Health-related Quality of Life and Depressive Symptoms in Children with Suspected Sleep-Disordered Breathing

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Study Objectives: Snoring and sleep-disordered breathing (SDB) are highly prevalent among children. The increasing trends of obesity in the pediatric population further predict an exacerbation of this public health problem. However, the impact of SDB on mood and quality of life and the confounder effect of obesity in this setting are unclear.

Design: We studied a group of 85 clinically referred children, aged 8 to 12 years, with snoring and suspected SDB and 35 asymptomatic children (controls). All children completed validated questionnaires for the presence of depression (Children's Depression Inventory) and for health-related quality of life (PedsQL™), and parents completed the Parent Report version of the PedsQL™. Children referred to the Sleep Medicine Center for sleep-disordered breathing were further subdivided according to their body mass index > 95% for age and sex (n = 44) and with BMI < 95% for age and sex as ClinN1 (n = 41).

Results: Parentally reported quality of life and physical health differed between obese and nonobese children. However, both groups with SDB had more-impaired quality of life and depressive symptoms than did controls.

Conclusions: Children with suspected SDB, regardless of the severity of apnea-hypopnea index or the presence of obesity, had more impairments in quality of life and depressive symptoms than did children who did not snore.

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INTRODUCTION

IN ADULT PATIENTS, SLEEP-DISORDERED BREATHING (SDB) HAS BEEN ASSOCIATED WITH BOTH DEPRESSION[1] AND IMPAIRED QUALITY OF LIFE.[2] While no studies have specifically addressed the relationship between depression and SDB in children, impaired quality of life, neurocognitive deficits, poor school performance, behavioral problems, and hyperactivity have all recently emerged as important morbidities of this frequent pediatric disorder[3-9] and appear to coincide in obese children with SDB,[10] underlying the potential associations between obesity, SDB, quality of life, and depression.

The prevalence of obesity in children has increased dramatically over the past 30 years, from 4% in 6- to 11-year-old children during the period of 1963-1974 to 13% in 1999, according to the National Health and Nutrition Examination Survey.[11] An expert committee comprising members of the Maternal and Child Health Bureau, the Health Resources and Services Administration, and the Department of Health and Human Services has recommended that all children with a body mass index (BMI) fulfilling the overweight criteria should receive a thorough medical assessment to evaluate possible underlying causes and to determine concomitant medical problems. Among the multiple morbidities associated with obesity, respiratory sleep disturbances, in general, and obstructive sleep apnea (OSA) and obesity hypoventilation syndrome, in particular, should be considered and evaluated.[12]

In addition to the physical health risks associated with being overweight, children may be at risk of psychological distress. The relationship between obesity and symptoms of depression in children has not been clearly established. While some studies have found a stronger relationship between weight concerns (rather than weight, per se) and depression,[13] others have found a strong association between obesity and depressive symptoms in childhood.[14] Furthermore, childhood-onset obesity has been associated with later psychopathology in adulthood, suggesting vulnerability in later psychological functioning among obese children.[15]

Dietz reported that perhaps the most significant difficulty associated with obesity in children was the negative psychosocial impact.[16] Many children who are overweight appear older than their age, leading adults to have unrealistically high expectations of them. When these expectations are not met, children may feel frustrated and become increasingly dependent upon their families and isolated from others. Depressed overweight children may respond more poorly to weight management programs and, therefore, are in need of psychological treatment in addition to strict weight-management programs.[12,17]

Obese children report a more negative quality of life than do children with chronic health conditions such as asthma or atopic dermatitis.[18] Severely obese children report a lower health-related quality of life (HRQOL) than do healthy children and an

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HRQOL similar to that of children diagnosed with cancer.[10] The impairments in quality of life, however, appear to be responsive to cognitive-behavioral intervention after an in-patient rehabilitation weight-loss program.[18,19] While some studies have assessed the quality of life[18,19]and depressive symptoms[13] of children who are overweight, very few have included a control group of normal-weight children in their assessments.[10]

Therefore, to examine the relationship among SDB, obesity, and psychosocial variables, we hypothesized that the presence of snoring and of obesity in children would independently lead to increased depression and decreased HRQOL in comparison to normal weight and healthy children.

METHODS

Participants

Eighty-five consecutive children between the ages of 8 and 12 years who were referred to the Kosair Children's Hospital Sleep Medicine Center for suspected SDB were recruited as the clinic-referred group. Children were classified as obese if their BMI was greater than or equal to the 95th percentile for their age and sex, as established by the National Center for Health Statistics and according to the Centers for Disease Control BMI-for-age growth charts. Children were classified as normal weight if their BMI was below the 95th percentile. On this basis, 44 children referred for SDB fulfilled the criteria for obesity (ClinOb), and the remaining 41 snoring children were considered as normal weight (ClinNl). Thirty-five additional children between the ages of 8 and 10 years whose parents reported that their children had no symptoms of SDB in a questionnaire mailed to former nonsnoring participants in a study of childhood SDB were recruited to participate as the control group. Because it was not feasible to recruit control children who were perfectly matched to the Clin groups, controls were matched on as many variables as possible, including age, sex, and geographical region of residence. Four children in the control group had a BMI above the 95th percentile for age and sex. Because this number was too small to analyze separately, these children were excluded, and only the responses of children without obesity were analyzed (Control; n = 31).

Snoring children with an AHI of at least 1 but 5 or less per hour of total sleep time (TST) with no clinically significant hypoxemia, hypercapnia, or excessive daytime sleepiness were considered to have primary snoring (PS), while children with clinically significant hypoxemia, hypercapnia, daytime sleepiness, an AHI of at least 5 per hour of TST, or a combination thereof, were considered to have SDB. The definition used for clinically significant hypoxemia was the presence of any events associated with oxyhemoglobin desaturations > 3% and a mean $SaO_2 \geq 95\%$, while that for hypercapnia required the presence of end-tidal carbon dioxide tension values > 50 mmHg for more than 3% of the total recording time. Sleepiness was considered to be potentially present if parental reports based on a modified questionnaire similar to the Epworth Sleepiness Scale was suggestive of daytime sleepiness or the recently derived intrapolysomnographic sleep pressure score was ≥ 0.25 or both.[20] SDB was further classified as mild or moderate to severe by physician analysis of presenting concerns, AHI, respiratory arousal index, and magnitude of hypoxemia and hypercapnia.[21] Control children had documented absence of snoring after having previously undergone polysomnography (PSG) as part of a study conducted by O'Brien et al.[19] Furthermore, parental report indicated that the children continued to be nonsnoring.

Questionnaires

Parents completed the parent version of the Pediatric Quality of Life Inventory, Version 4.0[22] (PedsQL™ 4.0), and the children completed the Children's Depression Inventory[33] (CDI) and child version of the PedsQL™ 4.0 during visits to the sleep medicine center. Control subjects completed the questionnaires by mail. Children in the clinic groups had their height and weight measured by medical staff at their clinic visits. Height and weight of the children in the control group were provided by parental report on the mailed questionnaire.

The PedsQL™ 4.0

The 23-item PedsQL™ 4.0 Generic Core Scales, developed by Varni,[22] include (1) Physical Functioning (8 items), (2) Emotional Functioning (5 items), (3) Social Functioning (5 items), and (4) School Functioning (5 items) and were created through focus groups, interviews, pretesting, and field-testing measurement development protocols.[22,23]

The PedsQL™ 4.0 Generic Core Scales are comprised of parallel child self-report and parent-report formats. The parent report is a proxy report and assesses parents' perceptions of their children's HRQOL. The items for each of the forms are essentially identical, differing in developmentally appropriate language or first- or third-person viewpoint. The instructions ask how much of a problem each item has been during the past month. A 5-point response scale is utilized (0 = never a problem; 1 = almost never a problem; 2 = sometimes a problem; 3 = often a problem; 4 = almost always a problem).

Items are reverse scored and linearly transformed to a 0 to 100 scale (0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0), so that higher scores indicate better HRQOL. Scale Scores are computed as the sum of the items divided by the number of items answered (this accounts for missing data). If more than 50% of the items in the scale are missing, the Scale Score is not computed.[24] The PedsQL™ 4.0 is the only non–disease-specific pediatric HRQOL measurement instrument to our knowledge to maintain item and scale construct consistency while covering a 2- to 18-year-old age range.[25-28]

Through validation studies, child-report measures have reflected significantly lower scores (reflecting poorer quality of life) in all subscales among children with chronic and acute illnesses than among healthy children.[29-32] Parent reports have shown poorer quality of life among chronically ill than among acutely ill children. Furthermore, acutely ill children's parents have reported poorer quality of life than have healthy children's parents. A multitrait-multimethod matrix has reflected a correlation between parent and child report; however, most scales have had correlation coefficients below 0.50, reflecting the importance of surveying both the child and the parent.[22]

Children's Depression Inventory

The CDI, developed by Kovacs, is a 27-item self-report measure of depressive symptoms in children ages 7 to 17 years.[33] Children are presented with a forced choice of 3 statements and asked to think of their feelings over the previous 2 weeks and determine which statement best describes themselves. Scores

obtained from the CDI include Total, Negative Mood, Interpersonal Problems, Ineffectiveness, Anhedonia, and Negative Self-Esteem.[33]

Polysomnography

A standard overnight multichannel PSG evaluation was performed for 72 children in the Clin groups in the sleep laboratory. Although all children in the Clin groups had been referred for nocturnal PSG, the remaining 13 failed to return to the clinic for PSG. Children were studied for up to 12 hours in a quiet darkened room with an ambient temperature of 24°C in the company of 1 of their parents. No drugs were used to induce sleep. The following parameters were measured: chest and abdominal wall movement by respiratory impedance or inductance plethysmography; heart rate by electrocardiogram; air flow with a sidestream end-tidal capnograph, which also provided breath-by-breath assessment of end-tidal carbon-dioxide levels ($PETCO_2$; BCI SC-300, Menomonee Falls, Wisc), an oronasal thermistor, and a nasal pressure transducer. SpO_2 was assessed by pulse oximetry (Nellcor N 100; Nellcor Inc., Hayward, Calif), with simultaneous recording of the pulse waveform. The bilateral electrooculogram, 8 channels of electroencephalogram, chin and anterior tibial electromyograms, and analog output from a body-position sensor (Braebon Medical Corporation, NY) were also monitored. All measures were digitized using a commercially available PSG system (Rembrandt, MedCare Diagnostics, Amsterdam). Tracheal sound was monitored with a microphone sensor (Sleepmate, Virg), and a digital time-synchronized video recording was performed.

Sleep architecture was assessed by standard techniques.[34] The proportion of time spent in each sleep stage was expressed as a percentage of TST. Awakenings were defined as a sustained arousal lasting longer than 15 seconds. Sleep efficiency was defined as TST divided by total recording time. The apnea index (AI) was defined as the number of apneas per hour of TST. Central, obstructive, and mixed apneic events were counted. Obstructive apnea was defined as the absence of airflow with continued chest wall and abdominal movement for duration of at least 2 breaths.[35-36] Hypopneas were defined as a decrease in nasal flow of at least 50% with a corresponding decrease in SpO_2 of at least 4%, an arousal, or both. The obstructive apnea-hypopnea index (AHI) was defined as the number of apneas and hypopneas per hour of TST.

The mean SpO_2, as measured by pulse oximetry in the presence of a pulse waveform signal void of motion artifact, and the SpO_2 nadir were recorded. Because criteria for arousals have not yet been developed for children, arousals were defined as recommended by the American Sleep Disorders Association Task Force report[37] using the 3-second rule, the presence of movement arousal, or both.[38] Arousals were divided into 2 types: spontaneous arousals and respiratory arousals. The total number of arousals was also calculated. The corresponding arousal indexes were calculated as a function of TST duration and are expressed as number per hour of sleep. No child had a TST of less than 4 hours, and all children had slow-wave and rapid eye movement sleep.

Descriptive statistics consisting of means and SD were used for initial assessment of the data and were followed by analyses of variance (ANOVA) procedures followed by posthoc tests, as appropriate, and multiple regression. χ^2 analyses were also utilized to determine differences in proportion of children meeting clinically significant levels of depressive symptoms. Statistical significance was set at a P value < .05.

RESULTS

One hundred twenty children and their parents participated in the study. The ClinOb group consisted of 44 children with a mean age of 10.05 ± 1.5 years and a mean BMI of 30.82 ± 6.5 kg/m^2; the ClinNl group comprised 41 children with a mean age of 10.17 ± 1.4 years and a mean BMI of 18.31 ± 2.7 kg/m^2; and the control group included 31 children with a mean age of 9.56 ± .9 years and a mean BMI of 17.50 ± 2.9 kg/m^2. Significantly more Caucasian children were represented in the Control group than in the ClinNl group. No other significant differences were observed in the demographics of the groups, other than targeted differences in BMI and weight (Table 1). PSG recordings for the ClinOb and ClinNl children revealed no significant differences in objective sleep recordings between the 2 groups (*P,* not significant; Table 2).

Both Clin groups had significantly lower scores on the PedsQL™ 4.0 in total parent- and child-reported HRQOL, compared to children in the control group (Table 3; ANOVA, F = 32.83, P < .001 Parent-Report; F = 13.24, P < .001 Child-Report), indicative of more impaired quality of life in the clinical sample. More specifically, all areas of parent-reported HRQOL (Table 3; Physical Health F = 31.27, P < .001; Emotional Functioning F = 16.58, P < .001, Social Functioning; F = 14.20, P < .001; School Functioning F = 34.71, P < .001) and all areas of child-reported HRQOL (Table 3; Physical Health F = 10.40, P < .001; Emotional Functioning, F = 7.25, P = .001; Social Functioning, F = 4.78, P = .01; School Functioning F = 16.62, P < .001) significantly differed between the Clin and Control groups. In addition, ClinOb had significantly lower PedsQL™ 4.0 scores in parent-reported total quality of life (P < .05) and physical health (P < .001) than did ClinNl (Table 3). However, there were no differences in child-reported PedsQL™ scores

Table 1—Demographic Characteristics of Obese and Nonobese Snoring Children and Controls

	ClinOb (n = 44)	ClinNl (n = 41)	Control (n = 31)
Age, y	10.05 ± 1.5	10.17 ± 1.4	9.56 ± .9
Boys / girls, no.	26/18	21/20	13/18
BMI, kg/m^2	30.82 ± 6.5	18.31 ± 2.7*	17.50 ± 2.9*
Height, cm	146.66 ± 12.0	140.73 ± 12.3†	135.70 ± 8.7*
Weight, kg	68.19 ± 23.2	36.97 ± 10.0*	32.51 ± 7.5*
Race, %			
Caucasian	73	66	87‡
African American	27	32	7
Latino	0	0	3
Biracial	0	2	3

Data are presented as mean ± SD unless otherwise noted.
ClinOb refers to children who snore and are obese; ClinNL, children who snore and are not obese; BMI, body mass index.
*P < .001 vs ClinOb
†P < .05 vs ClinNl
‡P < .05 vs ClinOb

between ClinOb and ClinNl (*P,* not significant; Table 3).

No racial differences were noted in HRQOL or depressive symptoms. Some sex differences were evident, however. Girls had significantly better parent-reported HRQOL than did boys (Table 4; Total $t = 2.4$, $P < .05$; Emotional Functioning $t = 2.2$, $P < .05$; Social Functioning t = 2.7, $P < .01$; School Functioning t = 2.6, p = .01). Girls also reported better overall HRQOL (Table 4; Total $t = 2.0$, $P < .05$), better social functioning (Table 4; $t = 2.1$, $P < .05$), and less anhedonia (Table 4; $t = 2.8$, $P < .01$) than did boys. When sex was used as a covariate, however, group differences between Clin and Control groups continued to be significant.

Depressive symptoms as derived from the CDI were significantly higher (ie, more depressive symptoms) for both Clin

Table 2—Polysomnography Results from Obese and NonObese Snoring Children

	ClinOb (n = 40)	ClinNl (n = 32)
TST, h	6.9 ± .8	6.9 ± .9
Sleep efficiency, % of TIB	85.5 ± 10.2	86.0 ± 10.1
Sleep latency, min	23.9 ± 24.9	34.2 ± 34.0
REM latency, min	162.9 ± 77.7	169.8 ± 72.3
SWS, % of TST	27.7 ± 10.4	31.3 ± 9.9
REM sleep, % of TST	13.0 ± 5.3	15.3 ± 6.1
Spontaneous Arousal Index	6.9 ± 4.8	6.3 ± 4.5
Respiratory Arousal Index	6.7 ± 9.2	3.6 ± 7.9
PLM Index, per hour of TST	5.6 ± 10.9	3.3 ± 4.7
AHI, per hour of TST		
(range: 0.02-82.86)	8.2 ± 14.9	4.2 ± 9.1
SpO_2, %		
Mean	96.7 ± 1.2	97.1 ± 1.5
Nadir	86.0 ± 6.0	87.8 ± 8.0

Data are presented as mean ± SD.
ClinOb refers to children who snore and are obese; ClinNL, children who snore and are not obese; TST, total sleep time; TIB, time in bed; SWS, slow-wave sleep; REM, rapid eye movement; PLM, periodic limb movements; AHI, apnea-hypopnea index.

Table 3—Health-Related Quality of Life Scores as Derived from the Pediatric Quality of Life Inventory™, Version 4.0 in Obese and Nonobese Snoring Children and Controls

	ClinOb (n = 42)	ClinNl (n = 40)	Control (n = 31)
Total			
Parent Report	55.93 ± 16.5*†	63.62 ± 19.1*†	86.43 ± 11.2
Child Report	64.63 ± 18.8*	66.00 ± 18.1*	84.47 ± 15.5
Physical Health			
Parent Report	56.83 ± 19.2*‡	72.82 ± 25.0*	92.94 ± 9.2
Child Report	68.77 ± 22.4*	74.75 ± 19.5†	89.72 ± 15.6
Emotional Functioning			
Parent Report	52.67 ± 19.8*	51.13 ± 20.5*	75.81 ± 18.7
Child Report	59.64 ± 19.5§	57.00 ± 23.1*	75.97 ± 24.2
Social Functioning			
Parent Report	61.86 ± 21.2*	69.76 ± 23.1*	87.10 ± 14.0
Child Report	67.93 ± 22.1§	73.25 ± 23.2¥	84.03 ± 20.3
School Functioning			
Parent Report	51.98 ± 20.5*	56.46 ± 18.9*	86.13 ± 14.2
Child Report	59.72 ± 23.3*	61.00 ± 20.7*	85.00 ± 14.5

Data are presented as mean ± SD.
ClinOb refers to children who snore and are obese; ClinNL, children who snore and are not obese.
*$P < .001$ vs Control
†$P < .05$ vs ClinicNl
‡$P < .001$ vs ClinicNl
§$P < .01$ vs Control
¥ $P < .05$ vs Control

Table 4—Health-Related Quality of Life and Depressive Symptoms in Girls and Boys

	Girls (n = 54)	Boys (n = 62)
Pediatric Quality of Life Inventory, Version 4.0		
Total		
Parent Report	72.12 ± 21.0*	63.01 ± 19.2
Child Report	74.37 ± 19.2*	67.17 ± 19.2
Physical Health		
Parent Report	76.21 ± 26.0	70.15± 22.1
Child Report	80.16 ± 20.0	74.83 ± 20.5
Emotional Functioning		
Parent Report	63.58 ± 24.5*	54.38 ± 19.9
Child Report	65.09 ± 24.8	61.02 ± 22.0
Social Functioning		
Parent Report	77.74 ± 20.3†	66.37 ± 23.7
Child Report	78.98 ± 21.8*	70.25 ± 22.7
School Functioning		
Parent Report	68.77 ± 24.1†	57.58 ± 21.8
Child Report	70.44 ± 21.9	63.64 ± 23.9
Children's Depression Inventory		
Total	47.17 ± 9.6	50.34 ± 11.2
Negative Mood	48.12 ± 8.8	49.56 ± 11.4
Interpersonal Problems	52.35 ± 10.8	50.25 ± 10.8
Ineffectiveness	47.10 ± 8.1	48.63 ± 9.7
Anhedonia	48.31 ± 11.9†	54.76 ± 12.2
Negative Self-Esteem	44.71 ± 7.4	46.44 ± 7.0

Data are presented as Mean ± SD.
*$P < .05$
†$P < .01$

Table 5—Depression T Scores as Derived from the Children's Depression Inventory in Obese and Nonobese Snoring Children and Controls

	ClinOb (n = 42)	ClinNl (n = 38)	Control (n = 31)
Total	51.40 ± 11.0*	51.24 ± 9.2†	43.23 ± 9.8
Negative Mood	50.88 ± 10.4†	51.08 ± 9.7†	44.16 ± 9.5
Interpersonal Problems	52.69 ± 11.4	53.34 ± 11.2	47.84 ± 8.7
Ineffectiveness	48.71 ± 8.8‡	50.24 ± 9.2†	44.19 ± 8.3
Anhedonia	55.12 ± 12.6*	54.26 ± 10.4*	44.23 ± 11.3
Negative Self-Esteem	46.79 ± 9.1	45.95 ± 6.1	44.55 ± 7.1

Data are presented as mean ± SD.
ClinOb refers to children who snore and are obese; ClinNL, children who snore and are not obese.
*$P < .001$ vs Control
† $P < .01$ vs Control
‡ $P < .05$ vs Control

groups than for the control group for Total Score (F = 7.23, P = .001), Negative Mood (F = 5.31, $P < .01$), Ineffectiveness (F = 4.26, $P < .05$), and Anhedonia (F = 9.29, $P < .001$; Table 5). CDI T scores ≥ 60 (ie, 1 SD above the mean) were considered in the clinically significant range. χ^2 analyses were used to compare the proportion of children in each group who had at least 1 subscale in the clinically significant range and revealed that both ClinOb and ClinNl had significantly more children in the clinically significant range on the Anhedonia subscale than did Controls (χ^2 = 6.99, $P < .01$ ClinOb; $\chi^2 = 5.21$, $P < .05$ ClinNl; Table 6).

Table 6—Proportion of Children Scoring in the Clinically Significant Range of the Children's Depression Inventory Among Obese and Nonobese Snoring Children and Controls

	ClinOb (n = 42)	ClinNl (n = 38)	Control (n = 31)
Total	23.8	15.8	6.5
Negative Mood	11.9	13.2	3.2
Interpersonal Problems	19.0	18.4	9.7
Ineffectiveness	11.9	13.2	6.5
Anhedonia	35.7*	31.6†	6.5
Negative Self-Esteem	9.5	5.3	6.5

Data are presented as percentages.
ClinOb refers to children who snore and are obese; ClinNL, children who snore and are not obese.
*$P < .01$ vs Control
†$P < .05$ vs Control

Table 7—Health-Related Quality of Life and depressive symptoms in children with either primary snoring or snoring and sleep-disordered breathing

	Sleep-disordered breathing (n = 31)	Primary snoring (n = 31)
Pediatric Quality of Life Inventory™, Version 4.0		
Total		
Parent Report	59.75 ± 17.2	59.86 ± 21.8
Child Report	64.13 ± 17.3	63.00 ± 22.8
Physical Health		
Parent Report	60.69 ± 19.8	66.78 ± 26.5
Child Report	70.75 ± 19.3	71.77 ± 23.1
Emotional Functioning		
Parent Report	53.83 ± 22.3	53.63 ± 20.5
Child Report	59.33 ± 22.0	56.83 ± 24.0
Social Functioning		
Parent Report	65.33 ± 23.4	63.13 ± 26.6
Child Report	64.67 ± 21.8	71.67 ± 26.5
School Functioning		
Parent Report	58.00 ± 21.36	53.28 ± 23.7
Child Report	59.62 ± 19.0	56.67 ± 27.8
Children's Depression Inventory		
Total	51.23 ± 10.6	51.83 ± 10.4
Negative Mood	49.93 ± 10.8	52.40 ± 9.3
Interpersonal Problems	50.73 ± 11.1	54.73 ± 12.0
Ineffectiveness	47.97 ± 9.3	50.60 ± 10.0
Anhedonia	57.03 ± 12.1	54.20 ± 11.8
Negative Self-Esteem	46.73 ± 7.8	45.70 ± 7.0

Data are presented as Mean ± SD.

Following nocturnal PSG, children in the clinically referred groups were divided into those with primary snoring (PS; n = 31) and those with SDB (n = 31). The remaining 10 children had other diagnoses (ie, periodic limb movement disorder, insomnia, no diagnosis). No significant differences emerged in either HRQOL or depressive symptoms between PS and SDB (P, not significant; Table 7). Children were further subdivided into those with PS (n = 31), mild SDB (n = 16), and moderate to severe SDB (n = 15) based upon 2 independent physicians' judgments of clinical severity. Decisions were based upon AHI, hypoxemia, hypercapnia, and excessive daytime sleepiness.[21] No significant differences emerged among groups in parent- or child-reported HRQOL or child-reported symptoms of depression (P, not significant; Table 8). Multiple regression was then used to determine if SDB severity as measured by AHI, respiratory arousal index, mean SaO_2 level, nadir oxygen level, and apnea index explained the variance in parent- and child-reported HRQOL or symptoms of depression. None of these variables independently, or in combination, explained a significant degree of variance in HRQOL (Parent Report $R^2 = .09$, $P > .05$; Child Report $R^2 = .08$, $P > .05$) or depressive symptoms (CDI Total $R^2 = .04$, $P > .05$).

Table 8—Health-Related Quality of Life and Depression Scores as Derived from the Pediatric Quality of Life Inventory™, Version 4.0 and Children's Depression Inventory in Children with Primary Snoring, Mild Sleep-Disordered Breathing, and Moderate to Severe Sleep-Disordered Breathing

	Primary Snoring (n = 31)	Mild SDB (n = 16)	Moderate to severe SDB (n = 15)
Pediatric Quality of Life Inventory™, Version 4.0			
Total			
Parent Report	60.18 ± 22.1	61.41 ± 11.3	57.85 ± 22.4
Child Report	63.90 ± 22.7	64.54 ± 14.8	63.66 ± 20.3
Physical Health			
Parent Report	67.22 ± 26.8	64.45 ± 14.0	56.38 ± 24.8
Child Report	72.09 ± 23.4	72.07 ± 15.6	69.24 ± 23.3
Emotional Functioning			
Parent Report	54.07 ± 20.7	53.44 ± 18.0	54.29 ± 27.1
Child Report	57.93 ± 23.6	59.38 ± 16.8	59.29 ± 27.5
Social Functioning			
Parent Report	63.55 ± 26.9	66.88 ± 19.9	63.57 ± 27.5
Child Report	72.59 ± 26.5	65.94 ± 21.9	63.21 ± 22.3
School Functioning			
Parent Report	53.23 ± 24.1	57.50 ± 18.9	58.57 ± 24.6
Child Report	58.45 ± 26.5	57.50 ± 16.3	62.05 ± 22.1
Children's Depression Inventory			
Total	51.62 ± 10.5	50.81 ± 7.9	51.71 ± 13.4
Negative Mood	52.00 ± 9.2	47.75 ± 7.5	52.43 ± 13.4
Interpersonal Problems	54.66 ± 12.2	49.62 ± 10.4	52.00 ± 12.2
Ineffectiveness	50.48 ± 10.1	49.31 ± 8.7	46.43 ± 9.9
Anhedonia	54.00 ± 12.0	57.13 ± 12.5	56.93 ± 12.2
Negative Self-Esteem	45.69 ± 7.2	46.25 ± 5.6	47.29 ± 10.3

Data are presented as Mean ± SD.
SDB refers to sleep-disordered breathing.

DISCUSSION

The findings of this study indicate that snoring children are not only at high risk for decreased HRQOL, but are also at high risk for the presence of depressive symptoms, particularly anhedonia. Furthermore, the presence of obesity in snoring children is not associated with differences in reported HRQOL or depressive symptoms compared to snoring children of normal weight. However, assessment of parental perception for obese snoring children revealed significantly worse quality of life than for nonobese children with SDB, and these differences were particularly related to parentally reported physical health impairments in obese children. These latter findings are similar to the physical health impairments observed by Rosen et al in children with SDB.[4] However, in the cohort studied by Rosen and colleagues, children with more severe SDB also had significantly higher BMI.[4] In contrast, no differences occurred between the severity of SDB and reported impaired HRQOL due to physical health in the present cohort. As such, the impairments in parentally reported physical health of the children appear to be more related to BMI than to SDB status, since no other parent- or child-reported quality of life differences emerged between the 2 groups, and since obese snoring children did not report more depressive symptoms than snoring children of normal weight. Additionally, Schwimmer and colleagues[10] have also shown that higher BMI in children is associated with increased impairments in parent-reported physical health, further supporting this relationship.

Children with reported SDB symptoms had both parent- and child-reported significant impairments in HRQOL that were independent of what has been considered as clinically significant AHI, but were markedly different from the control group of children with no SDB symptoms. Of note, the level of impaired HRQOL was substantially greater than that reported by chronically ill children and their parents in the validation study of the PedsQL™ 4.0 [22] and of children with obesity who did not have OSA in the study conducted by Schwimmer and colleagues.[10] Furthermore, the total and physical health PedsQL™ 4.0 scores are very similar to those found in obese children with OSA studied by Schwimmer et al.[10] While the mechanisms underlying the decrease in HRQOL in snoring children are unclear, it is likely that the sleep disturbance associated with snoring increases fatigue in children and, that as fatigue increases, snoring children will experience increased irritability, depressed mood, impaired concentration, and decreased interest in daily activities. These impairments in daily functioning may, in turn, interfere with functioning in all aspects of the child's life, including family, school, and peers. As a result, a vicious cycle may develop and lead to more impaired quality of life in all areas and to the presence of more depressive symptoms.

The report of anhedonia was one of the most substantial findings in the present study. Indeed, 36% of obese snoring children and 31% of normal-weight snoring children reported levels of anhedonia that were 1 SD above the mean in comparison to only 6% of control children. These findings further support the notion that the fatigue and sleepiness that emanate from disrupted sleep architecture in the context of snoring may greatly interfere with daily functioning. Not surprisingly, the more fatigued a child is, the more likely he or she will be to withdraw from previous activities. Similarly, as anhedonia increases, it is likely to interfere with quality of life. Taken together, the marked effect of snoring on the anhedonia scale of the CDI raises the possibility that some children with an underlying propensity for depression may develop overt clinical symptoms of this disorder if SDB is concurrently present. Notwithstanding the prominence of the effect of snoring on depressive scales, however, this study did not examine the reversibility of the affected measures in the CDI or in the PedsQL™ 4.0. Such study would be of great importance in more forcefully establishing the causal relationship between snoring, depression, and HRQOL.

Interestingly, no differences in quality of life or depressive symptoms were observed among children with PS, mild SDB, or moderate to severe SDB. The absence of any differences in depressive symptoms or HRQOL as it pertains to the severity of sleep-related breathing impairments (ie, hypoxemia, hypercapnia, respiratory-related arousals, AHI) would suggest that snoring should not be viewed simply as an "innocuous" symptom, since its presence may significantly interfere with children's psychosocial functioning.[39] This observation is consistent with a recent study from our laboratory on the association between PS and impaired neurocognitive functioning, whereby even children with PSG findings that would otherwise be considered clinically irrelevant (American Academy of Pediatrics consensus) demonstrated significant deficits in specific areas of behavior and cognitive ability.[39] Thus, the present study further stresses the importance of snoring and sleep disturbances as major contributing factors in the quality of life and in the occurrence of symptoms of depression among children with and without obesity. AHI was poorly predictive of psychosocial functioning in these children, and while it is tempting to use AHI as an index of severity of disease, it is clear from these findings that snoring is a more important marker of daytime impairment.

As mentioned above, while the present study has shed light on important determinants of psychosocial functioning in snoring children, it is unclear how children's HRQOL and magnitude of depressive symptoms will change following treatment of SDB. In a sample of 64 children, Goldstein and colleagues found that reports of sleep disturbance, caregiver concerns, and physical symptoms were all improved after tonsillectomy and adenoidectomy. However, SDB was not assessed by overnight PSG, and BMI was not specifically reported.[40] Based on the study by Goldstein at al and the present study, it is possible that after tonsillectomy and adenoidectomy, all children with SDB will demonstrate improvements in their quality of life and depressive-symptom measures. Alternatively, if SDB imposes a masking effect on the impact of obesity on psychosocial functioning, normal-weight children will reveal improvements after tonsillectomy and adenoidectomy in quality of life and depressive symptoms, but such improvements will be absent or attenuated in obese children. A goal of our laboratory is to further clarify this issue by examining the HRQOL and mood of these children after SDB has been treated with tonsillectomy and adenoidectomy.

While the present study has shed light on the importance of snoring in children's reduced psychosocial functioning, several limitations were present. The clinic-based sample in the current study precluded a rigorous examination of factors that may have further contributed to reduced quality of life and increased depression in the clinic group. Socioeconomic status, parental education, and neurocognitive status were not measured, and, thus, their contribution to the sample's psychosocial functioning cannot be assessed. Furthermore, snoring children who present to

sleep disorders centers may be inherently different from snorers in the community. Snoring children who experience impaired quality of life and depression may be more likely to seek treatment for their SDB. However, parents did not report any changes in mood, affect, or HRQOL during clinical interviews or when completing clinic-based questionnaires. Only when these variables were directly assessed were these daytime impairments noted. Rather, at initial presentation to the clinic, parents focused on their children's nighttime SDB symptoms. We believe that parents' reasons for seeking treatment are significant regarding the likelihood that the snoring children presenting to the clinic did not differ in regard to mood state from snoring children in the community.

Additional limitations regarding the recruitment of the control group must be noted. Because the control group was recruited from the community, unforeseen variables may have differed between the groups. The absence of an obese control group from the community further limited the conclusions that can be drawn from the results. Unfortunately, only 4 of the 35 control children had a BMI above the 95th percentile. Therefore, the sample size was insufficient for any valid comparisons and precluded assessment of the specific and individual roles of obesity and SDB in children's psychosocial functioning. Although the recruitment of obese controls would undoubtedly have added to the strength of the conclusions, we were simply unable to do so at this time. Our experience with attempts to recruit obese controls in previous prospective studies has revealed that when obese children without presenting complaints of SDB are recruited, they are discovered on PSG examination to snore. Therefore, in a clinic-based study, this degree of recruitment was not feasible.

It should also be noted that the age group selected in our study is older than the age at which peak prevalence of SDB occurs, namely 3 to 6 years. However, the sample selection was dictated by the age constraints imposed by the depression instrument used in this study, such that direct self-report of mood would not be possible in younger children.

In summary, 8- to 12-year-old children who snore have substantially impaired quality of life and mood that appears to be unrelated to either the presence of obesity or of OSA. While the pathophysiologic mechanisms that mediate this novel facet of SDB-associated morbidity remain to be defined, our present findings suggest that all school-aged children with symptoms of snoring should have a thorough assessment of their current mood and overall emotional functioning.

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