First Place—Resident Clinical Science Award 1999

Quality of life for children with obstructive sleep apnea

RAMON ARTURO FRANCO, JR, MD, RICHARD M. ROSENFELD, MD, MPH, and MADU RAO, MD, Brooklyn, New York

The caregivers of 61 eligible children (6 months to 12 years old) completed a 20-item (OSA-20) health-related quality-of-life survey after polysomnography was performed to psychometrically validate the OSA-20. Excellent test-retest reliability was obtained for the individual survey items ($R > 0.74$). Construct validity was shown by significant correlation of the mean survey score with the respiratory distress index ($R = 0.43$) and adenoid size ($R = 0.43$). Two items with poor validity were dropped, reducing the survey to 18 items (OSA-18). The relationship between the OSA-18 summary score and respiratory distress index remained significant when adjusted for tonsil size, adenoid size, body mass index, and child age. On the basis of the total survey score, the impact of OSAS on quality of life was small for 20 children (33%), moderate for 19 (31%), and large for 22 (36%). The OSA-18 is a practical means of office-based determination of quality-of-life impact for obstructive sleep apnea syndrome in children. (Otolaryngol Head Neck Surg 2000;123:9-16.)

Obstructive sleep apnea syndrome (OSAS) is the most common indication for tonsillectomy and adenoidectomy in young children. Despite a progressive decrease in tonsil and adenoid surgery for recurrent infection during the past 2 decades, the importance of OSAS as a surgical indication has increased.[1] Although the clinical picture of OSAS is easily recognized, the impact of OSAS on a child's quality of life is poorly understood and has been reported only anecdotally in the literature. There remains difficulty in deciding which children will, or will not, benefit from timely surgical intervention because of the inconvenience and limited availability of objective measures of OSAS severity and the absence of a valid and reliable surrogate measure of disease-specific quality of life. Attempts to overcome these limitations through shorter nap studies or home-based monitoring programs are encouraging, but issues of cost, practicality, and tolerance remain.

A promising but unexplored method for office-based determination of OSAS severity is to develop and validate a disease-specific quality-of-life survey. An OSAS survey is available for adults,[2] but no comparable instrument has been developed for pediatric use. Nonetheless, the method for survey development has been well established,[3] largely in response to the central role of such surveys in patient-based outcomes studies. Outcomes research incorporates broadened definitions of disease impact, including subjective assessments of quality of life. Health-related quality of life (HRQL) excludes other widely valued aspects of life that are not typically considered as health, including income, freedom, and quality of the environment. Although these aspects are important, they are rarely affected by health interventions.

An HRQL survey focuses on the physical problems, functional limitations, and emotional consequences of a disease. Most surveys are self-administered questionnaires, composed of items or questions grouped into domains that reflect a particular focus of attention. A survey can be designed either to discriminate among children who have a better HRQL and those who have a worse HRQL or, conversely, to evaluate how much HRQL has changed after an intervention. In the context of OSAS diagnosis, a discriminative survey is desired, one that could classify differences between patients at a point in time as small, moderate, or large.

A quality-of-life survey is judged psychometrically by its reliability and validity.[4,5] Reliability refers to the stability or reproducibility of survey results. Validity is the degree to which the survey measures what it purports to measure. Survey validation is a process of

From the Departments of Otolaryngology (Drs Franco and Rosenfeld) and Pediatrics (Dr Rao), SUNY Health Science Center at Brooklyn.
Supported by a Small Project Outcomes Research Grant from the American Academy of Otolaryngology–Head and Neck Surgery Foundation.
Presented at the Annual Meeting of the American Academy of Otolaryngology–Head and Neck Surgery, New Orleans, LA, September 26-29, 1999.
Reprint requests: Richard M. Rosenfeld, MD, MPH, SUNY HSCB, Box 126, 450 Clarkson Ave, Brooklyn, NY 11203.

0194-5998/2000/$12.00 + 0 **23/10/105254**
doi:10.1067/mhn.2000.105254

Table 1. Items and subscales of the OSA-20 quality-of-life survey

Item	Subscale	Content
1	Sleep disturbance	Loud snoring
2	Sleep disturbance	Breath holding spells or pauses in breathing at night
3	Sleep disturbance	Choking or gasping sounds while asleep
4	Sleep disturbance	Restless sleep or frequent awakenings from sleep
5	Physical symptoms	Mouth breathing because of nasal obstruction
6	Physical symptoms	Frequent colds or upper respiratory infections
7	Physical symptoms	Nasal discharge or runny nose
8	Physical symptoms	Difficulty swallowing foods
9	Emotional distress	Mood swings or temper tantrums
10	Emotional distress	Aggressive or hyperactive behavior
11	Emotional distress	Discipline problems
12	Emotional distress	Problems getting along with other children
13	Daytime function	Excessive daytime drowsiness or sleepiness
14	Daytime function	Poor attention span or concentration
15	Daytime function	Difficulty getting out of bed in the morning
16	Daytime function	School or learning problems
17	Caregiver concerns	Worrying about child's general health because of above problems
18	Caregiver concerns	Concern that child is not getting enough air at night
19	Caregiver concerns	Inability to perform daily activities because of above problems
20	Caregiver concerns	Frustration because of above problems

Parents rated symptom frequency during the previous 4 weeks using a 7-point ordinal scale of (1) none of the time, (2) hardly any of the time, (3) a little of the time, (4) some of the time, (5) a good bit of the time, (6) most of the time, and (7) all of the time.

hypothesis testing, where correlations are sought between survey items or results and external measures of similar properties (eg, polysomnography results, physical examination finding). By documenting the psychometric validity of the OSA-20 we hope to provide clinicians with a rapid and reliable means to assess the impact of OSAS on a child's quality of life. Future investigations will seek to validate the OSA-20 as a measure of longitudinal change, so that it may be incorporated into outcome studies of treatment effectiveness.

METHODS

This cross-sectional study was conducted from July 1, 1997, through July 1, 1998, at the State University of New York at Brooklyn University Hospital (a nonprofit, New York State–owned hospital) and the Kings County Medical Center (a nonprofit, New York City–owned hospital in Brooklyn, NY). The research protocol was reviewed by the institutional review board of each hospital, and approval was granted by both institutions for the study period. Specific inclusion criteria were (1) age 6 months through 12 years, inclusive; (2) history of snoring and disrupted sleep for 3 months or longer; (3) referral to the Division of Pediatric Pulmonary Medicine for polysomnography as part of routine clinical care; and (4) hyperplasia of tonsils or adenoids on physical examination. Specific exclusion criteria were (1) prior tonsil or adenoid surgery, (2) Down or other syndrome involving the head and neck, (3) neuromuscular disorders, (4) cleft palate or previous pharyngeal surgery, (5) known cognitive deficit or mental retardation, (6) known psychiatric disorder, and (7) inability of caregiver to read and understand English.

The OSA-20 is a caregiver-administered HRQL survey and designed according to established principles of outcomes research.[3] The survey consists of 20 questions divided into 5 domains, each of which contains 4 items (questions). Selection of these domains was based on the authors' personal experience with OSAS patients, targeted discussions with caregivers of children with OSAS, and consultation with experts in the field to achieve adequate face and content validity. Domains represented in the survey are: sleep disturbance, physical symptoms, emotional symptoms, daytime function, and caregiver concerns.

The 20 survey items (Table 1) were scored with a 7-point ordinal scale, which has been shown to possess adequate discriminative and evaluative properties.[6] Caregivers were asked to describe how often during the previous 4 weeks their child had exhibited specific symptoms with the following response scale: (1) none of the time, (2) hardly any of the time, (3) a little of the time, (4) some of the time, (5) a good bit of the time, (6) most of the time, and (7) all of the time. Frequency was assessed rather than severity because a recent quality-of-life study for sinusitis showed increased item reliability for the former.[7] The 4-week recall period was long enough to avoid acute fluctuations in quality-of-life status but short enough to avoid problems with recall bias.

The survey was graded to produce an OSA-20 survey score, an overall summary score, and additional scores for individual domains. The OSA-20 survey score was the sum of

Table 2. OSA-20 individual item responses for 61 children

Item	Content	Survey median	No. of survey responses (%)						
			1	2	3	4	5	6	7
1	Loud snoring	7	2 (3)	4 (6)	2 (3)	7 (11)	4 (7)	11 (18)	31 (51)
2	Breath holding/pauses	5	9 (15)	2 (3)	6 (10)	10 (16)	4 (7)	16 (26)	14 (23)
3	Choking or gasping	5	8 (13)	2 (3)	12 (20)	5 (8)	8 (13)	12 (20)	15 (23)
4	Fragmented sleep	5	6 (10)	6 (10)	4 (7)	7 (11)	8 (13)	17 (28)	14 (21)
5	Mouth breathing	5	12 (20)	4 (7)	4 (7)	4 (7)	8 (13)	7 (11)	23 (36)
6	Frequent colds or URIs	4	12 (20)	7 (11)	8 (13)	12 (20)	9 (15)	7 (11)	6 (10)
7	Rhinorrhea	4	8 (13)	10 (16)	11 (18)	13 (21)	9 (15)	6 (10)	4 (7)
8	Dysphagia	1	35 (57)	6 (10)	4 (7)	9 (15)	5 (8)	3 (2)	0
9	Mood swings or tantrums	3	26 (43)	3 (5)	11 (18)	13 (21)	2 (3)	4 (7)	2 (3)
10	Aggression/hyperactivity	3	26 (43)	4 (7)	9 (15)	9 (15)	6 (10)	2 (3)	5 (8)
11	Discipline problems	2	29 (48)	8 (13)	6 (10)	9 (15)	3 (5)	3 (5)	3 (5)
12	Social problems	1	41 (67)	9 (15)	1 (2)	5 (8)	1 (2)	1 (2)	3 (5)
13	Daytime drowsiness	2	28 (46)	11 (18)	8 (13)	5 (8)	2 (3)	3 (5)	4 (7)
14	Poor attention span	1	32 (52)	6 (10)	6 (10)	6 (10)	4 (7)	3 (5)	4 (7)
15	Difficulty awakening	2	30 (49)	2 (3)	6 (10)	6 (10)	4 (7)	5 (8)	8 (13)
16	School problems	1	47 (77)	1 (2)	5 (8)	3 (5)	1 (2)	2 (3)	2 (3)
17	Caregiver worried over child health	6	8 (13)	5 (8)	7 (11)	4 (7)	5 (8)	9 (15)	23 (40)
18	Caregiver concerned not enough air	6	6 (10)	0	8 (13)	9 (15)	5 (8)	12 (20)	21 (34)
19	Caregiver missed activities	2	22 (36)	9 (15)	6 (10)	11 (18)	5 (8)	3 (5)	5 (8)
20	Caregiver frustration	4	15 (25)	9 (15)	6 (10)	10 (16)	5 (8)	3 (5)	13 (21)

Parents rated symptom frequency during the previous 4 weeks using a 7-point ordinal scale of (1) none of the time, (2) hardly any of the time, (3) a little of the time, (4) some of the time, (5) a good bit of the time, (6) most of the time, and (7) all of the time.
URIs, Upper respiratory infections.

the 20 responses, ranging from 20 to 140. The summary score was the average of all 20 items. Domain scores reflected the average of the 4 items within that domain. Summary and domain scores ranged from 1.0 to 7.0, with higher scores indicating a poorer disease-specific quality of life.

Polysomnography (NAP study) was performed according to the usual protocol used by the Division of Pediatric Pulmonary Medicine at the State University of New York at Brooklyn. The NAP study was performed after a night of sleep deprivation. The child was accompanied by one parent while a trained technician placed the necessary transducers. An Eden Tec II (model 3711-001; Eden Tec Corp, Eden Prairie, MN) portable apnea recorder was used to record data from the following 5 transducers: (1) combined oral/nasal thermistors to record the respiratory flow, (2) chest and abdominal pneumobelts for recording respiratory effort, (3) finger probe for recording pulse oximetry, (4) electrode for recording heart rate, and (5) a body-position sensor. The studies lasted approximately 90 minutes, after which the director of the Pediatric Pulmonary Function Laboratory, who was blinded to the child's clinical history and OSA-20 responses, interpreted the sleep study results.

A respiratory distress index (RDI) was established by combining the mean number of hourly apneic episodes with the mean number of hypopneic events. The RDI was interpreted as follows: normal/mild OSAS (RDI ≤ 5); moderate OSAS (RDI 6-9); and severe OSAS (RDI ≥ 10).

When a suitable child finished NAP polysomnography testing, the parent or guardian was approached by the principal investigator, who explained the study and obtained informed consent. A targeted but detailed history and physical examination were performed in the clinic setting by the principal investigator. The history highlighted the symptoms of upper airway obstruction, sleep habits, onset of the OSAS symptoms, and existence of comorbid conditions such as asthma and allergic rhinitis.

A standard head and neck examination was performed with careful assessment and documentation of the following. First, tonsil size was recorded with the criteria described by Brodsky[8] in 1989. The percentages noted are the percentage decrease in pharyngeal luminal diameter: 1+, 0% to 25%; 2+, 26% to 50%; 3+, 51% to 75%; and 4+, 76% to 100%. Second, adenoid size was recorded based on a fiberoptic nasal endoscopy with an assessment of the percentage of choanal obstruction: 1+, 0% to 25%; 2+, 26% to 50%; 3+, 51% to 75%; and 4+, 76% to 100%. Next, the position of the nasal septum, height in meters, weight in kilograms, and body mass index (BMI) were recorded. The BMI was calculated by dividing the weight in kilograms by the height in square meters. The BMI allowed stratification of the subject into 3 categories: obese (BMI ≥ 30 kg/m^2), overweight (BMI = 25-30 kg/m^2), and normal (≤25 kg/m^2).

The child's caregiver completed the OSA-20 questionnaire and a brief form that recorded demographic informa-

Otolaryngology–Head and Neck Surgery
July 2000

Table 3. OSA-20 individual item reliability and validity for 61 children

		Reliability *(R)**		Validity *(R)**		
Item	Content	Test-retest	Item-total†	RDI	Tonsil size‡	Adenoid size‡
1	Loud snoring	0.89	0.51	0.45	0.29	0.45
2	Breath holding/pauses	0.87	0.68	0.39	0.10	0.25
3	Choking or gasping	0.93	0.73	0.35	0.16	0.25
4	Fragmented sleep	0.91	0.59	0.22	–0.03	0.36
5	Mouth breathing	0.84	0.49	0.27	0.25	0.43
6	Frequent colds or URIs	0.87	0.76	0.21	0.21	0.18
7	Rhinorrhea	0.90	0.51	0.19	0.04	0.02
8	Dysphagia	0.92	0.43	0.12	0.23	0.21
9	Mood swings or tantrums	0.92	0.75	0.17	0.20	0.36
10	Aggression/hyperactivity	0.92	0.86	0.15	0.24	0.33
11	Discipline problems	0.89	0.78	0.16	0.20	0.29
12	Social problems	0.86	0.45	0.03	0.06	0.17
13	Daytime drowsiness	0.85	0.53	0.12	0.18	0.26
14	Poor attention span	0.84	0.76	0.11	–0.03	0.03
15	Difficulty awakening	0.88	0.63	0.17	0.07	0.03
16	School problems	0.93	0.59	0.06	–0.03	–0.06
17	Caregiver worried over child health	0.92	0.61	0.38	0.22	0.26
18	Caregiver concerned not enough air	0.91	0.64	0.28	0.07	0.17
19	Caregiver missed activities	0.74	0.44	0.30	0.17	0.27
20	Caregiver frustration	0.91	0.38	0.35	0.06	0.30

URIs, Upper respiratory infections.
*Spearman rank correlation: $R \geq 0.25$ is significant at $P < 0.05$, $R \geq 0.32$ is significant at $P < 0.01$, and $R \geq 0.40$ is significant at $P < 0.001$.
†Correlation of the item score with the subscale score obtained when omitting that item; $R > 0.20$ indicates adequate internal consistency.
‡Size is graded as 1 for 0% to 25% obstruction, 2 for 26% to 50%, 3 for 51% to 75%, and 4 for 76% to 100%.

tion. A follow-up OSA-20 was administered up to 3 days after the initial OSA-20 to establish test-retest reliability. On completion of the second OSA-20 survey the caregiver was paid $20.

All statistical analyses were performed with True Epistat software for medical statistics, with statistical significance defined as a 2-tailed *P* value less than 0.05.[9] Because this was a cross-sectional study, there were no distinct independent (predictor) or dependent (outcome) variables. Instead, all variables were treated comparably for purposes of correlation. The primary variables were (1) OSA-20 survey summary score (mean of the 20 items), (2) OSA-20 domain scores (mean of 4 items in domain), (3) RDI on polysomnography, (4) tonsil size by physical examination, (5) adenoid size by nasal endoscopy, and (6) BMI.

Test-retest reliability of the OSA-20 was measured with Spearman rank correlation. Adequate test-retest reliability for the survey summary score and individual survey items required a correlation coefficient of at least 0.70.[4] Internal consistency of the OSA-20 was measured with the item-total correlation method.[5] Items within each domain were correlated with the domain total score obtained when that item was omitted. A Pearson correlation greater than 0.20 indicated adequate internal consistency. Validity of the OSA-20 was assessed by seeking correlation between survey results and external measures. These measures included the RDI (expected correlation $R > 0.50$) and tonsil and adenoid size (expected correlation $R = 0.30$). Spearman rank correlation was used for all validity measures. Step-wise multiple linear regression was used to relate the RDI (outcome variable) to the following predictor variables: OSA-20 summary score, tonsil size, adenoid size, and BMI.

RESULTS

During the 12-month study period 61 children were recruited after obtaining informed consent from the parent or caregiver. The median child age was 4 years (range 1-12 years), with upper and lower quartiles of 3 and 7 years, respectively. Thirty-five children were male (57%) and 26 were female (43%). Fifty-two children were black (85%), 5 were white (8%), and 4 were Hispanic (7%). Most (53 children, 86%) were receiving public assistance at the time of the study. With the BMI classification, 54 children (89%) were of ideal weight, 5 (8%) were overweight, and only 2 (3%) were obese. The median duration of OSA symptoms was 2 years (range 0-8), with upper and lower quartiles of 1 and 3.2 years, respectively.

All caregivers were able to complete the OSA survey without assistance. The mean completion time was 5

Table 4. OSA-18 subscale score validity for 61 children

Subscale (item Nos.)	Validity *(R)** RDI	Tonsil size†	Adenoid size†
Sleep disturbance (1-4)	0.45	0.19	0.45
Physical symptoms (5-8)	0.32	0.26	0.32
Emotional distress (9-11)	0.18	0.24	0.36
Daytime function (13-15)	0.19	0.11	0.13
Caregiver concerns (17-20)	0.47	0.18	0.34
OSA-18 score (all except 12, 16)	0.43	0.29	0.43

*Spearman rank correlation: $R \geq 0.25$ is significant at $P < 0.05$, $R \geq 0.32$ is significant at $P < 0.01$, and $R \geq 0.40$ is significant at $P < 0.001$.
†Size is graded as 1 for 0% to 25% obstruction, 2 for 26% to 50%, 3 for 51% to 75%, and 4 for 76% to 100%.

Table 5. Multiple linear regression of factors determining RDI for 61 children*

Factor	Coefficient	SE	*P* value
Tonsil size†	7.75	2.77	0.007
Adenoid size†	–2.95	2.74	0.287
BMI	–0.28	0.47	0.556
Age	0.63	0.80	0.431
OSA-18 score	0.26	0.11	0.016
Intercept	–7.11	—	—

*Overall model: $R = 0.50$, $R^2 = 25\%$, $P = 0.007$.
†Size is graded as 1 for 0% to 25% obstruction, 2 for 26% to 50%, 3 for 51% to 75%, and 4 for 76% to 100%.

minutes (range ~2-12 minutes). Responses for the 20 individual survey items (questions) are shown in Table 2. The domain with the highest frequency of reported symptoms was sleep disturbance (items 1-4), followed by caregiver concerns (items 17-20) and physical symptoms (5-9). The range of response was 1 to 7 for all items except item 8 (dysphagia), for which the highest response was 6.

Caregivers reported (Table 2) that children often spent most or all of their time with loud snoring (69%), breathing pauses while sleeping (49%), nocturnal choking or gasping (43%), and fragmented sleep (49%). The impact of the child's symptoms on caregivers was equally dramatic, with parents often spending most or all of their time worried about their child's general health (32%), concerned whether their child was getting enough air at night (54%), or frustrated about their child's OSA symptoms (26%). Mouth breathing and nasal symptoms were the most common physical symptoms, but dysphagia was infrequent. Emotional distress (items 9-12) and daytime problems (items 13-16) were the domains with the lowest median item scores.

All 20 survey items had excellent test-retest reliability and internal consistency (Table 3). Construct validity was suggested by fair-to-good correlation between the sleep disturbance and caregiver concern domain items and the RDI, which were all statistically significant except for item 4, fragmented sleep. This item, however, did show significant correlation with adenoid size, suggesting it was a valid question. Mouth breathing (item 5) showed an expected correlation with adenoid size, and dysphagia (item 8) had weak correlation with tonsil and adenoid size. Although items 6 and 7 had weak correlation with objective measures, we elected to retain them because they are important symptoms that might not necessarily correlate with adenotonsillar size (eg, small adenoids can have high concentrations of core pathogenic bacteria).

As expected, the poorest correlations with objective external measures were observed for items in the emotional distress and daytime function domains (Table 3). Items 12 and 16 were eliminated from the survey because they showed low problem rates (about 70% of caregivers reported no problem for each) and trivial correlation with all 3 validity measures (RDI, tonsil size, adenoid size). Items 9, 10, 11, and 13 were retained because they had significant correlations with at least 1 of the validity measures. Items 14 and 15 were retained because they have been described frequently in the OSA literature and are important components of OSA-related quality of life (even if the association with adenotonsillar size is weak).

The survey after the rejection of items 12 and 16 was renamed the OSA-18 (Fig 1). Validity of the OSA-18 domains is shown in Table 4. All of the domains had significant correlation with at least 1 of the external measures, except for daytime function. Sleep disturbance and caregiver concerns had the strongest associations with the RDI. A significant association was noted between emotional distress and adenoid size ($R = 0.36$), suggesting that nasal obstruction may adversely affect child well-being. Although daytime function showed poor correlation with the external measures, this was not unexpected given the lack of significant association previously noted for 2 of the 3 items composing the domain.

The relationship between the OSA-18 summary score and RDI remained significant when adjusted for potential confounding factors (Table 5). Tonsil size was the only other significant factor identified; the relationship with adenoid size, BMI, and child age was not significant in multivariate analysis. The regression model in Table 5 predicted 25% of the variability in RDI levels and was statistically significant ($P = 0.007$).

The median OSA-18 survey score was 70 (range 23-107), with upper and lower quartiles of 84 and 51,

Date:__/__/____

OSAS Quality of Life Survey (OSA-18) Name:_____

For each question below, please circle the number that best describes how often each symptom or problem has occurred during the past 4 weeks. Please circle only one number per question. Thank You.

	None of the time	Hardly any of the time	A little of the time	Some of the time	A good bit of the time	Most of the time	All of the time
Sleep Disturbance							
During the past *4 weeks*, how often has your child had...							
..loud snoring?	1	2	3	4	5	6	7
..breath holding spells or pauses in breathing at night?	1	2	3	4	5	6	7
..choking or made gasping sounds while asleep?	1	2	3	4	5	6	7
..restless sleep or frequent awakenings from sleep?	1	2	3	4	5	6	7
Physical Symptoms							
During the past *4 weeks*, how often has your child had...							
..mouth breathing because of nasal obstruction?	1	2	3	4	5	6	7
...frequent colds or upper respiratory infections?	1	2	3	4	5	6	7
..nasal discharge or a runny nose?	1	2	3	4	5	6	7
..difficulty in swallowing foods?	1	2	3	4	5	6	7
Emotional Symptoms							
During the past *4 weeks*, how often has your child had...							
..mood swings or temper tantrums?	1	2	3	4	5	6	7
..aggressive or hyperactive behavior?	1	2	3	4	5	6	7
..discipline problems?	1	2	3	4	5	6	7
Daytime Function							
During the past *4 weeks*, how often has your child had...							
..excessive daytime sleepiness?	1	2	3	4	5	6	7
..a poor attention span or concentration?	1	2	3	4	5	6	7
..difficulty getting up in the morning?	1	2	3	4	5	6	7
Caregiver Concerns							
During the past *4 weeks*, how often have the problems described above...							
..caused you to worry about your child's general health?	1	2	3	4	5	6	7
..created concern that your child is not getting enough air?	1	2	3	4	5	6	7
..interfered with your ability to perform daily activities?	1	2	3	4	5	6	7
..made you frustrated?	1	2	3	4	5	6	7

Fig 1. OSA-18 for children with OSAS.

respectively. Validity of the survey was suggested by significant correlation with the RDI, tonsil size, and adenoid size (Table 4). Fig 2 shows the relationship between the OSA-18 survey score and the RDI. The relationship is fair (R = 0.43), but statistically significant, and accounted for about 19% of the variance in the RDI levels.

When the RDI was categorized into 3 distinct groups (Fig 3), the OSA-18 survey score remained significantly associated (Kruskal-Wallis analysis of variance, H = 9.25, P = 0.01). The first 2 groups were statistically equivalent, the third was distinct (Newman-Keuls multiple comparison test, $P < 0.05$). On the basis of these findings, we recommend using the OSA-18 survey score as follows: scores less than 60 suggest a small impact on HRQL, scores between 60 and 80 suggest a moderate impact, and scores above 80 suggest a large impact. With this clinical classification, in 20 children studied (33%) OSAS had a small impact on HRQL, in 19 (31%) it had a moderate impact, and in 22 (36%) it had a large impact.

DISCUSSION

Although OSAS has a substantive impact on a child's quality of life and caregiver concerns, some aspects of quality of life are uniquely subjective and do not correlate with objective measures such as the RDI, tonsil size, or adenoid size. This is highlighted in a recent study by Gozal.[10] The mean school grades for a group of children studied increased from C+ to B the year after adenotonsillectomy, but there was no change for the untreated group. This study demonstrates that sleep disorders can have tangible effects on cognition and emphasizes the importance of early diagnosis and appropriate medical intervention. In our study the OSA-18 was able to reliably measure the subjective aspects of OSA-related quality of life in a brief and easily administered questionnaire, making it ideal for use during patient encounters. The OSA-18 allows clinicians to better assess the full impact OSAS has on a child's life and to stratify them into appropriate treatment categories when coupled with proper clinical assessment of objective parameters such as tonsil size, adenoid size, and RDI.

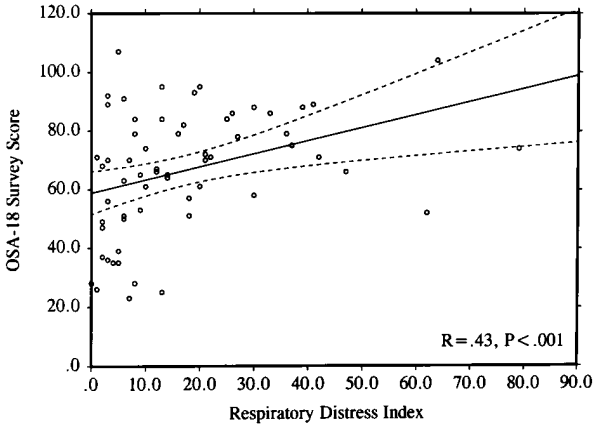

Fig 2. Scattergram showing a significant positive association of RDI with the OSA-18 survey score (Spearman rank correlation $R = 0.43$, $P < 0.001$). *Dotted lines* represent the 95% CI for the *solid regression line.*

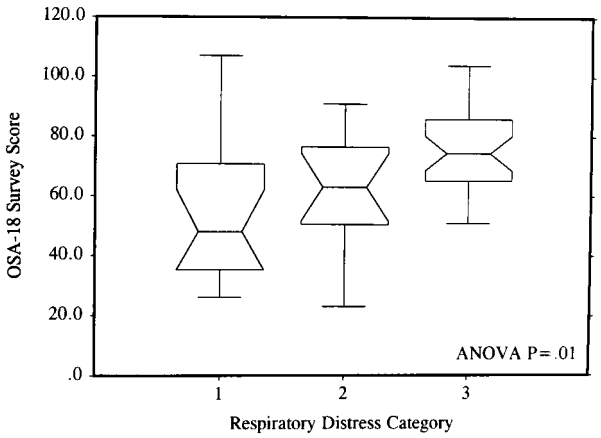

Fig 3. Notched box plot showing the distribution of OSA-18 survey scores for each respiratory distress category (Kruskal-Wallis analysis of variance, $P = 0.01$). Category 3 is severe OSAS, category 2 is moderate OSAS, and category 1 is none or mild OSAS. Each box is limited by the 25th and 75th percentiles, with extension lines indicating the 10th and 90th percentiles. The notch shows the approximate 95% CI about the median (waist).

This prospective study has several study strengths that allowed the collection of sound and consistent data. Because it was protocol driven, data were collected exclusively by the principal investigator to ensure consistency. Each subject underwent NAP polysomnography, retest questionnaires, a history, and a physical examination; also of note, each subject had fiberoptic nasopharyngeal evaluation of adenoid size for direct evaluation of the nasopharynx. The low administrative burden associated with the OSA-18 and the speed with which parents could complete it allowed it to be administered unobtrusively during patient encounters.

Our study has several limitations. The modest sample size does not allow us to distinguish whether there are quality-of-life differences among younger versus older children. Additional research is necessary to thoroughly address this question. Presently there is no consensus in pediatric quality-of-life research about the suitability of including caregiver concerns in a given instrument. Although we consider caregiver concerns to be an important and valid component of overall quality-of-life impact, readers who differ can easily exclude this domain and its associated items from the OSA-18 if they desire.

The sleep studies from which the RDIs were calculated were NAP studies that lasted approximately 90 minutes, as opposed to all-night polysomnograms. Conceivably there could have been differences in the RDIs obtained from each because the NAP study might not have sampled a representative slice of the sleep disturbance. This point is important because the RDI was one of the variables used in determining the validity of the OSA-18. Portable sleep apnea devices have proven validity in evaluating OSAS. In a 1995 study by Man and Kang,[11] a portable sleep apnea–monitoring device was compared with a standard polysomnogram. The overall accuracy of the device was calculated to be 92.3%, with a sensitivity of 85.7% and specificity of 94.7%. Portable systems provide a convenient, timesaving system with which to make accurate assessment of the severity of sleep apnea.

The subjects studied were from the immediate areas surrounding the study hospitals, which were situated in central Brooklyn, NY. Most subjects were black children of low socioeconomic status on public assistance. Socioeconomic status as well as the child's access to regular medical care could make our study population unique, making generalizability of the study results somewhat more difficult.

Finally, the correlations we observed between OSA-18 scores and external measures (Table 4) were modest, particularly for the domains of emotional distress and daytime function. Given the multitude of factors that affect quality of life, however, we would not expect more than modest correlations to occur. The overall correlation of the OSA-18 score with RDI is statistically and clinically significant ($R = 0.43$) and does explain nearly 20% of the variance observed. Unfortunately, there is no presently accepted gold standard criterion of quality-of-life impact for OSAS against which to compare the OSA-18.

The OSA-18, because of its ease of administration, reliability, and validity, is a practical means of office-

based determination of quality-of-life impact from OSAS. The traditional variables of adenotonsillar size and RDI do not reliably correlate with the subjective impact of quality of life and fall short in unveiling the true picture of the disease process. Our results represent the first attempts to validate a disease-specific quality-of-life survey for OSAS against RDI and other objective measures, and they are considered a starting point for further research, not a definitive statement about these relationships. Further studies are planned to assess the evaluative performance of the OSA-18 after various medical and surgical interventions. We hope future research will lead to a more standardized and effective treatment of OSAS in children.

REFERENCES

1. Rosenfeld RM, Green RP. Tonsillectomy and adenoidectomy: changing trends. Ann Otol Rhinol Laryngol 1990;99:187-91.
2. Piccirillo JF, White DA, Schechtman KB, et al. Development of the OSA patient oriented severity index [abstract]. Fourth World Congress on Sleep Apnea, San Francisco, (CA); Oct 4, 1994.
3. Guyatt GH, Patrick DL. Measuring health-related quality of life. Ann Intern Med 1993;118:622-9.
4. Litwin MS. How to measure survey reliability and validity. Thousand Oaks (CA): SAGE Publications; 1995.
5. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. Oxford: Oxford Medical Publications; 1995.
6. Juniper EF, Guyatt GH, Willan A, et al. Determining a minimal important change in a disease-specific quality of life questionnaire. J Clin Epidemiol 1994;47:81-7.
7. Gliklich RE, Metson R. Techniques for outcomes research in chronic sinusitis. Laryngoscope 1995;105:387-90.
8. Brodsky L. Modern assessment of the tonsils and adenoids. Pediatr Clin North Am 1989;36:1551-69.
9. Gustafson TL. TRUE EPISTAT. 5th ed. Richardson (TX): Epistat Services; 1994.
10. Gozal D. Sleep-disordered breathing and school performance in children. Pediatrics 1998;102:616-20.
11. Man GCW, Kang BV. Validation of a portable sleep apnea monitoring device. Chest 1995;108:388-93.