



## Snoring and Attention deficit hyperactivity disorder in Children in Qom, Iran

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### Abstract

### Original Article

**BACKGROUND:** Attention deficit hyperactivity disorder (ADHD) is an important and common problem in children (4-12%) which affects their daily activities and quality of life. About 1-2% of children suffer from sleep apnea with a common symptom of snoring which might cause behavioral disorders due to the lower quality of sleep. In the present study, we aim to determine the association between snoring and ADHD.

**METHODS:** In this case control study, we enrolled 100 children of 2-12 years who snored as the case group and 100 healthy peers as the control group. Snoring and behavioral problems were assessed by the standard questionnaires of the Berlin Questionnaire and Behavioral Disorder Questionnaire [DSM-IV], respectively.

**RESULTS:** The mean age, height, and weight of children were 6.81 years, 116.11 cm, and 25.39 Kg, respectively. In addition, 53.5% of participants of both groups were boys. A significant relationship was found between snoring and ADHD and its subtypes ( $P < 0.001$ ).

**CONCLUSION:** Increasing the information of parents and colleagues on the association of snoring with behavioral disorders might assist in early diagnosis and treatment.

**KEYWORDS:** Snoring, Attention deficit hyperactivity disorder (ADHD), Behavioral Disorders, Children, Sleep Apnea

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### Introduction

Snoring is a coarse and loud sound caused by the obstruction of air passage which prevents the movement of air during breathing while sleeping. Snoring occurs in the throat after relaxation of the muscles in respiratory structures due to the vibration of soft tissues while breathing.<sup>1</sup> Snoring is a common sign presenting in 10-12% of children less than 7 years of age.<sup>2-5</sup> The incidence decreases gradually by increasing of the age after 9 years of age. Resistance at upper airway passage is the main reason of snoring, which can cause obstructive sleep apnea (OSA). Snoring is the most common symptom of OSA. Its other

symptoms are difficulty in breathing and asphyxia.<sup>6</sup> Airway obstruction causes the child to wake up frequently.

The incidence of OSA is 1-2% among children of 2-8 years of age.<sup>1,2</sup> Snoring without apnea and hypopnea during sleep is termed primary snoring.<sup>7</sup> The most important cause of snoring in children is adenotonsillar hypertrophy which usually requires medical or surgical intervention. However, according to recent studies, primary snoring will improve gradually by age and does not need any treatment.<sup>8,9</sup>

Attention deficit hyperactivity disorder (ADHD) is one of the most common disorders among school-aged children with an incidence rate of 4-12%.<sup>10</sup> The prevalence of ADHD in American studies has been reported to be in the range of 2% to 26% depending on the definition

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used.<sup>11</sup> Based on criteria of the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), 8.7% of children of 8 to 15 years of age in the USA are affected.<sup>11</sup> In Iran, ADHD has been estimated to affect 15.2% of elementary schoolboys.<sup>12</sup> Others have reported a prevalence of 10.1% in Shiraz, a major Iranian city.<sup>13</sup> In two studies performed in the Northeast of Tehran, the incidence was reported to be 12.3% and 11% of preschool children.<sup>14,15</sup> In a meta-analysis of an epidemiologic study which included 24 studies on parents and 10 studies on teachers using a questionnaire, the incidence of ADHD was 5.3 and 10.3%, respectively.<sup>16</sup> The main symptoms of this disease are inattentiveness, hyperactivity, and impulsivity. The pathophysiology of ADHD is unclear, but there are a number of theories such as involvement of dopamine, glutamatergic, or other neurotransmitter systems in the prefrontal cortex.<sup>17,18</sup>

The DSM-IV divided ADHD into 3 subtypes: predominantly inattentive (ADHD-I), predominantly hyperactive and impulsive (ADHD-HI), or combined form (ADHD-C).<sup>19</sup> Children who snore may suffer from daytime sleepiness, hyperactivity, learning disorder, restless sleep, and movement, and behavioral disorder while sleeping.<sup>20-24</sup> In many of these children, it is difficult to differentiate between primary snoring and OSA.<sup>25-27</sup> A recent study performed by the American Academy of Children demonstrated that the rate of daytime behavioral and cognitive disorders observed in children with OSA was higher than three times that in children without apnea.<sup>28</sup> In another comparative study on the effect of snoring in presenting with hyperactivity, it was demonstrated that 22% of patients with habitual snoring were hyperactive compared to only 12% of hyperactive children without snoring.<sup>29</sup> In spite of the increasing obesity and inactive lifestyle, and consequently, high prevalence of snoring among children in Iran, this research was performed with the aim of finding the association of snoring with ADHD.

## Materials and Methods

This case control study was performed in winter 2011 in Qom, Central Iran. The study subject consisted of children of 2-12 years of age referring to the Baharan Private Clinic and Beheshti Hospital in Qom. The inclusion criteria comprised of children of 2-12 years without chromosomal and brain abnormalities such as Down syndrome and cerebral palsy. Participants with snoring were established as case group, and those without snoring as control group. According to the inclusion and exclusion criteria and considering previous studies, 200 individuals (100 patients in each group) were selected using simple random sampling method.<sup>30,31</sup>

Data gathering tools consisted of 3 questionnaires; a demographic questionnaire, the Berlin Questionnaire, and the DSM-IV. The Berlin Questionnaire is a validated questionnaire developed in 1996, and its validity and accuracy in primary care settings has been approved.<sup>32</sup> It explores known symptoms and features of OSA. The details of the questionnaire have been published previously.<sup>33</sup> The questionnaire is divided into 3 sections. Section 1 addresses snoring and witnessed apnea. Respondents, who snore, are asked to rate their snoring with regard to loudness, frequency, and whether their snoring bothers other people. Section 2 addresses daytime fatigue and sleepiness. Section 3 addresses personal history of hypertension, as well as, height, weight, and gender. Then, the body mass index (BMI) is calculated. In this study we only used section 1 of the questionnaire. The validity and reliability of the questionnaire have been investigated and approved in different studies and several languages, including Persian.<sup>34,35</sup>

To assess inattentiveness, impulsivity, and hyperactivity in patients with ADHD, the DSM-IV was applied. This standard questionnaire consists of 18 questions; 9 questions assess inattentiveness, and the other 9 questions assess hyperactivity and impulsivity. The cut-off score for evaluating inattentiveness in this questionnaire was at least 6 and for hyperactivity

and impulsiveness (both together) at least 6. The subtypes of this disorder were also identified according to this questionnaire. Therefore, the children were categorized as ADHD-I subtype, ADHD-C subtype, or ADHD-HI subtype. The validity and reliability of this questionnaire has been approved.<sup>19,36,37</sup> In this study, children's parents were selected and invited for an interview by the research team. In addition, to increase the accuracy of the test, the questionnaire was completed during a programmed interview by trained interviewers. ADHD diagnosis was provided by a physician. Considering ethical issues and confidentiality (personal identification was not recorded), and after explaining the goal of the study to the children and their parents, the questionnaires were completed with their consent. The data were analyzed using SPSS statistical software (version 18, SPSS Inc., Chicago, IL, USA). Chi-square test or Fisher's exact test were used for data analysis of qualitative variables. For adjustment of age and weight, multiple logistic regression models with backward method were performed. Differences

were considered significant at P-values of less than 0.05.

## Results

In this study, the mean  $\pm$  SD age, weight, and height of participants were  $6.68 \pm 3.01$  years,  $26.66 \pm 17.02$  kg,  $115.81 \pm 21.91$  cm, respectively. Moreover, 53.5% of precipitants were male. Details of demographic parameters in each group are illustrated in table 1.

Among the case group, 27% snored which bothered others, 35% snored slightly louder than breathing, and 12% snored very loudly and could be heard in adjacent rooms. In the case group, the snoring experience intervals were as follows: 31% snored every night, 21% snored 3-4 times a week, 21% snored 1-2 times a week, and 27% snored 1-2 times a month.

In the present study, 72% of children in the case group had ADHD, and 49.9% of boys and 38.3% of girls below 7 years had ADHD which all showed significant relationship among ADHD and snoring ( $P < 0.001$ ,  $P < 0.001$ , and  $P = 0.048$ , respectively). Details of other results have been given in table 2.

**Table 1. Average and standard deviation of age, weight, and height in both groups**

Variable	Group	Mean $\pm$ SD	Minimum	Maximum
Age	Case	7.51 $\pm$ 2.81	2	12
	Control	5.85 $\pm$ 3.00	2	12
Weight	Case	28.82 $\pm$ 12.12	12	65
	Control	24.50 $\pm$ 20.64	9	66
Height	Case	119.59 $\pm$ 22.54	65	161
	Control	112.10 $\pm$ 20.73	75	164

SD: Standard deviation

**Table 2. Frequency distribution of attention deficit hyperactivity disorder combined (ADHD-C) generally and according to sex and age in case and control groups**

Variables		ADHD-C		B	SE	P	Adjusted OR	95% CI for OR	
		Yes n (%)	No n (%)					Lower	Upper
Group	Case	52 (72.2)	48 (37.5)	1.36	0.34	< 0.001	3.91	1.99	7.66
	Control	20 (27.8)	80 (62.5)						
Gender	Boy	53 (49.5)	54 (50.5)	1.14	0.342	< 0.001	3.14	1.60	6.14
	Girl	19 (20.4)	74 (79.6)						
Age (year)	< 7	44 (38.3)	71 (61.7)	0.63	0.339	0.048	1.89	0.97	3.67
	> 7	28 (32.9)	57 (67.1)						

ADHD-C: Attention deficit hyperactivity disorder combined; SE: Standard Error; CI: Confidence interval; OR: Odds ratio

**Table 3. Frequency distribution of attention deficit hyperactivity disorder inattentive (ADHD-I) in general and considering gender and age in case and control groups**

Variables		ADHD-I		B	SE	P	Adjusted OR	95% CI for OR	
		Yes n (%)	No n (%)					Lower	Upper
Group	Case	40 (95.2)	60 (38.0)	3.48	0.74	< 0.001	18.60	5.48	63.68
	Control	2 (4.8)	95 (62.0)						
Gender	Boy	31 (29.0)	76 (71.0)	0.48	0.43	0.106	1.98	0.86	4.55
	Girl	11 (11.8)	82 (88.2)						
Age (year)	< 7	18 (15.7)	97 (84.3)	0.62	0.40	0.290	0.66	0.30	1.43
	> 7	24 (28.2)	61 (71.8)						

ADHD-I: Attention deficit hyperactivity disorder inattentive; CI: Confidence interval; OR: Odds ratio

**Table 4. Frequency distribution of attention deficit hyperactivity disorder hyperactive and impulsive (ADHD-HI) in general and according to gender and age in case and control groups**

Variables		ADHD-HI		B	SE	P	Adjusted OR	95% CI for OR	
		Yes n (%)	No n (%)					Lower	Upper
Group	Case	45 (69.2)	55 (40.7)	1.06	0.341	0.002	2.90	1.48	5.70
	Control	20 (30.8)	80 (59.3)						
Gender	Boy	48 (44.9)	59 (55.1)	1.14	0.344	< 0.001	3.12	1.57	6.19
	Girl	17 (18.3)	76 (81.7)						
Age (year)	< 7	41 (35.7)	74 (64.3)	0.68	0.349	0.043	1.99	1.02	3.88
	> 7	24 (28.2)	61 (71.8)						

ADHD-HI: Attention deficit hyperactivity disorder hyperactive and impulsive; CI: confidence interval; OR: Odds ratio

This study showed that there is a significant relationship between snoring and ADHD-I ( $P < 0.001$ ). However, according to gender and age, there were no prominent relationships among ADHD-I and snoring ( $P = 0.106$  and  $P = 0.290$ , respectively). Table 3 shows other results of this study.

Furthermore, as can be inferred from the table 4, there are significant relationships among snoring and ADHD-HI generally ( $P = 0.002$ ) and according to age below and over 7 years ( $P = 0.043$ , CI: 1.02-3.88). Moreover, there was a significant relationship between snoring and ADHD-HI according to gender ( $P < 0.001$ , CI: 1.57-6.19).

## Discussion

Few studies have been performed on daytime behavioral disorders related to snoring in Iran. This study was performed using the Berlin Questionnaire and DSM-IV. In this study, a significant number of participants with snoring had ADHD-I and ADHD-HI. Chervin et al.

conducted a study to examine the relationship between behavioral disorders and snoring in 220 children between 2-12 years.<sup>38</sup> Based on their results, the prevalence of hyperactivity was 13%. Children with habitual snoring are 4.4 times more at risk, those with loud snoring 4.5 times, and those with apnea 4 times more at risk of hyperactivity than others.<sup>38</sup>

Other studies showed a strong relationship between snoring and daytime behavioral disorder.<sup>5,29,39</sup> Animal models have been used to uncover the biological mechanism, which found hypoxia, multiple awakening during the night, or both as responsible factors.<sup>40</sup> In the study conducted by LeBourgeois et al., a significant relationship was observed between chronic snoring in children and ADHD-HI.<sup>41</sup> Sleepiness in hyperactive children can be attributed to the low quality of sleep.<sup>42</sup> In our study, based on the percentage rates and OR, correlation among boys and children over 7 years of age were more significant. However, some researches, like a

study on 113 children by Kaemingk et al., found no significant relationship between snoring and OSA, and hyperactivity.<sup>43</sup>

In another study in which 69 children had OSA and 70 children did not have this problem, no differences were reported between the two groups regarding hyperactivity, inattentiveness, and the symptoms of ADHD.<sup>44</sup> Another study was performed on 205 children by Gottlieb et al.<sup>45</sup> Although this research showed a significant relationship between snoring and OSA, and behavior disorders based on history and cognitive tests of children's attention using polysomnography, these findings were not significant.<sup>45</sup>

In a previous study, the majority of patients with sleep apnea suffered from snoring, which shows that snoring is an important risk factor for OSA.<sup>46</sup> Apnea can cause brain hypoxia which is very dangerous in children and might leave permanent damage. For this reason apnea in children can be interpreted differently than in adults. Contrary to adults, even 1 apnea per hour in children should be considered important. Furthermore, snoring and apnea causes frequent waking up during sleep time, and consequently, decreases the quality of sleep due to shortening of rapid eye movement (REM), and non-REM sleeps at steps 3 and 4. This problem can be the cause of behavioral and movement disorders during night time and cause inattentiveness, sleepiness, depression and anxiety, learning disorder, and impulsivity during day.<sup>47,48</sup>

There were some limitations in this study such as unwillingness of some parents to cooperate in completing the questionnaires, and lack of knowledge about signs and symptoms of sleep disorders and snoring and scientific resources and researches among children in this regard.

### Conclusion

In summary, considering the prevalence of snoring among children, its relation with behavioral disorders, and the effects of sleep disorders on children's growth, education, and

quality of life, it is fundamental to identify the causes of snoring and escalation of factors, and find solutions to improve their life.

### Conflict of Interests

Authors have no conflict of interests.

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