Characteristics of Obese Children Aged 1–4 Years at a Referral Clinic

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Objective: To describe characteristics and indicators of nutritional status of young, obese children.

Study Design: Medical records of 135 children aged 1–4 years seen in an urban referral setting between January 2000 and June 2006 were reviewed. Characteristics associated with severe obesity [percent ideal body weight (%IBW) ≥160%] were determined. Relationships between %IBW, weight-for-height Z score (WHZ), body mass index (BMI) and BMI Z score (BMIZ) were evaluated. Receiver operating characteristic analyses evaluated BMI values classifying severe and moderate (140–159% IBW) obesity.

Results: Children were: 41% male, 71% Hispanic, 76% Medicaid/uninsured, 64% ever breastfed, had median BMI of 25.0 kg/m^2 and median %IBW of 159. Fifty-two percent of mothers had BMI ≥30 kg/m^2. Severely obese children more frequently had an obese mother, birthweight ≥4 kg, were older, male, never breastfed and reported higher juice intake. WHZ and BMIZ were lowest at 4 years; BMI and %IBW were lowest at 1 year. %IBW and BMI were highly correlated. BMI ≥22.2 kg/m^2 indicated moderate obesity (sensitivity=0.90, specificity=0.93), and BMI ≥25.0 kg/m^2 indicated severe obesity (sensitivity=0.97, specificity=0.92).

Conclusion: Few current health behaviors and many family or past risk factors were associated with degree of obesity. %IBW and BMI may be the most useful nutritional status measures to track progress in young, obese children.

Key words: children/adolescents ■ referral ■ treatment ■ body mass index ■ body weight

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INTRODUCTION

In 2004, 13.9% of U.S. children aged 2–5 years were obese [body mass index (BMI) ≥95th percentile for age], which is a 35% rise (from 10.3%) in approximately 5 years.[1] Specific samples of children have reported even higher prevalence; among children aged 2–5 years presenting to community health centers, 22% were obese,[2] as were 24% of Chicago school children aged 3–5 years.[3]

Thus, it comes as no surprise that infants and young children are presenting to referral centers for evaluation and treatment of obesity. Past studies that describe or evaluate outcomes among children attending nutrition referral settings include few, if any, very young children.[4-11] Because even young obese children are at high risk for persistence of obesity,[12] clinical information on their characteristics and health behaviors can be used to guide care of such children in any clinical setting.

Clinical monitoring and interpretation of nutritional status using anthropometric measures (i.e., comparing child weight in relationship to height) in young children can be challenging. Age- and gender-specific BMI curves for children ≥2 years are well established,[13] but are lacking for younger children. For children aged 1–4 years, weight-for-height reference curves can be used. Conducting an accurate anthropometric-based follow-up assessment of the very young overweight child may be challenging due to difficulties determining and applying age- and gender-adjusted nutritional status interpretations that will allow comparisons across various ages.

An established alternative that allows nutritional status interpretation across ages is to evaluate degree of obesity by calculating the percent ideal body weight for height (%IBW).[14] This measure has been used in past evaluations of nutrition referral clinics[4,5] and in recent studies that include very young children.[6] Two frequently used methods to calculate %IBW are the Moore[15] and the McLaren methods.[14] In the Moore method, ideal weight is considered to be the weight at the same standard deviation from the mean as height-for-age. For example, a 3-year-old boy at the 90th percentile of height-for-age and 90th percentile weight-for-age would be considered

at 100% of Moore ideal weight, while having a BMI of 16.6 kg/m^2 and BMI percentile of 69%. This same child would be 106% IBW by the alternative McLaren method. The McLaren method involves applying the following steps: 1) determine the age at which the child would be at the 50th percentile height-for-age; 2) determine the 50th percentile weight for that age (ideal weight); and 3) compute %IBW by dividing actual weight by ideal weight. Thus, the McLaren method yields a %IBW that is the ratio of actual body weight to the median weight-for-height age.

Various %IBW cut-points to classify severity of overweight have been used.[4-6,16] A child at 120% IBW is generally accepted as being at the start of a concerning weight in relationship to height.[16]

This study aims to: 1) better understand characteristics of a diverse sample of obese children aged 1–4 years presenting to a referral clinic for weight management, and 2) to compare the performance of methods to interpret nutritional status in these children.

METHODS

Subjects

A retrospective medical review of initial visits of children aged 1–4 years seen at the nutrition evaluation clinic (NEC) at Children's Memorial Hospital between January 2000 and June 2006 for management of overweight was conducted. Eligible children were those with %IBW ≥120%, who had height measured at a first visit and were without severe medical conditions. Additionally, to omit children with unusual, undiagnosed conditions, analyses were additionally limited to those with height-for-age ≥5th percentile. The Children's Memorial Hospital institutional review board approved this study.

The NEC is a multidisciplinary clinic meeting 2 afternoons each week that includes physicians, dietitians, physical therapists and a social worker. It provides family-centered care based on a standard set of guidelines, which are individually tailored according to family needs during visits. Usual clinic recommendations include: avoidance of sweetened beverages; ≤8 ozs of juice/day; stopping the bottle by 18 months of age; avoiding television viewing at meal times; limiting television viewing to 1–2 hours/day; and promoting structure, including bedtime by 9 PM (or earlier). At the initial visit, data are gathered on child and family health history, child's dietary practices (daily beverage intake, 24-hour food recall, family patterns and child restrictions related to foods), and television viewing practices (usual hours/day on weekdays and weekend days, use of television at mealtimes). Children's measurements are obtained while wearing hospital gowns and without shoes. Weight measurements (to nearest 0.01 kg) are obtained by clinic staff members according to hospital protocols using digital scales. Children are measured to the nearest 0.1 cm using either a recumbent infant length board for children <2 years or a stadiometer affixed to the wall for older children.

Data

Data on child and family were abstracted from standardized paper charting forms used in the NEC. Information gathered about the family included: demographics, family history and parent self-reported weight and height. Information on the child included: medical history, physical findings and measurements, diet history and feeding habits, television viewing practices and usual bedtime.

Analysis

Data were analyzed using SPSS® for Windows®, version 15.0 (SPSS Inc., Chicago, IL). Significance was set at $p<0.05$.

Two software programs were used to interpret nutritional status. First, EpiInfo (National Center for Health Statistics, Centers for Disease Control and Prevention, Atlanta, GA, 2004) was applied to provide weight-for-age, height-for-age and weight-for-height percentiles and, weight-for-height Z score (WHZ), BMI and BMI Z-score (BMIZ) interpretations. Second, the Health Indicators Analyzer (© 2003, Children's Memorial Hospital, Chicago, IL), which uses Centers for Disease Control and Prevention 2000 growth chart interpretations[17] and the McLaren method,[14] was applied to provide %IBW interpretations.

Children were grouped into mild (120–139% IBW), moderate (140–159% IBW) and severe (≥160% IBW) obesity categories.[16] Chi-square and Fisher's exact tests were used to examine associations with severe obesity.

Data distributions were examined and nutritional status indicators were normally distributed within age categories. However, when the entire sample was considered, %IBW, WHZ and BMIZ were not normally distributed. Thus, analysis of variance was used to examine differences between ages, while relationships between BMI and the other nutritional status indicators were examined using Spearman's correlation.

Receiver-operating characteristic (ROC) analyses were used to evaluate how well BMI, WHZ and BMIZ (for children aged 2–4 years) identified children with severe and moderate obesity. ROC analyses plot the true-positive rate (sensitivity) as a function of the false-positive rate (1-specificity) for various cut-points to allow evaluation of the overall accuracy of the test at various cut points. The ROC plot point closest to the upper left corner represents the most accurate point in the relationship.[18] A high area under the ROC curve (AUC) indicates better performance of the measure. For evaluation of values to identify severe obesity, the sample was limited to children with moderate and severe obesity. For evaluation of values to identify moderate obesity, the

Table 1. Child and family characteristics (n=135)

Characteristic		n	(%)
Child			
Age	1 year	18	(13)
	2 years	32	(24)
	3 years	47	(35)
	4 years	38	(38)
Gender	Male	56	(41)
	Female	79	(59)
Race/ethnicity*	Hispanic	87	(71)
	African American/black	11	(9)
	White	19	(15)
	Other	6	(5)
Insurance	Medicaid/uninsured	100	(74)
	Private insurance	35	(26)
Birthweight*	<4.0 kg	106	(82)
	≥4.0 kg	24	(18)
Breastfeeding duration*	Never	44	(36)
	<6 months	45	(37)
	≥6 months	33	(27)
Asthma	Yes	27	(20)
	No/not noted	108	(80)
History of snoring*	Yes	77	(59)
	No	54	(41)
Acanthosis nigricans*	Present	39	(31)
	Absent	85	(69)
Obesity classification	Mild (120–139% IBW†)	29	(21)
	Moderate (140–159% IBW)	39	(29)
	Severe (≥160 % IBW)	67	(50)
Health Behaviors			
Usual bedtime*	9 PM or earlier	39	(36)
	After 9–10 PM	36	(34)
	After 10 PM	32	(30)
Television on at mealtimes*	Always/often	38	(35)
	Occasionally/never	72	(65)
Milk type*	Whole	11	(9)
	2%	85	(66)
	1%/skim	33	(26)
Television, hours/day*	<2 hours	24	(25)
	2–3 hours	50	(51)
	≥4 hours	23	(24)
Juice, oz/day*	None	33	(25)
	1–8 oz/day	44	(33)
	≥9 oz/day	55	(42)
Sweet beverages, oz/day*	None	56	(49)
	Any	58	(51)
Family			
Mother's body mass index group*	<25 kg/m^2	21	(20)
	25–29 kg/m^2 (overweight)	30	(28)
	≥30 kg/m^2 (obese)	55	(52)
Father's body mass index group*	<25 kg/m^2	11	(13)
	25–29 kg/m^2 (overweight)	33	(39)
	≥30 kg/m^2 (obese)	40	(48)
Obese parent or sibling*	Yes	88	(70)
	No	38	(30)
Parent or sibling with diabetes*	Yes	18	(14)
	No	111	(86)

* These strata add to <135 due to missing data; † IBW: Ideal body weight

sample was limited to children with mild and moderate obesity.

RESULTS

Records of 151 children aged 1–4 years were reviewed, and data of 135 (89%) analyzed. Exclusions were for medical conditions (n=13), including myelomeningocoele (n=4), severe anemia conditions (n=3), Prader-Willi syndrome (n=1), Down syndrome (n=1), brain malformations (n=3), severe pervasive developmental delay (n=1), height-for-age <5th percentile (n=2) and no height measured at visit (n=1).

Characteristics of Children and Families

Many children were Hispanic and Medicaid recipients or uninsured; many parents were overweight or obese (Table 1). Half of the children were in the severe obesity category of ≥160% IBW (Table 1). Most children (77%, 90/116) resided with 2 parents. Most fathers were employed (93%, 100/108), as were nearly ½ of mothers (46%, 56/122). Approximately ⅓ of children (35%, 44/124) attended school and 49% (66/135) received child care from someone other than a parent.

Growth Interpretations

Children were generally at the upper limits of weight-for-age percentile (median 100%, range 97–100%), weight-for-height percentile (median 100%, range 98–100%), and height-for-age percentile (median 90%, range 8–100%). Children had median BMI of 25.0 kg/m^2 and median 159% IBW. Among children aged 2–4 years, median BMI percentile was 100% (range 97–100%). Children's WHZ and BMIZ were lowest at age 4 years, while %IBW and BMI were lowest at age 1 year (Table 2). Among the children aged 2–4 years, 12% (14/117) had a BMIZ ≥5.0.

Associations with Severe Obesity Status

Associations of presenting characteristics with severe obesity status are shown in Table 3. Other characteristics examined (father's BMI group, diabetes in immediate family, child snoring, bedtime, television at meals, television time, sweet beverages) were not significantly associated with severe obesity status (data not presented).

Relationships between Nutritional Status Interpretations

Figure 1 displays relationships between %IBW and WHZ, BMI and BMIZ. BMI and %IBW were most closely related (n=135, p<0.001, Spearman's rho=0.977), while %IBW was significantly, but less closely, related to WHZ (n=135, p<0.001, Spearman's rho=0.544) and BMIZ (n=117, p<0.001, Spearman's rho=0.765). ROC analyses were used to explore relationships between severe and moderate obesity cut-points and other nutritional status indicators (Figure 2). For both %IBW cut-points, AUC is higher for BMI than for WHZ or BMIZ (Table 4).

DISCUSSION

Major Findings

This is the first paper to focus evaluation exclusively on young, obese children presenting to a referral setting for obesity-related care. Our urban sample included primarily Hispanic and low-income families. Such children were at weight-for-age and weight-for-height extremes. Weight-for-age Z score and WHZ were lowest for oldest children, while %IBW and BMI were lowest for youngest children. Height-for-age Z scores did not significantly vary by age, and BMIZ was highest for children aged 3 years.

A prior evaluation of children presenting for obesity care to our clinic 10 years ago included 26 preschool children presenting at an average of approximately

Table 2. Growth interpretations by child age

	Mean (SD) by Child Age								
	1 Year		2 Years		3 Years		4 Years		
Growth Interpretation	(n=18)		(n=32)		(n=47)		(n=38)		p*
Weight-for-age Z score	3.7	(0.7)	3.9	(1.1)	3.9	(1.0)	3.3	(0.7)	0.008
Height-for-age Z score	1.3	(0.8)	1.4	(0.9)	1.2	(1.0)	1.4	(0.9)	0.927
Weight-for-height Z score	4.1	(0.8)	3.9	(1.0)	3.6	(0.8)	2.8	(0.4)	<0.001
BMI Z score	NA†	NA	3.8	(1.0)	4.3	(1.2)	3.4	(0.8)	<0.001
Percent ideal body weight	142	(12)	157	(21)	174	(31)	166	(27)	<0.001
Body mass index, kg/m^2	23.9	(2.4)	24.7	(3.4)	27.0	(4.8)	25.7	(4.1)	0.017

* Analysis of variance tests; † NA: Not applicable

175% IBW,[4] which is most similar to the 3- and 4-year-old children in this sample. Few other recent studies of children in referral obesity treatment settings include very young children and those that do combine them with children of older ages.[19-21]

Child Characteristics

Many of the children in our sample had characteristics commonly found in obese children.[22] However in the group studied, there were more girls than boys. National obesity rates for children aged 2–5 years are similar for boys and girls overall and show a slight preponderance of boys among the Mexican-American young participants.[1] Most children in our sample had a family member who was obese, and severely obese young children more commonly had an obese mother.[11,23] A focus on improving health habits of the entire family may be an important step toward improving health of young children, as has been found for older children.[24,25]

While breastfeeding is a protective factor in obesity prevention efforts,[26] 42% of children who breastfed for ≥6 months were severely obese, indicating the importance of other factors in weight gain of young children. Many children had late bedtimes and snoring, indicating a need for further assessments to evaluate sleep patterns and sleep disturbances.[27] Acanthosis nigricans was not unusual, and its presence was associated with severe obesity. This physical finding may have increased primary care clinician awareness of the obesity diagnosis[28] and, thus, precipitated a referral.

We evaluated the health behavior items that had been the focus of the clinical interviews and used the NEC usual recommendations to guide how we grouped responses for analyses. Of the health behavior items we assessed, juice intake was the only health behavior risk associated with obesity severity. Our experience is that many families reported having adopted healthier behaviors between the time of referral and the NEC visit,

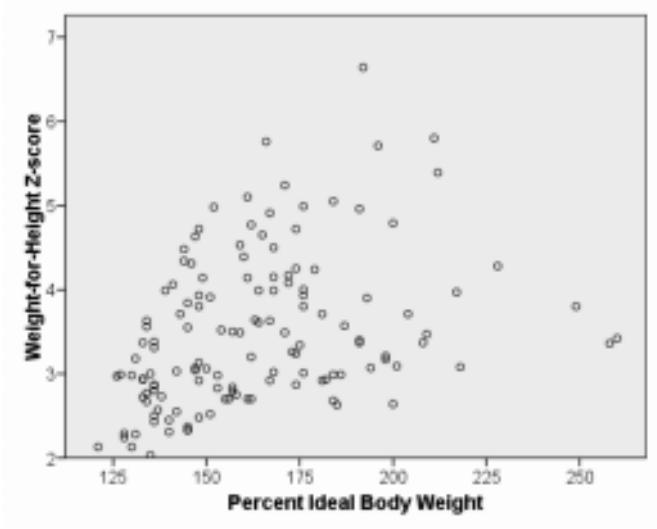
Table 3. Characteristics associated with severe obesity (≥160% ideal body weight)

			With Severe Obesity*		
Characteristic		**Total n***	**n**	**(%)**	**p**
Age	1 year	18	2	(6)	0.001
	2 years	32	15	(17)	
	3 years	47	31	(29)	
	4 years	38	19	(48)	
Gender	Boy	56	33	(61)	0.030
	Girl	79	34	(41)	
Race/ethnicity†	Hispanic	87	48	(55)	0.028‡
	Black/African American	11	7	(64)	
	White	19	4	(21)	
	Other	6	2	(33)	
Insurance	Medicaid/uninsured	100	57	(57)	0.004
	Private insurance	35	10	(29)	
Child birthweight†	<4.0 kg	106	47	(44)	0.019
	≥4.0 kg	24	17	(71)	
Breastfeeding duration†	Never	44	28	(64)	0.037
	<6 months	45	17	(39)	
	≥6 months	33	14	(42)	
Asthma	Yes	27	19	(70)	0.016
	No/not noted	108	48	(44)	
Acanthosis nigricans†	Present	39	28	(72)	0.002
	Absent	85	36	(42)	
Juice, oz/day†	None	33	15	(45)	0.037
	1–8 oz/day	44	16	(36)	
	≥9 oz/day	55	34	(62)	
Mother's body mass index group†	<25 kg/m^2	21	9	(43)	0.02
	25–29 kg/m^2 (overweight)	30	10	(33)	
	≥30 kg/m^2 (obese)	55	35	(64)	
Obese parent or sibling†	Yes	88	53	(60)	0.001
	No	38	11	(29)	

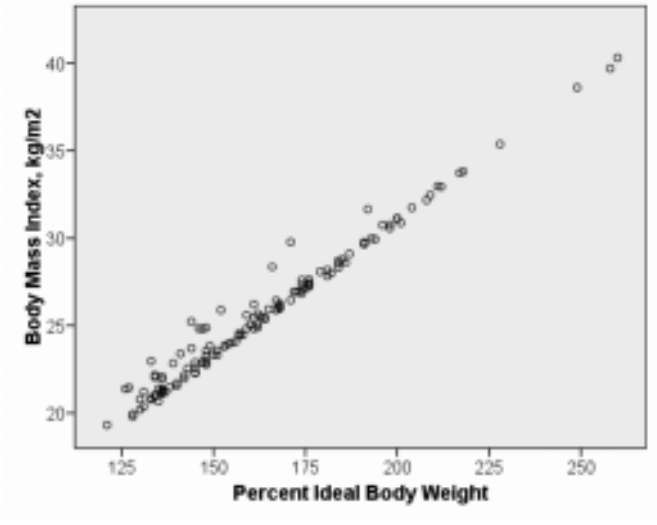
* Row counts and percents; † These strata add to <135 due to missing data; ‡ Fisher's exact test

Figure 1. These figures display the relationship between percent ideal body weight (%IBW) and weight-for-height Z score (A), BMI (B) and BMI Z score (C). Figure C only includes children aged 2–4 years.

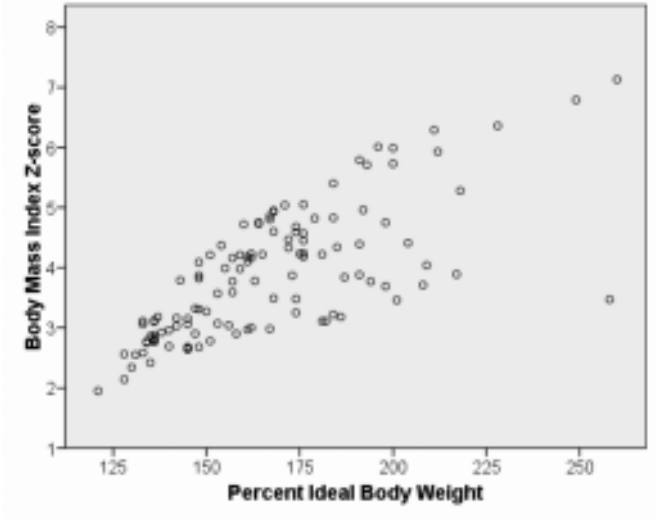
A.



B.



C.



which was generally several months later. Nevertheless, we find such assessments useful to focus counseling and have developed and implemented parent-completed assessment forms for the clinic (www.childrensmrc.org/pprg/resources/obesity) that gather and expand on the information presented here. Future research must be done to decipher which, if any, behavioral risk factor modifications improved outcomes for children treated at referral centers such as ours.

Nutritional Status Interpretations

We applied the McLaren method for %IBW calculations. This method does not account for changes in body composition that are known to occur as children progress in age. However, we found the McLaren method %IBW interpretations to be closely correlated with BMI. Thus, %IBW and BMI may be useful ways to assess clinical outcomes of young children like those seen at our clinic. In our clinical experience, we find that calculating the McLaren %IBW facilitates clinician and parent understanding of the magnitude of excess weight and enhances tracking of child progress. Categorization by BMI percentile or weight-for-height percentile in samples such as this one is not useful clinically, because the children are all at the high extreme of the various growth interpretation measures.

Our data indicate that because of its close relationship with %IBW, BMI may be a useful measure of nutritional status to assess obesity severity in young children and may prove to be useful tool for tracking progress. Remembering cut-points of BMI=25.0 kg/m^2 to classify severe obesity and BMI=22.2 kg/m^2 to classify moderate obesity for young children may be useful clinically. How-

ever, practically speaking, the BMI cut-point of 22.0 kg/m^2 for classification of moderate obesity worked nearly as well (sensitivity 0.92, specificity 0.83) and may be easier to remember. In a community sample of kindergarten children across a wider weight spectrum, BMI was an optimal way to assess adiposity over a 9-month period.[29]

Z-score interpretations did not fit as well with obesity severity classifications in the ROC analyses. Thus, their use in describing samples that include preschool children may be problematic.

Figure 2. These receiver operating characteristic curves plot the ability of BMI and weight-for-height Z score to evaluate %IBW cut-points for severe obesity (A) and moderate obesity (B) and the ability of BMI and BMI Z score to evaluate %IBW cut-points for severe obesity (C) and moderate obesity (D). Figures C and D only include children aged 2–4 years.

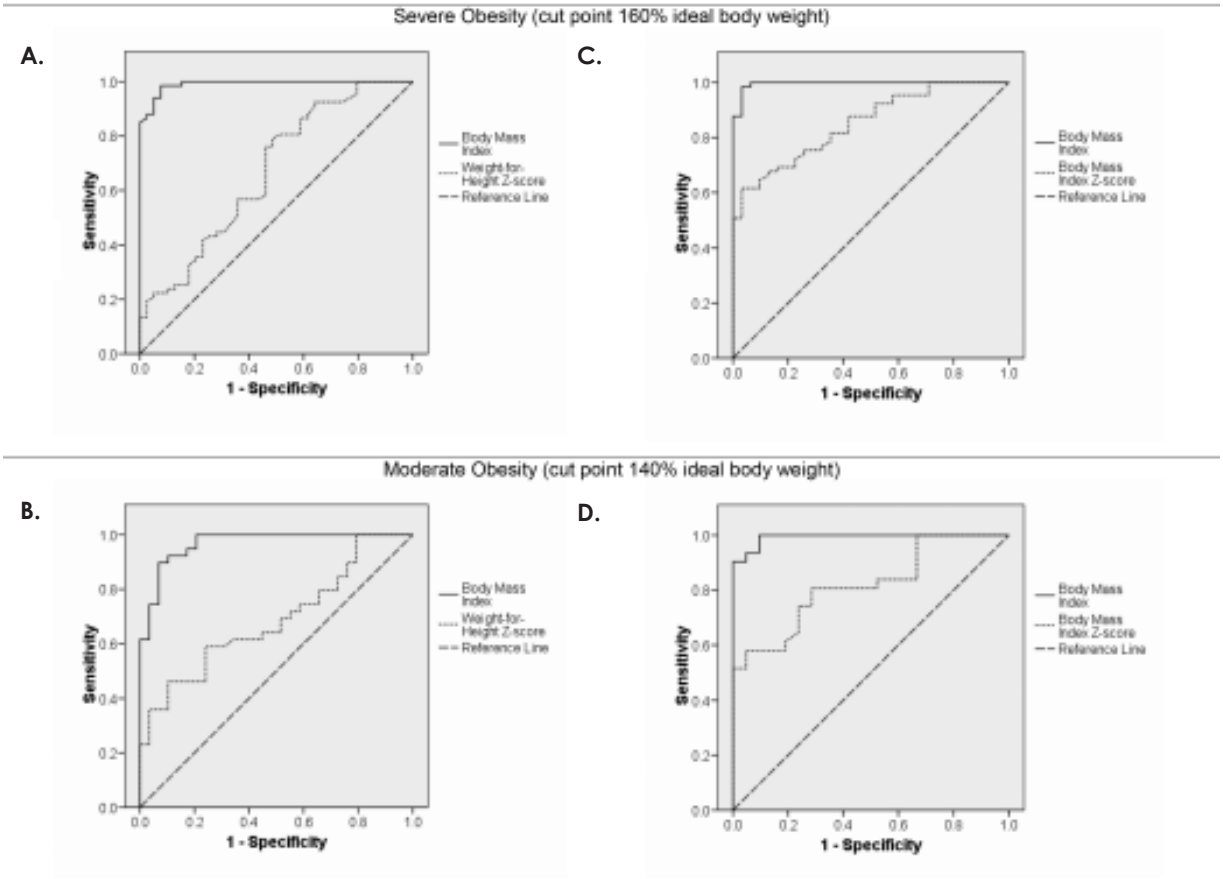


Table 4. Performance of receiver operating characteristic analyses to evaluate nutritional status indicator performance in relationship to obesity category (defined by percent ideal body weight cut-points)

Nutritional Status Indicator	n	AUC*	(95% CI)	Indicator Value	Sensitivity	Specificity
Severe Obesity (Cut-Point=160% IBW)						
Body mass index	106	0.99	(0.98, 1.00)	25.0	0.97	0.92
Weight-for-height Z score	106	0.70	(0.56, 0.78)	3.0	0.84	0.41
Body mass index Z score	96†	0.85	(0.78, 0.93)	4.0	0.62	0.85
Moderate Obesity (Cut-Point=140% IBW)						
Body mass index	68	0.97	(0.93, 1.00)	22.2	0.90	0.93
Weight-for-height Z score	68	0.69	(0.56, 0.81)	2.5	0.85	0.28
Body mass index Z score	52†	0.82	(0.71, 0.93)	3.0	0.71	0.76

IBW: Ideal body weight; * AUC: Area under curve; † Children aged 2–4 years only

LIMITATIONS

There are several limitations to this study. First, data were from medical record documentations in the midst of a busy practice. However, because the clinic uses a standard documentation form, many data elements were available for most of the children. Second, because families are referred, their dietary and behavioral practices at the initial NEC visit may not necessarily reflect the past conditions and health behaviors that resulted in the excessive weight gain patterns. Third, the children in the sample are not representative of overweight children but are those whose weight concerns had been recognized and who had completed a referral visit.

CONCLUSIONS

Children are presenting for obesity treatment at very young ages, and many are severely obese. Family risk factors, such as maternal BMI, were significantly associated with obesity severity. Among health behaviors clinically assessed at an initial visit, only excess juice intake was significantly associated with obesity severity. It is less clear how other clinically assessed health behaviors are associated with obesity severity. Obtaining a detailed family history and a history of past health behaviors may be needed to more completely understand factors that contributed to severe obesity in children presenting in referral settings.

We found %IBW and BMI to be closely correlated in our sample of obese young children, while WHZ and BMIZ less optimally correlated with %IBW. BMI and %IBW appear to be more useful than Z-score interpretations to clinically track nutritional status in obese very young children.

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