001$) (Table 1).

4. Discussion

In the present study based on the random sampling of Population Register Center data, we found that the prevalence of snoring in young children was common without significant changes with age: 19% of Finnish young children snore at least sometimes, and 7% are habitual snorers. Snoring associated with upper respiratory infections and acute otitis media, allergic rhinitis, and parental snoring and exposure to tobacco smoke and a child's age was not predictive for snoring. Although most of these associated factors are already known risks for children's snoring [9,12,13,16], we were surprised to find frequent snoring among children who had already undergone upper airway surgery. For a survey of the general population, overall response rate to the mailed questionnaires was good (72%).

In Finland, the adenoidectomy rate for young children has been very high compared to that of other countries [17,18], and in our study population the overall adenoidectomy rate was 15%. Most of the adenotomies were likely to be performed because of recurrent ear infections, not because of snoring. Significant differences appeared in adenoidectomy rates between snoring (24%) and non-snoring children (13%). Adenotonsillectomy, widely accepted treatment of OSA once the diagnosis has been established, is effective in most cases [2,19–23], but no good studies compare different modes of surgery in

Table 2 Correlations between snoring frequency and sleep-related symptoms in children

Symptom	<i>p</i> -Value	<i>r</i>
Initiating and maintaining sleep		
Sleep latency ^a	0.13	
Going to bed reluctantly	0.02	
Difficulty in falling asleep	0.03	
Falling asleep anxiety	<0.001	0.10
Night awakenings	<0.001	0.09
Difficulty in falling asleep after awakenings	0.02	
Sleep breathing disorders		
Breathing problems ^b	<0.001	0.37
Sleep apnoea ^c	<0.001	0.29
Arousals/nightmares		
Sleepwalking	<0.01	0.09
Sleep terrors	<0.01	0.10
Nightmares ^d	<0.01	0.10
Sleep/wake transition disorders		
Hypnic jerks	<0.001	0.22
Rhythmic movement disorders	<0.01	0.11
Hypnagogic hallucinations ^e	<0.01	0.12
Nocturnal hyperkinesias	<0.001	0.24
Sleeptalking	<0.001	0.18
Bruxism	<0.001	0.17
Disorders of excessive somnolence		
Difficulty in waking up	<0.01	0.10
Tired when waking up	<0.001	0.14
Daytime somnolence	<0.001	0.09
Sleep paralysis ^f	<0.01	0.11
Bed-wetting	0.33	
Sleep hyperhydrosis		
Night sweating	<0.001	0.23
Falling asleep sweating	<0.001	0.21

^a How long after going to bed does child usually fall asleep.

^b Child has difficulty in breathing during the night.

^c Child gasps for breath or is unable to breathe during sleep.

^d Child has nightmares which he/she does not remember the next day.

^e Child experiences vivid dream-like scenes while falling asleep.

^f Child feels unable to move when waking up in the morning.

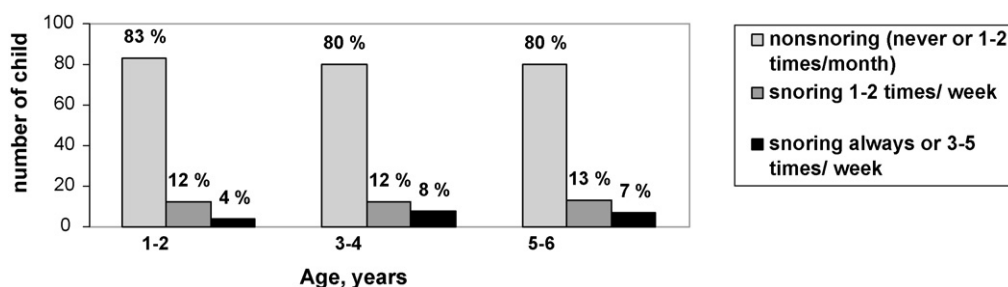


Fig. 1 Prevalence of snoring (%) among age groups 1–2, 3–4 and 5–6 years.

OSA management, i.e. comparing the effectiveness of adenotomy, tonsillectomy and combined adenotonsillectomy [10,23–25]. Our findings suggest that removal of adenoids is often insufficient in treating snoring since a large portion of our snoring children already had adenotomies. In our study population, adenoidectomy alone may have been performed for young children as the first treatment for snoring because of its lower morbidity and mortality than tonsillectomy. The overall number of tonsillectomies was lower, but the same trend emerged, tonsillectomies being 6% among snoring but only 3% among non-snoring children.

Snoring children were heavier, and if the trend toward obesity in children [26] continues, obesity may become a more important risk factor for snoring even in young children. Like some others [27], we saw no significant difference in snoring prevalence by gender.

Similarly, as in other studies, we found a significant association between snoring frequency and breathing problems, excessive night-time sweating, tiredness upon waking, and daytime somnolence, as well as sleep–wake transition disorders. Conversely, we found no relationship between snoring frequency and disorders of initiating or maintaining sleep, similar to results from other studies [8,28].

Of our children, one-third had a smoking parent. Smoking and even passive smoking has been an independent risk factor for snoring in adults [29], and children suffering from snoring are more likely to live in smoking households [30,31]. Ali et al. demonstrated a dose–response relationship between passive smoking and habitual snoring in children, especially for maternal smoking [32]. Although history of parental snoring indicates a role for heredity in development of snoring in young children [33–34], the relationship we found between parental snoring and snoring in children could be explained at least in part by parental smoking.

As a conclusion we have shown that snoring is more common in children and on a population level still exists after previous adenoidectomy and tonsillectomy. Snoring is often observed in children with tobacco smoke exposure.

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References

- [1] E. Hultcrantz, B. Lofstrand-Tidestrom, J. Ahlquist-Rastad, The epidemiology of sleep related breathing disorder in children, *Int. J. Pediatr. Otorhinolaryngol.* 32 (Suppl.) (1995) S63–S66.
- [2] T. Gislason, B. Benediktsdottir, Snoring, apneic episodes, and nocturnal hypoxemia among children 6 months to 6 years old: an epidemiologic study of lower limit of prevalence, *Chest* 107 (1995) 963–966.
- [3] L.R. Lu, J.K. Peat, C.E. Sullivan, Snoring in preschool children: prevalence and association with nocturnal cough and asthma, *Chest* 124 (2003) 587–593.
- [4] X. Liu, Y. Ma, Y. Wang, Q. Jiang, X. Rao, X. Lu, et al., Brief report: an epidemiologic survey of the prevalence of sleep disorders among children 2 to 12 years old in Beijing, China, *Pediatrics* 115 (2005) 266–268.
- [5] A.G. Kaditis, J. Finder, E.I. Alexopoulos, K. Starantzis, K. Tanou, S. Gampeta, et al., Sleep-disordered breathing in 3680 Greek children, *Pediatr. Pulmonol.* 37 (2004) 499–509.
- [6] L.M. O'Brien, C.B. Mervis, C.R. Holbrook, J.L. Bruner, C.J. Klaus, J. Rutherford, et al., Neurobehavioral implications of habitual snoring in children, *Pediatrics* 114 (2004) 44–49.
- [7] S. Blunden, K. Lushington, B. Lorenzen, J. Martin, D. Kennedy, Neuropsychological and psychosocial function in children with a history of snoring or behavioral sleep problems, *J. Pediatr.* 146 (2005) 780–786.
- [8] S. Eitner, M.S. Urschitz, A. Guenther, P.M. Urschitz-Duprat, B. Bohnhorst, M. Schlaud, et al., Sleep problems and daytime somnolence in a German population-based sample of snoring school-aged children, *J. Sleep Res.* 16 (2007) 96–101.
- [9] W. Anuntaseree, K. Rookkapan, S. Kuasirikul, P. Thongsuksai, Snoring and obstructive sleep apnea in Thai school-age children: prevalence and predisposing factors, *Pediatr. Pulmonol.* 32 (2001) 222–227.
- [10] B. Joshua, G. Bahar, J. Sulkes, T. Shpitzer, E. Raveh, Adenoidectomy: long-term follow-up, *Otolaryngol. Head Neck Surg.* 135 (2006) 576–580.
- [11] D. Gozal, L. Kheirandish, Oxidant stress and inflammation in the snoring child: confluent pathways to upper airway pathogenesis and end-organ morbidity, *Sleep Med. Rev.* 10 (2006) 83–96.
- [12] M.S. Urschitz, A. Guenther, S. Eitner, P.M. Urschitz-Duprat, M. Schlaud, O.S. Ipsiroglu, et al., Risk factors and natural history of habitual snoring, *Chest* 126 (2004) 790–800.
- [13] G. Zhang, J. Spickett, K. Rumchev, A.H. Lee, S. Stick, Snoring in primary school children and domestic environment: a Perth school based study, *Respir. Res.* 5 (2004) 19.
- [14] L.M. O'Brien, C.R. Holbrook, C.B. Mervis, C.J. Klaus, J.L. Bruner, T.J. Raffield, et al., Sleep and neurobehavioral characteristics of 5- to 7-year-old children with parentally reported symptoms of attention-deficit/hyperactivity disorder, *Pediatrics* 111 (2003) 554–563.
- [15] O. Bruni, S. Ottaviano, V. Guidetti, M. Romoli, M. Innocenzi, F. Cortesi, et al., The sleep disturbance scale for children (SDSC): construction and validation of an instrument to evaluate sleep disturbances in childhood and adolescence, *J. Sleep Res.* 5 (1996) 251–261.
- [16] A.M. Ferreira, V. Clemente, D. Gozal, A. Gomes, C. Pissarra, H. Cesar, et al., Snoring in Portuguese primary school children, *Pediatrics* 106 (2000) E64.
- [17] E.H. Van Den Akker, A.W. Hoes, M.J. Burton, A.G. Schilder, Large international differences in (adeno)tonsillectomy rates, *Clin. Otolaryngol. Allied Sci.* 29 (2004) 161–164.

- [18] G. Karevold, J. Haapkyla, A. Pitkaranta, K.J. Kvaerner, Otitis media surgery: large variability between Finland and Norway, *Int. J. Pediatr. Otorhinolaryngol.* 71 (2007) 1035–1039.
- [19] S.E. Brietzke, D. Gallagher, The effectiveness of tonsillectomy and adenoidectomy in the treatment of pediatric obstructive sleep apnea/hypopnea syndrome: a meta-analysis, *Otolaryngol. Head Neck Surg.* 134 (2006) 979–984.
- [20] P. Nieminen, U. Tolonen, H. Loppinen, T. Loppinen, J. Luotonen, K. Jokinen, Snoring children: factors predicting sleep apnea, *Acta Otolaryngol. Suppl.* 529 (1997) 190–194.
- [21] C. Guilleminault, K.K. Li, A. Khramtsov, R. Pelayo, S. Martinez, Sleep disordered breathing: surgical outcomes in prepubertal children, *Laryngoscope* 114 (2004) 132–137.
- [22] J. Arrarte, J.F. Lubianca Neto, G.B. Fischer, The effect of adenotonsillectomy on oxygen saturation in children with sleep breathing disorders, *Int. J. Pediatr. Otorhinolaryngol.* 71 (2007) 973–978.
- [23] A.J. Lipton, D. Gozal, Treatment of obstructive sleep apnea in children: do we really know how? *Sleep Med. Rev.* 7 (2003) 61–80.
- [24] P. Nieminen, U. Tolonen, H. Löppönen, Snoring and obstructive sleep apnea in children: a 6-month follow-up study, *Arch. Otolaryngol. Head Neck Surg.* 126 (2000) 481–486.
- [25] T. Shintani, K. Asakura, A. Kataura, The effect of adenotonsillectomy in children with OSA, *Int. J. Pediatr. Otorhinolaryngol.* 44 (1998) 51–58.
- [26] P. Canning, M.L. Courage, L.M. Frizzell, T. Seifert, Obesity in a provincial population of Canadian preschool children: differences between 1984 and 1997 birth cohorts, *Int. J. Pediatr. Obes.* 2 (2007) 51–57.
- [27] D.B. Teculescu, I. Caillier, P. Perrin, E. Rebstock, A. Rauch, Snoring in French preschool children, *Pediatr. Pulmonol.* 13 (1992) 239–244.
- [28] S. Blunden, K. Lushington, B. Lorenzen, T. Ooi, F. Fung, D. Kennedy, Are sleep problems under-recognised in general practice? *Arch. Dis. Child.* 89 (2004) 708–712.
- [29] K.A. Franklin, T. Gislason, E. Omenaas, R. Jogi, E.J. Jensen, E. Lindberg, et al., The influence of active and passive smoking on habitual snoring, *Am. J. Respir. Crit. Care Med.* 170 (2004) 799–803.
- [30] R. Ersu, A.R. Arman, D. Save, B. Karadag, F. Karakoc, M. Berkem, et al., Prevalence of snoring and symptoms of sleep-disordered breathing in primary school children in Istanbul, *Chest* 126 (2004) 19–24.
- [31] D. Gozal, D.W. Pope Jr., Snoring during early childhood and academic performance at ages thirteen to fourteen years, *Pediatrics* 107 (2001) 1394–1399.
- [32] N.J. Ali, D.J. Pitson, J.R. Stradling, Snoring, sleep disturbance, and behaviour in 4–5 year olds, *Arch. Dis. Child.* 68 (1993) 360–366.
- [33] M. Kalra, G. Lemasters, D. Bernstein, K. Wilson, L. Levin, A. Cohen, et al., Atopy as a risk factor for habitual snoring at age 1 year, *Chest* 129 (2006) 942–946.
- [34] S. Redline, P.V. Tishler, M. Schluchter, J. Aylor, K. Clark, G. Graham, Risk factors for sleep-disordered breathing in children. Associations with obesity, race, and respiratory problems, *Am. J. Respir. Crit. Care Med.* 159 (1999) 1527–1532.

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