Parental poverty and occupation as risk factors for pediatric sleep-disordered breathing.

Friberg, Danielle; Lundkvist, Karin; Li, Xinjun; Sundquist, Kristina

Published in:
Sleep Medicine

DOI:
10.1016/j.sleep.2015.05.012

2015

Document Version:
Peer reviewed version (aka post-print)

Parental poverty and occupation as risk factors for pediatric sleep-disordered breathing

Short title: **Poverty as risk factor for pediatric SDB**

Danielle Friberg[1], MD, PhD, Karin Lundkvist[1], MD, PhD, Xinjun Li[2], MD, PhD, Kristina Sundquist[2], MD, PhD

[1]Department of Otorhinolaryngology, Department of Clinical Science Intervention and Technology, Karolinska Institutet, Stockholm, Sweden;

[2]Center for Primary Health Care Research, Lund University, Lund, Sweden

Corresponding author: Associate Professor Danielle Friberg, ORL Department, Karolinska University Hospital, Huddinge, Department of Clinical Science Intervention and Technology, Karolinska Institutet, Stockholm, Sweden.

Phone: +46 8 58581408. Fax: +46 8 7467551. E-mail: danielle.friberg@karolinska.se

Financial disclosure: The authors have no financial relationships relevant to this article to disclose. This was not an industry-supported study.

Conflicts of interest: None. The authors have no conflicts of interest relevant to this article to disclose.

Funding: This study was supported by the Acta Otolaryngologica Foundation, and Karolinska Institutet, Department of Clinical Science Intervention and Technology.

Key words

Hospitalized children

Obstructive sleep apnea

Sleep-disordered breathing

Tonsil hypertrophy

Abbreviations

ATH, Adenotonsillar hypertrophy

OSA, Obstructive sleep apnea

OR, Odds ratio

SDB, Sleep-disordered breathing

SES, socioeconomic status

Contributors' statement page

Danielle Friberg conceptualized the study, analyzed the data, and wrote the manuscript as submitted.

Karin Lundkvist conceptualized the study, analyzed the data, drafted the initial manuscript, and critically reviewed and approved the final manuscript as submitted.

Xinjun Li performed the statistical analysis and critically reviewed and approved the final manuscript as submitted.

Kristina Sundquist designed the study, analyzed the data and provided the database, and critically reviewed and approved the final manuscript as submitted.

Highlights

- Previous studies have found associations between pediatric sleep-disordered breathing and socioeconomic status, as well as a neighborhood disadvantage. The role of the parental occupation as a risk factor for SDB in offspring has not been studied previously.
- This study showed that low familial socioeconomic status and several parental occupations associated with a low level of education increased, while academic and farming occupations decreased the risk of SDB in Swedish offspring.

ABSTRACT

Objectives/Background: Previous studies have found associations between pediatric sleep-disordered breathing (SDB) and socioeconomic status (SES), as well as a neighborhood-related disadvantage. This study analyzes the association between familial SES, parental occupation, and SDB in Swedish offspring.

Methods: A nationwide dataset was constructed by linking Swedish census data to Hospital Discharge Register data on all first hospitalizations of children and adolescents aged 0–18 years during the study period 1997–2007. The outcome variable was SDB, defined as diagnostic codes for obstructive sleep apnea (OSA), adenotonsillar hypertrophy, or tonsillar hypertrophy. Familial SES was defined as family income and maternal education. The odds ratio (OR) was calculated with a 95% confidence interval (CI).

Results: Totally 34,933 of 3 million children had a first hospital diagnosis of SDB. The OR was significantly increased in offspring in families with a low income (1.79) and maternal education (1.21). Significantly increased ORs were found in 14 of 38 maternal (37%) and 13 of 48 paternal (27%) occupations, and 6 of them involved both parents: drivers, welders, workers in mechanics and iron metalware, chemical processing, food and glass manufacture. A significantly decreased OR was found in 12 (25%) of the paternal occupations, e.g., scientists, physicians, teachers, artists, administrators, and farmers, as well as in maternal occupations; artists and farmers, with offspring aged 0–6 years.

Conclusion: This study indicates that low familial SES and parental occupations associated with a low educational level increased, while academic parental occupations and farmers decreased the risk of SDB in offspring.

1. Introduction

Sleep disordered breathing (SDB) comprises a spectrum of disorders ranging from primary snoring to obstructive sleep apnea (OSA) [1,2]. In children, the prevalence of OSA varies from 1% to 4% [3,4] and that of SDB from 11% to 15% [4,5]. The peak prevalence of SDB occurs at preschool age when the size of the adenotonsillar tissue is largest [6]. The most usual treatment of SDB in children and adolescents is adenotonsillectomy [7].

There are several complications of pediatric SDB. Studies have shown that school-aged children with SDB, irrespective of severity, are at risk for neurocognitive and academic deficits and also behavioral problems, compared to controls [8]. A recent longitudinal study has shown that after 4 years, irrespective of treatment or non-treatment, the improvements in SDB are concomitant with improvements in neurocognition, but not academic ability, in school-aged children [9]. There is also evidence of increased arterial blood pressure in children with SDB [10].

Obesity is a risk factor for SDB, especially among older children [11]. Further risk factors are African American race and environmental tobacco smoke, which show significant associations with the apnea-hypopnea index in children [12]. Epidemiologic Swedish studies from our group have indicated that OSA in adults [13] and also SDB in children display familial clustering [1]). The reasons are still unclear, but studies from North America have found associations between pediatric SDB and socioeconomic status (SES), as well as a neighborhood disadvantage [15,16]. Furthermore, a study from our group found that a neighborhood disadvantage and a low level of parental education increased the risk of the offspring being hospitalized for obesity (17).

In another study from our group, we investigated the population's likelihood of hospitalization for adult OSAS according to region of residence, education, and occupation [18]. Highly educated men and individuals in large cities had a decreased risk for OSAS. Among male occupations, there were increased risks for OSAS among drivers, sales agents, seamen, cooks, and engine and motor operators. As for females, only drivers had such an increased risk. Surprisingly, adjusting for obesity had no effect on these risk levels. The role of occupation as a risk factor for OSAS in adults is multifactorial, including, e.g., work-related exposure to organic solvents and chemical irritants, but also environmental risk factors, low-level education, neighborhood disadvantage, tobacco smoking, and alcohol abuse. However, parental occupations as a risk factor for SDB in offspring probably do not reflect work-related exposure, but similar environmental risk factors. Whether the parental occupation is a risk factor for SDB in offspring has not been studied previously. The aim of the present study was to analyze whether or not family SES and parental occupation influenced hospitalization for SDB in Swedish offspring.

2. Methods

2.1 Source of data

Data were from Statistics Sweden (census data) and the Swedish National Board of Health and Welfare (hospital data). The national Swedish data registers included the Population Register, the Multigeneration Register, and the Swedish Hospital Discharge Register covering 1997–2007. During the study period a total of 3,050,263 children and adolescents (1,567,656 boys and 1,482,607 girls) were included. Information from the registers in the dataset was linked at the individual level via the national 10-digit civic registration number assigned to each person in Sweden. That number was replaced by a serial number to ensure the anonymity of each individual. Information from the Multigeneration Register made it possible to link the children and adolescents to their biological parents.

Sweden, with approximately 9 million inhabitants at the end of the study period, has a social welfare system comprising public primary and hospital health care for all residents, which is free of charge for children less than 18 years of age. Children in the present study were mostly referred to an otolaryngological clinic for symptoms of SDB. They were in hospitals in most cases for surgical treatment of adenotonsillar hypertrophy, the first- line treatment for SDB in children. There are some regional differences in Sweden; for example, some regions have access to private hospitals, although they are few, and the Swedish Hospital Discharge Register also includes data from these hospitals. Around 80% of the adenotonsillectomies due to SDB were performed at hospitals during the study period 1997–2007 according to the Swedish National Quality Register for tonsil surgery (Hessén Soderman AC, personal communication). Approximately 20% of these procedures were, however, performed at outpatient clinics and were not included in this study.

Polysomnography in Swedish children with SDB were rarely performed during the study period, mainly due to a lack of resources and awareness. Similarly, conservative treatment, such as CPAP and dental devices, were only occasionally used to treat children with SBD. The nationwide registers did not contain detailed individual-level data on, for example, weight, allergic rhinitis, or other potential confounding factors.

2.2 Outcome variable

The outcome variable was SDB, which has no hospital diagnostic code in Sweden. Instead, OSAS and adenotonsillar hypertrophies (ATHs) are regularly used as proxy codes for SDB. The 10th revision of the *International Classification of Diseases* (ICD-10) was used to identify all first hospital admissions for individuals aged 0–18 years during the study period 1997–2007 for (1) OSAS, G 47.3, (2) hypertrophy of the tonsils, J 35.1, and (3) hypertrophy of the adenoids and tonsils, J 35.3. An ancillary analysis comprised all five forms of SDB diagnoses: (4) snoring (R06.5) and (5) hypertrophy of the adenoids (J35.2). Primary diagnoses of acute tonsillitis or pharyngitis were excluded.

2.3 Independent variables

Gender and age were obtained from population data.

Period of birth was divided into cohorts from 1979 through 2007.

Familial SES was defined as family income or maternal education.

Family income was provided by Statistics Sweden and was categorized into four groups: low, low-middle, high-middle, and high. The income was measured for the year of childbirth, divided by the number of people in the mother's household. A

weighted system was also used; small children were given lower weights than adolescents since the costs of living for a small child are lower than those for an adolescent.

Educational attainment was defined as the mother´s educational level, divided into three groups: compulsory school or less (≤ 9 years), vocational high school or some theoretical (regular) high school (10–11 years), or theoretical (regular) high school and/or college (≥ 12 years).

Geographic region of residence was divided into (1) large cities (cities with a population of more than 200,000, i.e., Stockholm, Gothenburg, and Malmö), (2) Southern Sweden, and (3) Northern Sweden. The mother´s geographic region of residence was used as a proxy for the family's region of residence. It was included as an individual variable to adjust for possible differences between regions in Sweden regarding hospital admissions, which we have partly accounted for in the present analysis.

Family History

Offspring were divided into two groups: those with and those without a parental history of a first hospital diagnosis of OSAS.

Parental occupation was used as a proxy for certain environmental factors. Information on parental occupations was obtained from the 1990 Swedish census. It includes nationwide individual-level occupational categories that are consistent with the International Standard Classification of Occupations (ISCO). The census has 99.2% complete information on occupations for the entire population of Sweden. Census information was coded using a national Swedish adaptation of the ISCO, i.e., the Nordic Occupational Classification (NOC) (19). Since some occupational groups in the census included too few individuals to conduct a meaningful statistical

analysis, we combined the occupational groups in the NOC into 48 large occupational categories, which have been used in a previous study [20].

2.4 Statistical analysis

Using logistic regression analysis, the odds ratios were estimated for hospitalization for pediatric OSAS, or hypertrophy of the tonsils, or hypertrophy of the adenoids and tonsils (ATH), by family income, region of residence, educational attainment, family history of OSAS, and parental occupation. The reference groups were period of birth between 1979 and 1988, female, highest family income, large cities, highest educational attainment, and no family history of sleep apnea (OR, 1.0). For parental occupation, the reference group consisted of all women or all men in the parental population. All estimates were adjusted for period of birth. The estimates of SDB by occupational status were adjusted for the children's gender, period of birth, family income, region of residence, maternal education, and family history of OSAS. There were no gender differences in the outcomes for family SES or parental occupation; the results are therefore given for females and males together. In the adjusted models for occupation, all other explanatory variables were entered into the model simultaneously. Secondary analyses were performed to stratify children by age groups. A power calculation was not applicable since the study was based on the entire population in that age group. SAS version 9.2 was used for the statistical analyses.

2.5 Ethical considerations

This study was approved by the Ethics Committee of Lund University, Sweden.

3. RESULTS

Totally, 34,933 children, 1.1%, had a first hospital diagnosis of SDB (Table 1). The OR was significantly higher for boys (1.12). Regarding family income, the ORs were significantly increased for children and adolescents in families with low (1.79), low middle (1.83), and high middle income (1.41). The ORs were also significantly higher in Southern (1.34), and Northern Sweden (1.27), compared to large cities. Furthermore, there were significantly increased ORs for compulsory school or less (1.21), vocational high school and some theoretical (regular) high school (1.35). The OR in offspring with a family history of OSAS was also significantly increased (1.78).

The ORs for SDB by parental occupation are shown in Table 2. For maternal occupations, significantly increased ORs were observed in 14 of 38 (37%) occupations, i.e., assistant nurses, drivers, textile workers, mechanics and iron and metalware workers, welders, electrical workers, chemical process workers, food manufacture workers, glass, ceramics and tile workers, packers, loaders, and warehouse workers, public safety and security workers, cooks and stewards, home helpers, and hairdressers. Among paternal occupations, significantly increased ORs were observed among 13 of 48 (27%) occupations: drivers, smelters and metal foundry workers, mechanics and iron and metalware workers, welders, woodworkers, painters and wallpaper hangers, other construction workers, bricklayers, printers and related workers, chemical process workers, food manufacturer workers, glass, ceramics and tile workers, and engine and motor operator workers. Notable are the increased ORs for six parental occupations, both maternal and paternal: drivers, mechanics and iron and metalware workers, welders, chemical process workers, food manufacture workers and glass, ceramics, and tile workers. Significantly decreased ORs for SDB were found for 12 (25%) paternal occupations, i.e., technical and scientific research-related workers and physicians,

teachers, religious, juridical and other social science-related workers, artistic occupations, journalists, administrators and managers, clerical workers, sales agents, farmers, postal and communication workers, building caretakers and cleaners, and launderers and dry cleaners.

The ORs for SDB in different age groups according to maternal occupation are shown in Table 3. Significantly increased ORs were found in all age groups for the following maternal occupations: assistant nurses and drivers. In children aged 0–6 years and 7–12 years, there were significantly increased ORs for three maternal occupations: textile workers, electrical workers, and food manufacture workers. In children aged 0–6 and adolescents aged 13–18 years, there were significantly increased ORs for following maternal occupations: glass, ceramic and tile workers, packers, loaders and warehouse workers, and home helpers. For children aged 0–6 years, ORs were significantly increased for those with mothers who were welders, woodworkers, public safety and security workers, and hairdressers. Decreased ORs were observed in the age group 0–6 years for the maternal occupational groups artistic occupations and farmers.

The ORs for SDB in different age groups by paternal occupation are shown in Table 4. They were significantly increased in children under 13 years old for 10 paternal occupational groups. Four paternal occupational groups had significantly increased ORs in the age group 0–6 years. A decreased OR was observed in all age groups for the paternal occupational group teacher. Among five paternal occupational groups, the ORs for SDB in children aged 0–6 years and 7–12 years were significantly decreased. There were more cases of SDB in children aged 0–6 years than among the older children for both maternal and paternal occupational groups.

The ancillary analysis, including the hospital diagnoses snoring and hypertrophy of the adenoid, yielded an additional 4,154 children (12%). The results of these analyses did not affect the significant ORs.

4. Discussion

The present study showed a significantly increased risk for pediatric SDB in families with low SES. After adjusting for SES, there were also significantly increased ORs for offspring in 14 (37%) of the maternal and in 13 (27%) of the paternal occupations, as well as in 6 (13%) of both parental occupations.

The finding that the risk for SDB in offspring was increased among drivers and several industrial workers is novel and interesting. These occupational groups are non-academic, often characterized by low salaries and levels of education. This is in line with the other findings in the present study; a low level of maternal education and a low family income also increased the risk for SDB in offspring.

Further consistent results are the decreased ORs in offspring in 12 (25%) paternal occupations, e.g., scientists, physicians, teachers, administrators, and farmers. After stratification into different age groups, there were decreased ORs in offspring aged 0–6 years for the maternal occupations artists and farmers. The majority of these occupations is academic and is often associated with a higher SES.

The risk for the parental occupation was adjusted for SES and the maternal educational level and, therefore, our results could also be explained by other factors, e.g., environmental. This is supported by the findings in the North-American studies [15,16], showing that residence in neighborhoods with socioeconomic disadvantages was significantly associated with OSA, after adjusting for the effects of age, prematurity, obesity, and race. Another environmental risk factor is tobacco smoking,

which in the CHAT study was shown to be a risk factor for pediatric OSA [21]. A possible confounding factor in families with low SES could be co-rooming, which would allow parents to notice their children´s sleep behavior more readily. US Census data from 1996 revealed that the percentage of people living in homes with more than one person per room is linearly related to house-hold income levels [22]. In Sweden during 2008-09 there was cramped housing accommodation among 37 % of households with a single parent, and among 16 % of double-parents [23].

The decreased risk for SDB in offspring to farmers found in the present study could be explained by the known link between asthma and SDB. A German study found a reduced risk of asthma and hay fever in offspring to farmers [24]. The authors explained their results in terms of such environmental influences on a farm as increased exposure to bacterial compounds in stables, which could prevent the development of allergic disorders in children. A recent US study found that there was a higher prevalence of SDB in asthmatic children compared to non-asthmatic children and the prevalence of SDB increased with increasing asthma severity (25).

Other known risk factors for SBD are the maternal ones during pregnancy, which may be affected by SES and parental occupation. Another study showed a significant association between prenatal or perinatal distress and childhood SDB [26]. The authors suggested an association between childhood SDB and prenatal exposure to maternal smoking and age during pregnancy and perinatal complications. Studies from our group have shown an increased risk for preterm birth [27] and small for gestational age [28] in families with low income and among some occupational groups, all resembling the results from this SDB study.

Drivers and industrial workers could be exposed to air pollution, toxins, and environmental irritants. In our previous investigation of the association between occupation and risk for hospitalization for OSAS in adults, both female and male drivers, as well as engine and motor operators, had such an increased risk [18]. However, one of the possible explanation for the results in the present study, i.e., that the offspring might have been exposed to pollution stemming from their parents' occupation and were therefore hospitalized for SDB, is rather farfetched. Furthermore, large cities generally have more pollutions than the countryside, but such cities had decreased risks for hospitalization for SDB in both adults [18] and in the present study on children.

This study has several limitations. Firstly, there are no individual weight data. Obesity is a possible confounding factor for our results as it was correlated with low SES and neighborhood disadvantage in a previous study from our group [17]. On the other hand, the same study showed that the prevalence of hospitalization for obesity in Swedish children between 2000 and 2010 was only 1% [17]. In another study on 4-year-old children from 2002 to 2008, the prevalence of overweight was 15% among girls and 20% among boys [29]. Also in the other study on adults from our group, some occupations with a low level of education and SES, similar to that in the present study, increased the risk for OSAS, although obesity did not affect the risk levels [18]. Also in North-American studies, neighborhood disadvantage remained a risk factor after adjusting for obesity and race [15,16]. It is therefore uncertain whether obesity in offspring affected the results in the present study. Data on other risk factors, e.g., premature birth, passive smoking, tonsil size, and ethnicity, were not available. However, a report from 2008 showed that the Swedish population

consisted of 14% immigrants, the majority from Finland and Iraq, and probably Caucasians [30].

Furthermore, the validity of the diagnoses OSAS and ATH chosen as proxies for SDB was not confirmed and we had no access to outpatient data or detailed data on the clinical management of the patients in this nationwide study. Other diagnoses in the Swedish Hospital Discharge Register have, however, been validated and are generally high [31]. In addition, we used only primary diagnoses, and the patients included were hospitalized because they had symptoms of SDB, thereby increasing the likelihood of valid diagnoses. The reason for the larger number of children with the diagnosis ATH than for OSAS is that sleep studies are required to make an OSA diagnosis, but such studies were rarely available for Swedish children during the study period. Codes for snoring and adenoid hypertrophy are also seldom used at Swedish hospitals since such children usually undergo ambulatory treatment. Our ancillary analysis with inclusion of these diagnoses showed a small increase (12%) in the study sample, which did not, however, influence the ORs for pediatric SDB. In addition, the bias for not including patients treated on ambulatory wards is most likely similar in all the occupational categories and would therefore be of minor importance. Diagnostic and therapeutic traditions may, however, vary somewhat in different parts of Sweden, which might explain the geographical differences.

This study has several strengths. The study population was based on well-defined national, cohort data. The civic registration number made it possible to trace the records of every individual, thereby ensuring no loss to follow-up. The data in the Swedish Hospital Discharge Register are remarkably complete. In 2001 the main diagnosis was missing in 0.9% and the national civic registration number in 0.4% of hospitalizations. Furthermore, the 1990 data on occupational status used in this study were also remarkably complete (99.2%). The quality of data on occupational titles in

the Sweden census data has been assessed and found to be reasonable [32]. The proportion of concordant occupational titles was 72%. In terms of reliability, the coding showed that about 10% of the occupations were misclassified. However, this is comparable to similar studies and should not affect the results to a large extent. This is because the magnitude of the miscoding is most likely to be similar in all occupational groups and the potential bias caused by the miscoding is therefore probably non-differential. A further strength was the availability of family income for the year of birth.

5. Conclusions

This Swedish study indicates that a low familial income and several parental occupations involving a low level of education increase the risk for SDB in offspring. Furthermore, farming and academic occupations decrease this risk. Caregivers should be aware of the fact that familial poverty and certain occupations are possible risk factors for pediatric SDB.

6. References

1. American Academy of Sleep Medicine. International Classification of Sleep Disorders, 2nd ed. Diagnostic and Coding Manual. Westchester, IL: American Academy of Sleep Medicine 2005.
2. Marcus CL, Brooks LJ, Draper KA, et al. Diagnosis and management of childhood obstructive sleep apnea. Pediatrics 2012; 130: 576–584
3. Bixler EO, Vgontzas AN, Lin HM, et al. Sleep disordered breathing in children in a general population sample: prevalence and risk factors. Sleep. 2009; Jun; 32(6): 731–6
4. Spilsbury JC, Storfer-Isser A, Rosen CL, Redline S. Remission and incidence of obstructive sleep apnea from middle childhood to late adolescence. Sleep 2014; Oct 17. pii: sp-00091-14. [Epub ahead of print]
5. Lumeng JC, Chervin RD. Epidemiology of pediatric obstructive sleep apnea. Proc Am Thorac Soc 2008; 5: 242–52
6. Nixon GM, Brouillette RT. Sleep. 8: paediatric obstructive sleep apnoea. Thorax. 2005;60(6):511–6
7. Mitchell RB. Adenotonsillectomy for obstructive sleep apnea in children: outcome evaluated by pre- and postoperative polysomnography. Laryngoscope 2007; 117: 1844–54
8. Bourke RS, Anderson V, Yang JS, et al. Neurobehavioral function is impaired in children with all severities of sleep disordered breathing. Sleep Med 2011; 12: 222–9
9. Briggs SN, Vlahandonis A, Anderson V, et al. Long-term changes in neurocognition and behavior following treatment of sleep disordered breathing in school-aged children. Sleep 2014; 37(1): 77–84

10. Horne RS, Yang JS, Walter LM, et al. Elevated blood pressure during sleep and wake in children with sleep-disordered breathing. Pediatrics 2011; 128: 85–92

11. Kaditis AG, Alexopoulos EI, Hatzi F, et al. Adiposity in relation to age as predictor of severity of sleep apnea in children with snoring. Sleep Breath 2008; 12 : 25–31

12. Weinstock TG, Rosen CL, Marcus CL, et al. Predictors of obstructive sleep apnea severity in adenotonsillectomy candidates. Sleep 2014; 37(2): 261–269

13. Sundquist J, Li X, Friberg D, Hemminki K, Sundquist K. Obstructive sleep apnea syndrome in siblings: an 8-year Swedish follow-up study. Sleep 2008; 31: 817–23

14. Friberg D, Sundquist J, Li X, et al. Sibling risk of pediatric obstructive sleep apnea syndrome and adenotonsillar hypertrophy. Sleep 2009; 32: 1077–83

15. Spilsbury JC, Storfer-Isser A, Kirchner HL, et al. Neighborhood disadvantage as a risk factor for pediatric obstructive sleep apnea. J Pediatr 2006; 149: 342–7

16. Brouillette RT, Horwood L, Constantin E, et al. Childhood sleep apnea and neighborhood disadvantage. J Pediatr 2011; 158: 789–95

17. Li X, Memarian E, Sundquist J, et al. Neighbourhood deprivation, individual-level familial and socio-demographic factors and diagnosed childhood obesity: a nationwide mulitlevel study from Sweden. Obes Facts 2014; 7: 253–263

18. Li X, Sundquist K, Sundquist J. Socioeconomic status and occupation as risk factors for obstructive sleep apnea in Sweden: a population-based study. Sleep Med 2008; 9(2): 129–36

19. Swedish National Central Bureau of Statistics, Socioeconomic Classification. Report on Statistical Coordination Stockholm, 1982.

20. Pukkala E, Martinsen JI, Lynge E, et al. Occupation and cancer – follow-up of 15 million people in five Nordic countries. Acta Oncol 2009; 48: 646–790

21. Weinstock TG, Rosen CL, Marcus CL, et al. Predictors of obstructive sleep apnea severity in adenotonsillectomy candidates. Sleep 2014; 37(2): 261–9

22. Myers D, Baer W, Choi S. The changing problem of overcrowded housing. J Am Plan Ass 1996; 62: 66–84

22. http://www.scb.se/sv_/Hitta-statistik/Artiklar/Trangboddheten-i-Sverige-minskar/

24. v Ehrenstein OS, v Mutius E, Illi S, et al. Reduced risk of hay fever and asthma among children of farmers. Clin Exp All 2000; 30: 187–193

25. Goldstein NA[1], Aronin C, Kantrowitz B. The prevalence of sleep-disordered breathing in children with asthma and its behavioral effects. Pediatr Pulmonol. 2014 Dec 2. doi: 10.1002/ppul.23120. [Epub ahead of print]

26. Calhoun SL, Vgontzas AN, Mayes SD, et al. Prenatal and perinatal complications: is it the link between race and SES and childhood sleep disordered breathing? J Clin Sleep Med 2010; 6: 264–9

27. Li X, Sundquist J, Kane K, et al. Parental occupation and preterm births: a nationwide epidemiological study in Sweden. Paediatr Perinat Epidemiol 2010; 24: 555–63

28. Li X, Sundquist J, Sundquist K. Parental occupation and risk of small-for-gestational-age births: a nationwide epidemiological study in Sweden. Hum Reprod 2010; 25:1044–50

29. Bergstrom E, Blomquist HK. Is the prevalence of overweight and obesity declining among 4-year-old Swedish children? Acta Paediatr 2009; 98:1956–1958

30. Statistics Sweden. Description of the population in Sweden 2008. http://www.scb.se/default_2154.asp

31. Ludvigsson J, Andersson E, Ekbom A, et al. External review and validation of the Swedish national inpatient register. BMC Public Health 2011; 11:450

32. Warnryd B, Ostlin P, Thorslund M. Living conditions. Appendix 11. Quality in retrospective questions on previous occupational exposures: an evaluation of occupational histories in the investigation on living conditions. Statistics Sweden, Stockholm 1989

Table 1. Study population, number of cases and odds ratios (ORs) of sleep disordered breathing

Characteristics	Total population		Sleep disordered breathing			
	No.	%	No.	OR	95% CI	
Total	3,050,263		34,933			
Age at diagnosis (year)						
0-6			21216			
7-12			9506			
13-18			4211			
Gender						
Female	1,482,607	48.6	16,019	1		
Male	1,567,656	51.4	18,914	**1.12**	**1.10**	**1.14**
Period (birth year)						
1979–1988	1,023,660	33.6	3847	1		
1989–1998	1,133,966	37.2	21,914	**4.81**	**4.65**	**4.98**
1999–2007	892,637	29.3	9172	**2.62**	**2.52**	**2.72**
Family income						
Low income	1,161,333	38.1	14,839	**1.79**	**1.70**	**1.87**
Low-middle income	886,286	29.1	12,208	**1.83**	**1.74**	**1.92**
High-middle income	650,668	21.3	5849	**1.41**	**1.34**	**1.48**
High income	351,976	11.5	2037	1		
Region of residence						
Large cities	1,005,601	33.0	9155	1		
Southern Sweden	1,267,533	41.6	15,867	**1.34**	**1.31**	**1.38**
Northern Sweden	777,129	25.5	9911	**1.27**	**1.23**	**1.31**
Educational attainment						
Compulsory school or less (≤ 9 years)	1,290,646	42.3	15,157	**1.21**	**1.18**	**1.25**
Vocational high school or some theoretical high schools (10–11 years)	904,727	29.7	12,211	**1.35**	**1.31**	**1.39**
Theoretical high school and/or college (≥ 12 years)	854,890	28.0	7565	1		
Family history of sleep apnea						
No	3,031,476	99.4	34,622	1		
Yes	18,787	0.6	311	**1.78**	**1.59**	**1.99**

Abbreviations: No, number of individuals; OR, odd ratio; CI, confidence interval.

Bold type: 95% CI does not include 1.00.

Table 2. Odds ratio and 95% confidence intervals for sleep disordered breathing by parental occupation

	By maternal occupation				By paternal occupation			
Occupation of parents	No	OR	95% CI		No	OR	95% CI	
Technical and scientific research-related workers and physicians	429	0.88	0.73	1.06	1978	**0.80**	**0.76**	**0.84**
Dentists	30	1.03	0.70	1.53	34	0.82	0.59	1.14
Nurses	784	1.15	0.96	1.37	130	0.89	0.75	1.06
Assistant nurses	2810	**1.32**	**1.12**	**1.56**	236	0.90	0.79	1.03
Other health and medical workers	410	1.05	0.87	1.27	63	0.82	0.64	1.05
Teachers	1122	0.95	0.80	1.12	458	**0.67**	**0.60**	**0.73**
Religious, juridical and other social science-related workers	901	0.99	0.84	1.18	794	**0.70**	**0.65**	**0.75**
Artistic occupations	108	0.81	0.63	1.03	138	**0.69**	**0.58**	**0.81**
Journalists	47	0.81	0.58	1.12	58	**0.66**	**0.51**	**0.85**
Administrators and managers	171	0.81	0.65	1.01	309	**0.70**	**0.63**	**0.78**
Clerical workers	2799	1.08	0.92	1.28	647	**0.88**	**0.81**	**0.95**
Sales agents	497	1.15	0.96	1.38	1274	**0.93**	**0.88**	**0.99**
Shop managers and assistants	1197	1.17	0.99	1.39	587	0.95	0.87	1.03
Farmers	119	0.86	0.68	1.09	409	**0.79**	**0.72**	**0.88**
Gardeners and related workers	101	1.15	0.89	1.48	205	1.02	0.89	1.17
Fishermen, whalers, and sealers	-				37	1.05	0.77	1.44
Forestry workers	-				250	1.07	0.95	1.22
Miners and quarry workers	-				76	0.94	0.75	1.17
Seamen	-				24	0.72	0.49	1.07
Transport workers	48	0.97	0.70	1.34	189	1.01	0.88	1.16
Drivers	187	**1.49**	**1.20**	**1.84**	1399	**1.11**	**1.04**	**1.18**
Postal and communication workers	382	1.06	0.88	1.28	325	**0.88**	**0.79**	**0.98**
Textile workers	195	**1.39**	**1.13**	**1.72**	125	1.17	0.98	1.39
Shoe and leather workers	-				21	1.22	0.80	1.86
Smelters and metal foundry workers	26	1.23	0.81	1.86	332	**1.34**	**1.20**	**1.50**
Mechanics and iron and metalware workers	353	**1.22**	**1.01**	**1.48**	3047	**1.16**	**1.11**	**1.22**
Plumbers	-				286	1.04	0.93	1.17
Welders	44	**1.74**	**1.24**	**2.44**	530	**1.26**	**1.15**	**1.38**
Electrical workers	235	**1.36**	**1.11**	**1.67**	1169	1.02	0.96	1.09
Woodworkers	94	1.24	0.96	1.60	1558	**1.17**	**1.10**	**1.24**

Painters and wall-paperhangers	35	1.38	0.95	1.99	460	**1.11**	**1.01**	**1.22**
Other construction workers	-				904	**1.20**	**1.12**	**1.29**
Bricklayers	-				150	**1.36**	**1.16**	**1.60**
Printers and related workers	108	1.06	0.83	1.36	261	**1.13**	**1.00**	**1.28**
Chemical process workers	70	**1.58**	**1.20**	**2.10**	316	**1.23**	**1.10**	**1.38**
Food manufacture workers	213	**1.47**	**1.19**	**1.81**	414	**1.23**	**1.11**	**1.36**
Beverage manufacture workers	-				20	1.18	0.77	1.82
Glass, ceramics, and tile workers	220	**1.42**	**1.16**	**1.75**	500	**1.25**	**1.14**	**1.37**
Packers, loaders, and warehouse workers	390	**1.31**	**1.08**	**1.58**	865	1.02	0.95	1.10
Engine and motor operator workers	47	1.35	0.97	1.86	672	**1.19**	**1.10**	**1.29**
Public safety and security workers	181	**1.44**	**1.16**	**1.79**	453	1.04	0.94	1.14
Cooks and stewards	803	**1.24**	**1.04**	**1.47**	309	0.99	0.88	1.11
Home helpers	2958	**1.26**	**1.07**	**1.48**	129	0.90	0.76	1.07
Waiters	270	1.11	0.91	1.36	90	0.97	0.79	1.19
Building caretakers and cleaners	1001	1.17	0.99	1.39	487	**0.85**	**0.77**	**0.93**
Chimney sweeps	-				25	0.92	0.62	1.35
Hairdressers	241	**1.27**	**1.03**	**1.55**	24	1.28	0.87	1.88
Launderers and dry cleaners	286	1.10	0.90	1.34	141	**0.84**	**0.71**	**0.99**

Abbreviations: No, number of individuals; OR, odd ratio; CI, confidence interval. Analysis adjusted for children's sex, period of birth, family income, region of residence, maternal educational attainment, and family history of sleep apnea.

Bold type: 95% CI does not include 1.00.

Table 3. Odds ratio and 95% confidence intervals for sleep disordered breathing in different age groups by maternal occupation

	0–6 yrs				7–12 yrs				13–18 yrs			
Occupation of parents	No	OR	95% CI		No	OR	95% CI		No	OR	95% CI	
Technical and science research-related workers and physicians	237	0.88	0.69	1.13	119	0.82	0.59	1.15	73	1.26	0.80	1.98
Dentists	13	0.97	0.54	1.74	10	1.13	0.57	2.22	-			
Nurses	357	1.08	0.85	1.36	254	1.17	0.86	1.60	173	**1.61**	**1.06**	**2.46**
Assistant nurses	1490	**1.30**	**1.04**	**1.62**	913	**1.40**	**1.04**	**1.87**	407	**1.59**	**1.06**	**2.39**
Other health and medical workers	207	1.10	0.85	1.41	125	1.02	0.73	1.43	78	1.28	0.82	2.01
Teachers	524	0.92	0.73	1.16	356	0.93	0.68	1.26	242	1.27	0.84	1.92
Religious, juridical, and other social science-related workers	480	1.00	0.79	1.26	291	1.07	0.79	1.46	130	1.09	0.71	1.67
Artistic occupations	45	**0.58**	**0.41**	**0.84**	42	1.09	0.72	1.65	21	1.42	0.80	2.54
Journalists	33	1.00	0.67	1.50	10	0.60	0.30	1.18	-			
Administrators and managers	90	0.82	0.61	1.11	48	0.77	0.51	1.15	33	1.05	0.62	1.76
Clerical workers	1596	1.10	0.88	1.37	772	1.01	0.75	1.36	431	1.40	0.93	2.10
Sales agents	285	1.15	0.90	1.46	137	1.11	0.79	1.54	75	**1.60**	**1.02**	**2.51**
Shop managers and assistants	683	1.12	0.89	1.40	358	1.21	0.89	1.65	156	**1.62**	**1.06**	**2.47**
Farmers	44	**0.67**	**0.46**	**0.96**	48	1.04	0.70	1.56	27	1.16	0.68	1.97
Gardeners and related workers	59	1.15	0.83	1.61	31	1.19	0.76	1.88	11	1.29	0.64	2.61
Transport workers	26	0.88	0.57	1.36	17	1.24	0.71	2.14	-			
Drivers	102	**1.51**	**1.13**	**2.02**	56	**1.48**	**1.00**	**2.18**	29	**1.83**	**1.08**	**3.12**
Postal and communication workers	220	1.08	0.84	1.39	121	1.14	0.81	1.59	41	0.99	0.60	1.63
Textile workers	105	**1.45**	**1.09**	**1.93**	64	**1.47**	**1.01**	**2.14**	26	1.45	0.85	2.47
Smelters and metal foundry workers	16	1.49	0.87	2.54	-				-			
Mechanics and iron and metalware workers	187	1.20	0.93	1.56	111	1.29	0.92	1.81	55	1.58	0.99	2.55
Welders	26	**1.96**	**1.26**	**3.04**	13	1.67	0.91	3.08	-			
Electrical workers	127	**1.38**	**1.05**	**1.82**	77	**1.45**	**1.01**	**2.08**	31	1.50	0.90	2.51
Woodworkers	57	**1.42**	**1.01**	**1.98**	22	0.94	0.57	1.55	15	1.66	0.89	3.10
Painters and wall-paperhangers	19	1.33	0.81	2.19	13	1.74	0.94	3.21	-			
Printers and related workers	56	0.98	0.70	1.37	41	1.38	0.91	2.10	11	0.99	0.49	2.01
Chemical process workers	35	1.43	0.97	2.12	24	**1.75**	**1.07**	**2.85**	11	**2.38**	**1.24**	**4.57**
Food manufacture workers	123	**1.47**	**1.11**	**1.94**	66	**1.56**	**1.07**	**2.26**	24	1.65	0.94	2.88
Glass, ceramics, and tile workers	117	**1.40**	**1.06**	**1.86**	68	1.44	0.99	2.09	35	**1.94**	**1.17**	**3.23**
Packers, loaders, and warehouse workers	229	**1.35**	**1.05**	**1.73**	109	1.25	0.89	1.76	52	**1.68**	**1.04**	**2.71**
Engine and motor operator workers	28	1.44	0.94	2.20	14	1.33	0.74	2.41	-			
Public safety and security workers	109	**1.52**	**1.15**	**2.02**	50	1.37	0.92	2.04	22	1.59	0.90	2.82
Cooks and stewards	455	1.22	0.96	1.54	256	1.33	0.97	1.82	92	1.37	0.88	2.12
Home helpers	1565	**1.25**	**1.01**	**1.56**	926	1.27	0.95	1.71	467	**1.50**	**1.00**	**2.25**
Waiters	166	1.09	0.84	1.42	73	1.07	0.74	1.55	31	1.49	0.88	2.52
Building caretakers and cleaners	477	1.04	0.83	1.32	360	**1.37**	**1.01**	**1.86**	164	1.48	0.97	2.25

Hairdressers	142	**1.31**	**1.00**	**1.71**	73	1.27	0.88	1.83	26	1.37	0.80	2.34
Launderers and dry cleaners	193	1.22	0.94	1.57	66	0.89	0.61	1.30	27	1.20	0.70	2.06

Abbreviations: No, number of individuals OR, odd ratio; CI, confidence interval. Analysis adjusted for children's sex, period of birth, family income, region of residence, maternal educational attainment, and family history of sleep apnea

Bold type: 95% CI does not include 1.00.

Table 4. Odds ratio and 95% confidence intervals for sleep disordered breathing in different age groups by paternal occupation

	0-6 yr				7-12 yr				13-18 yr			
Occupation of parents	No	OR	95% CI		No	OR	95% CI		No	OR	95% CI	
Technical and science research-related workers and physicians	1031	**0.81**	**0.75**	**0.88**	591	**0.78**	**0.71**	**0.86**	356	0.88	0.75	1.03
Dentists	10	**0.54**	**0.29**	**0.99**	15	1.13	0.69	1.85	-			
Nurses	66	0.90	0.71	1.15	36	0.79	0.57	1.10	28	1.12	0.76	1.65
Assistant nurses	149	0.95	0.81	1.12	65	0.86	0.67	1.10	22	0.90	0.60	1.34
Other health and medical workers	30	0.82	0.57	1.16	19	0.78	0.50	1.22	14	0.99	0.58	1.67
Teachers	216	**0.65**	**0.57**	**0.75**	141	**0.63**	**0.53**	**0.75**	101	**0.78**	**0.62**	**0.98**
Religious, juridical, and other social science-related workers	421	**0.71**	**0.64**	**0.79**	225	**0.65**	**0.56**	**0.75**	148	0.83	0.68	1.01
Artistic occupations	70	**0.63**	**0.50**	**0.80**	49	0.82	0.62	1.09	19	0.69	0.44	1.10
Journalists	29	**0.63**	**0.44**	**0.90**	19	0.72	0.46	1.12	10	0.71	0.38	1.33
Administrators and managers	133	**0.63**	**0.53**	**0.76**	94	**0.66**	**0.53**	**0.81**	82	0.94	0.74	1.20
Clerical workers	374	0.90	0.80	1.00	188	0.88	0.75	1.02	85	0.86	0.68	1.10
Sales agents	663	0.93	0.85	1.01	381	0.93	0.83	1.04	230	1.08	0.90	1.29
Shop managers and assistants	388	1.03	0.93	1.15	146	**0.84**	**0.71**	**0.99**	53	0.84	0.63	1.12
Farmers	195	**0.78**	**0.67**	**0.90**	133	**0.79**	**0.66**	**0.94**	81	0.90	0.70	1.14
Gardeners and related workers	113	1.10	0.91	1.33	64	1.03	0.80	1.31	28	0.89	0.61	1.29
Fishermen, whalers, and sealers	19	0.98	0.63	1.53	12	1.13	0.65	1.95	-			
Forestry workers	122	1.05	0.88	1.26	80	1.08	0.86	1.35	48	1.25	0.92	1.69
Miners and quarry workers	35	0.88	0.63	1.23	27	1.05	0.72	1.53	14	0.99	0.59	1.65
Seamen	-				11	1.10	0.62	1.95	-			
Transport workers	95	0.97	0.79	1.19	66	1.15	0.90	1.46	28	0.99	0.69	1.42
Drivers	726	**1.13**	**1.04**	**1.23**	442	**1.13**	**1.02**	**1.27**	231	1.14	0.96	1.37
Postal and communication workers	185	0.91	0.78	1.06	84	**0.76**	**0.61**	**0.94**	56	1.15	0.87	1.52
Textile workers	68	1.18	0.93	1.49	41	1.28	0.94	1.74	16	1.14	0.70	1.84
Shoe and leather workers	11	1.26	0.70	2.27	10	**1.92**	**1.05**	**3.50**	-			
Smelters and metal foundry workers	184	**1.45**	**1.25**	**1.69**	104	**1.35**	**1.11**	**1.65**	44	1.15	0.84	1.57
Mechanics and iron and metalware workers	1739	**1.22**	**1.14**	**1.30**	914	**1.16**	**1.06**	**1.27**	394	1.14	0.97	1.34
Plumbers	157	1.06	0.90	1.25	82	1.00	0.80	1.25	47	1.25	0.92	1.69
Welders	293	**1.32**	**1.16**	**1.49**	166	**1.30**	**1.11**	**1.53**	71	1.22	0.94	1.58
Electrical workers	672	1.05	0.96	1.15	364	1.07	0.96	1.21	133	0.92	0.75	1.13
Woodworkers	851	**1.18**	**1.08**	**1.27**	509	**1.26**	**1.14**	**1.40**	198	1.11	0.92	1.33

Painters and wall-paperhangers	268	**1.16**	**1.02**	**1.32**	132	1.07	0.89	1.28	60	1.17	0.90	1.54
Other construction workers	500	**1.23**	**1.11**	**1.35**	291	**1.28**	**1.13**	**1.45**	113	1.13	0.91	1.40
Bricklayers	89	**1.45**	**1.17**	**1.78**	47	**1.46**	**1.10**	**1.94**	14	1.04	0.61	1.76
Printers and related workers	156	**1.24**	**1.05**	**1.45**	78	1.15	0.91	1.44	27	0.86	0.58	1.26
Chemical process workers	173	**1.28**	**1.10**	**1.50**	103	**1.32**	**1.08**	**1.61**	40	1.06	0.77	1.46
Food manufacture workers	246	**1.28**	**1.12**	**1.46**	123	**1.24**	**1.03**	**1.49**	45	1.18	0.87	1.60
Beverage manufacture workers	16	**1.63**	**1.00**	**2.66**	-				-			
Glass, ceramics, and tile workers	296	**1.35**	**1.20**	**1.53**	138	1.16	0.97	1.38	66	**1.33**	**1.02**	**1.73**
Packers, loaders, and warehouse workers	477	0.99	0.90	1.10	280	**1.13**	**1.00**	**1.29**	108	1.05	0.84	1.31
Engine and motor operator workers	367	**1.23**	**1.11**	**1.38**	204	**1.16**	**1.00**	**1.35**	101	1.24	0.99	1.55
Public safety and security workers	248	1.08	0.95	1.23	125	0.94	0.79	1.13	80	1.20	0.94	1.54
Cooks and stewards	193	1.01	0.88	1.18	84	0.96	0.77	1.19	32	1.12	0.79	1.60
Home helpers	82	0.92	0.74	1.15	36	0.90	0.65	1.25	11	0.87	0.48	1.57
Waiters	58	1.01	0.78	1.30	24	0.93	0.62	1.37	-			
Building caretakers and cleaners	263	**0.86**	**0.76**	**0.98**	144	**0.83**	**0.70**	**0.99**	80	0.96	0.75	1.24
Chimney sweeps	12	0.81	0.46	1.42	-				-			
Hairdressers	14	1.38	0.82	2.32	-				-			
Launderers and dry cleaners	81	0.84	0.67	1.04	37	0.76	0.55	1.04	23	1.15	0.76	1.74

Abbreviations: No, number of individuals; OR, odd ratio; CI, confidence interval. Analysis adjusted for children's sex, period of birth, family income, region of residence, maternal educational attainment, and family history of sleep apnea

Bold type: 95% CI does not include 1.00.