ELSEVIER

Sleep Medicine 7 (2006) 357–361

SLEEP MEDICINE

www.elsevier.com/locate/sleep

Original article

Waist circumference predicts the occurrence of sleep-disordered breathing in obese children and adolescents: A questionnaire-based study

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Received 9 October 2005; received in revised form 4 January 2006; accepted 10 January 2006

Abstract

Background and purpose: To assess the presence of sleep-disordered breathing (SDB) in a population of obese children and adolescents and to investigate the role of fat distribution in predicting SDB.

Patients and methods: One hundred and thirty-two obese children and adolescents, aged 5.0–14.2 years, were consecutively referred to the Department of Pediatrics of the Second University of Naples for screening of obesity. The control group consisted of 453, sex- and age-matched lean subjects selected from local schools in Campania region. The sleep disturbances scale for children (SDSC) questionnaire was used to evaluate SDB prevalence. In all subjects, waist circumference, triceps and sub-scapular skin folds were measured, and *Z*-scores were calculated.

Results: Obese subjects showed significantly higher SDB and sleep hyperhydrosis (SHY) scores than controls. The *Z*-score of waist circumference correlated with SDB ($r=0.32$; $P=0.006$) and SHY factor scores ($r=0.37$; $P=0.005$), while the *Z*-score of body mass index (BMI), triceps and sub-scapular skin folds were not correlated with any SDSC factor scores. Subjects in the higher tertile for *Z*-score of waist circumference had a significantly higher risk for developing SDB (OR 1.9; 95% IC 1.8–3.2) and SHY (OR 2.1; 95% IC 2.0–4.5).

Conclusions: Waist circumference is a more reliable index than total adiposity and subcutaneous fat in predicting the risk of obese children to develop SDB.

Keywords: Obesity; Children; Sleep breathing disorders; Fat distribution

1. Introduction

Sleep-disordered breathing (SDB) consists of frequent and repetitive episodes of pharyngeal obstruction during sleep, often with consequent desaturation in arterial oxygen quote, sleep fragmentation and daytime sleepiness in adults.

In children, the most commonly documented cause of SDB is upper airway obstruction, which can be classified into three grades of severity: primary snoring with a prevalence ranging from 3.2 to 10% [1,2], upper airway resistance syndrome (UARS) with highly variable prevalence ranging from 6 to 63% and obstructive sleep apnea syndrome (OSAS) with a prevalence of about 1–3% [3,4].

Similar to adults, obesity may predispose children to OSA [5,6] Obese children with SDB might experience an increase in the size of the soft tissue structures surrounding the upper airways, size of their tongue, soft palate, and lateral pharyngeal walls [7,8].

Marcus et al. [6] reported that obese children are at risk for OSAS, and that the degree of OSAS is proportional to the degree of obesity. Further, Gozal et al. [9] found that the severity of the apnea index positively correlated with body mass index (BMI) and with tendency to develop excessive daytime somnolence. In the converse, a population-based study failed to confirm that children categorized as obese are more likely to have a higher respiratory disturbance index (RDI) [10].

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1389-9457/$ - see front matter
doi:10.1016/j.sleep.2006.01.005

Different studies in adults and children reported that sleep apnea is more closely related to visceral fat than BMI [11,13] and, additionally, the severity of OSA in children seems to be independent of degree of obesity expressed as BMI [13].

Since few studies focused on SDB in Italian children [4,14,15] and did not attempt to relate SDB to obesity, in the present study we aimed (a) to verify the presence of SDB in a school-aged population of Italian obese children and adolescents and (b) to investigate whether the fat distribution, measured as waist circumference and triceps and sub-scapular skin folds, may predict the SDB.

2. Methods

2.1. Subjects

One-hundred and thirty-two children (67 males, 65 females), aged 5.0–14.2 years, (mean: 8. 7±2.0 years) were referred from primary care physicians to the Department of Pediatrics of the Second University of Naples for screening of obesity. All subjects agreed to participate in the study. Informed consent was obtained from parents and children. The ethical committee approved the study design. The BMI (weight/height^2) of all obese subjects was >95th percentile for age and sex reference values [16].

Ninety (68.2%) obese children were prepubertal (Tanner stage 1) while the others were pubertal: 15 (11.4%) Tanner stage 2, 17 (12.9%) Tanner stage 3 and 10 (7.5%) Tanner stage 4 [17].

Children were excluded from the study if they had known clinical conditions such as genetic diseases (Down syndrome or Prader–Willi syndrome), craniofacial abnormalities, or neuromuscular diseases. None of the recruited children presented inter-current respiratory tract infections. Another criterium for exclusion was the use of anticonvulsant or psychoactive drugs.

The control group consisted of 453 normal-weight (BMI <85th percentile), sex- (240 males, 213 females) and age-matched controls (mean age: 8.9±1.8 years) randomly selected from local schools in Campania region, between January 2004 and July 2004. Among controls, 97 children were excluded from the original population ($n=550$) because they were overweight (percentile BMI >85th). The Tanner stage distribution was similar to the obese group: 317 controls (69.9%) were prepubertal (Tanner stage 1), 52 (11.6%) were in Tanner stage 2, 54 (11.9%) in Tanner stage 3 and 30 (6.6%) in Tanner stage 4).

2.2. Procedure

The University Ethics Committee approved the study, and parents gave written informed consent during the first screening visit. Both obese children and controls were evaluated in the Endocrinology Unit of the Department of Pediatrics of the University of Naples to undergo the body measurements needed for the study.

All subjects' mothers filled out the sleep disturbances scale for children (SDSC) [18]. The SDSC is a sleep questionnaire that consists of 26 items subdivided into six sleep disorders subscales: disorders in initiating and maintaining sleep (DIMS), sleep breathing disorders (SBD), disorders of arousal (DA), sleep-wake transition disorders (SWTD), disorders of excessive somnolence (DES), sleep hyperhydrosis (SHY).

In all subjects, waist circumference was measured by trained technicians using a tape measure at just above the uppermost lateral border of the right ilium, at the end of a normal expiration, and was recorded at the nearest millimeter. *Z*-scores were calculated according to Zannolli and Morgese [19]. Triceps and sub-scapular skin folds (TSF and SSF), used as marker of subcutaneous fat, were measured as previously described [20]. Briefly, the measure was taken by the same operator using an Holtain–Tanner caliper (Harpenden and Holtain, Anthropometric Instruments, UK) on the non-dominant side. Measurements were repeated in duplicate. *Z*-scores were calculated according to Frisancho [21].

2.3. Statistical analysis

Analysis of variance (ANOVA) was generated to evaluate differences in clinical and anthropometric measures and in the six SDSC factor scores between obese and non-obese children. A Pearson's correlation was used to correlate the six SDSC factor scores in the obese population with *Z*-score BMI, *Z*-score of waist circumference, *Z*-score of triceps and sub-scapular skin folds (divided into tertiles). A logistic regression analysis was performed in order to assess the risk of developing sleep disturbances by being in a higher tertile for the *Z*-score BMI, waist, sub-scapular or triceps skin folds. The factor scores that were significantly higher in obese children were converted into a discrete variable and entered in the logistic regression.

The P level was set at <0.05 for statistical significance. All data were coded and analyzed using the commercially available STATISTICA 6.0 package for Windows (StatSoft, Inc., Tulsa, OK).

3. Results

Table 1 shows the anthropometric and clinical characteristics of the two groups studied. The mean age of obese and non-obese children was comparable, while the *Z*-score BMI was obviously significantly higher in obese children. The waist mean *Z*-score in obese children was 1.9±0.9, higher than that of the non-obese group. The *Z*-scores for