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Health-Related Quality of Life of Overweight and Obese Children

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Context The negative effects of childhood overweight and obesity on quality of life (QOL) have been shown in clinical samples but not yet in population-based community samples.

Objective To determine relationships between weight and health-related QOL reported by parent-proxy and child self-report in a population sample of elementary school children.

Design, Setting, and Participants Cross-sectional data collected in 2000 within the Health of Young Victorians Study, a longitudinal cohort study commenced in 1997. Individuals were recruited via a random 2-stage sampling design from primary schools in Victoria, Australia. Of the 1943 children in the original cohort, 1569 (80.8%) were resurveyed 3 years later at a mean age of 10.4 years.

Main Outcome Measures Health-related QOL using the PedsQL 4.0 survey completed by both parent-proxy and by child self-report. Summary scores for children's total, physical, and psychosocial health and subscale scores for emotional, social, and school functioning were compared by weight category based on International Obesity Task Force cut points.

Results Of 1456 participants, 1099 (75.5%) children were classified as not overweight; 294 (20.2%) overweight; and 63 (4.3%) obese. Parent-proxy and child self-reported PedsQL scores decreased with increasing child weight. The parent-proxy total PedsQL mean (SD) score for children who were not overweight was 83.1 (12.5); overweight, 80.0 (13.6); and obese, 75.0 (14.5); $P<.001$. The respective child self-reported total PedsQL mean (SD) scores were 80.5 (12.2), 79.3 (12.8), and 74.0 (14.2); $P<.001$. At the subscale level, child and parent-proxy reported scores were similar, showing decreases in physical and social functioning for obese children compared with children who were not overweight (all $P<.001$). Decreases in emotional and school functioning scores by weight category were not significant.

Conclusion The effects of child overweight and obesity on health-related QOL in this community-based sample were significant but smaller than in a clinical sample using the same measure.

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In 2003, Schwimmer et al[1] reported in *JAMA* that "severely obese children and adolescents have lower health-related QOL [quality of life] than children and adolescents who are healthy and similar QOL as those diagnosed as having cancer." Child overweight and obesity are now so endemic that many countries are reporting prevalences of 25% or higher.[2] If the associations seen in the study by Schwimmer et al remain for overweight and obese children across the population, then a substantial proportion of children and adolescents could be experiencing major reductions in health-related QOL due to their weight.

Health-related QOL refers to the subset of QOL directly related to an individual's health,[3] which as defined by the World Health Organization includes physical, mental, and social well-being.[4] During the last decade, new instruments measuring health and well-being have been developed that are suitable for epidemiological studies. In adults,[5] adolescents,[6] and children,[7] these measures have been shown to discriminate among population groups known to have different levels of health. Because it is subjective, health-related QOL should be assessed whenever possible from the participant's (ie, the child's) perspective. Nonetheless, the parent-proxy's perspective about the child's health is also important because a parent's perspective is likely to be a strong driver of health service use.[8] However, few studies have compared parents' and children's perspective of how health varies according to weight and none have been performed in community samples of elementary school children. This largely reflects the absence of parallel parent and child measures until recently.[6]

If childhood overweight and obesity lead to a significant reduction in health-related functioning, this could have population ramifications beyond the known complications associated with concurrent and future cardio-

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vascular, endocrine, and psychosocial morbidity.[9-13] To date, only 2 population-based studies relating health and well-being to child body mass index (BMI)[13] have been published, both suggesting a less striking relationship with weight status than that reported by Schwimmer et al.[1] Both studied children of elementary school age and used the parent-reported Child Health Questionnaire as their measure of a child's health-related QOL. Parents of children in the "at risk for overweight" category in the US study and the comparable "overweight" category in the Australian study reported similar scores to normal-weight children on nearly all Child Health Questionnaire scales. For children in the "overweight" category in the US study and the comparable "obese" category in the Australian study, parents were more likely to report reduced scores on some scales, but even for these heaviest groups many domains appeared unaffected. However, neither study included children's reports of their own health because the Child Health Questionnaire does not have a child self-report suitable for this age group.

The PedsQL is a short survey instrument assessing physical, emotional, social, and school functioning. Strengths of the PedsQL include the availability of parallel reports by a parent-proxy and a child and relatively low ceiling effects, which occur if most participants achieve a near perfect score on a questionnaire. Using this measure, we hypothesized that PedsQL scores reported in parallel by elementary school children and parents in a large Australian community-based sample would decrease with increasing weight. In exploratory analyses, we examined whether age, sex, and socioeconomic status modify apparent effects of overweight and obesity. Finally, hypothesizing that major effects will be limited to more severe degrees of overweight that may not coincide with current empirical BMI cut points, we explored possible relationships between health-related QOL and BMI to look for evidence of a threshold effect.

METHODS

Design and Sample

The Health of Young Victorians Study was established in 1997. Sampling and methods have been reported in detail previously.[14] Briefly, participants were selected from the state of Victoria, Australia (population 4.69 million in 1998[15]), using a stratified 2-stage sampling design based on school education sector (government, Catholic, or independent) and school class level. For the primary school cohort, 24 schools were randomly selected with a probability proportional to size, and one class at each year level from each school was then randomly selected. The baseline response rate for students in grades kindergarten through third grade (ages 5-8 years) in 1997 was 83.2% (1943 of 2336 identified children). The achieved sample mirrored Victorian census data for age distribution, sex, ethnicity (parental county of birth), and proportion of indigenous persons.

This study draws on cross-sectional data from the follow-up conducted in 2000 when 1569 children (80.8% of the original sample of children in kindergarten through third grade) were resurveyed when in grades 3 through 6. Each child's height and weight were measured and each child and one of his/her parents completed brief written questionnaires. In 2000, the children's ages ranged between 8 and 13 years, but 99.3% were aged 9 to 12 years. Because of the small number of 8- and 13-year-olds, it was not possible to calculate meaningful mean PedsQL scores for these age groups, so only the 1456 children aged 9 to 12 years were retained in the analyses.

The study was approved by the ethics in human research committee of the Royal Children's Hospital, the Victorian Department of Education, the Catholic Education Office, and the Independent Schools Office. A parent-proxy provided written informed consent.

Measures

Children's height and weight were measured at school by trained field workers. Investigation of anthropometric reliability found no evidence of systematic bias for intra- or inter-rater comparisons. Body mass index was calculated as the weight in kilograms divided by the square of height in meters. Children were classified into 3 mutually exclusive categories of not overweight, overweight, or obese according to the sex- and age-specific cut points developed by the International Obesity Task Force.[16] The cut points were derived from the results of nationally representative surveys of childhood BMI conducted in 6 different countries. For each survey, centile curves were drawn that at age 18 years passed through the BMI cut points for overweight and obesity (25 and 30), and the curves were then averaged to provide age- and sex-specific cut points from 2 to 18 years. Furthermore, using the US Centers for Disease Control and Prevention 2000 Growth Chart data,[17] BMI was transformed to externally standardized z scores based on sex and age to adjust for right skew in the BMI distribution and physiological changes that occur in BMI with age. We used Nutstat software (EPI Info, Centers for Disease Control and Prevention, Atlanta, Ga) to calculate the BMI transformations.

Health-Related QOL

The PedsQL 4.0 is a validated 23-item questionnaire for children aged 2 to 18 years. It assesses physical, emotional, social, and school functioning, from which total, physical, and psychosocial health summary scores are derived. The best possible score on the PedsQL is 100 (range of 0-100). Near-identical parallel parent-proxy and child self-report versions are available, which were completed independently by the parents (at home) and the children (at school) in this study. Recently published US population normative data indicate high levels of internal consistency for both the self-report and parent-proxy report in 8- to 12-year-olds.[18]

Socioeconomic Status

Using population census data, the Australian Bureau of Statistics computes so-

cioeconomic indices.[19] These indices summarize the social and economic conditions of Australia by geographic area. The disadvantage index (population mean [SD] of 1000 [100]) was used in this study as a measure of neighborhood socioeconomic status with each individual assigned to a disadvantage index score based on the postal area in which he/she lived. The disadvantage index distribution for the population was then divided into 4 quartiles as equally as possible, with quartiles 1 and 4 representing the lowest and highest disadvantage indexes, respectively. As a proxy for personal socioeconomic status, maternal education was stratified into 3 categories (<11 years, 11 or 12 years with or without a diploma or trade certificate, and >12 years).

Analysis

The sample size had at least 80% power to detect differences of 5 points on each of the summary or subscale scores. Male and female differences in demographic variables were explored using χ^2 tests for categorical variables and *t* tests to compare means of continuous variables. Total, physical, and psychosocial summary and subscale scores were computed for both the parent-proxy and child self-reported PedsQL according to the manual. One-way analyses of variance were used to test for significant overall mean differences by weight category groupings. Univariate generalized linear models were used to determine the estimated marginal means of the PedsQL scales and subscales adjusting for the child's age, sex, maternal education, and disadvantage index as covariates. There were interactions between maternal education and disadvantage index but no other interactions were significant. Bonferroni tests were applied to the estimated marginal means to provide pairwise comparisons between weight categories to determine which (if any) groups most influenced any significant overall differences found. Finally, to examine possible threshold and nonlinear relationships that might cut across current overweight and obese cut points, locally weighted regression techniques were used to generate lines of best fit for the relationships between BMI *z* scores and PedsQL total, summary, and subscale scores that differed significantly by weight category; $P<.05$ was considered significant. Data were analyzed using SPSS statistical software (version 11.5, SPSS Inc, Chicago, Ill).

RESULTS

Demographic and weight characteristics of the sample are shown in TABLE 1. The sample reflects population characteristics in terms of sociodemographics, but as noted in previously published data, children retained in the cohort had a lower mean BMI at baseline than children lost to follow-up (16.9 vs 17.5; $P<.001$).[20] The mean (SD) age of the child participants was 10.4 (1.1) years (range, 9-12 years), the mean (SD) BMI *z* score was 0.50 (0.92), and the prevalences of overweight and obesity were 20.2% and 4.3%, respectively. A slightly higher proportion of females than males were classified as overweight or obese (21.3% overweight and 4.9% obese females vs 19.2% overweight and 3.8% obese males), but this difference was not significant ($P=.33$). Males and females did not differ significantly by height, weight, BMI, age in years, weight category, location of residence, disadvantage index, or maternal education; therefore, except where specified, males and females were combined for analyses.

TABLE 2 shows the mean (SD) scores for each of the PedsQL scales and subscales by weight category. Parent and child perceptions were strikingly similar, with obese children having the lowest summary and subscale scores. Parent- and child-reported physical and social functioning and total scores decreased significantly with increasing weight, as did the child self-reported psychosocial summary score ($P=.004$). Similar, although not statistically significant, trends were seen for the parent-proxy psychosocial summary score and school functioning and for parent- and child-reported emotional functioning.

Table 1. Participant Characteristics*

	No. (%) of Participants			
	Total (N = 1456)	Boys (n = 736)	Girls (n = 720)	*P* Value†
Age, y				
9	408 (28.0)	198 (26.9)	210 (29.2)	.76
10	335 (23.0)	170 (23.1)	165 (22.9)	
11	428 (29.4)	218 (29.6)	210 (29.2)	
12	285 (19.6)	150 (20.4)	135 (18.8)	
Weight category				
Not overweight	1099 (75.5)	567 (77.0)	532 (73.9)	.33
Overweight	294 (20.2)	141 (19.2)	153 (21.3)	
Obese	63 (4.3)	28 (3.8)	35 (4.9)	
Location of residence‡				
Urban	865 (60.4)	442 (61.5)	423 (59.3)	.41
Rural	567 (39.6)	277 (38.5)	290 (40.7)	
Maternal education, y‡§				
≤10	300 (25.1)	141 (23.9)	159 (26.3)	.62
11 or 12	612 (51.2)	308 (52.1)	304 (50.3)	
>12	283 (23.7)	142 (24.0)	141 (23.3)	
Socioeconomic disadvantage quartile‡‖				
1	302 (25.1)	147 (24.7)	155 (25.6)	.94
2	293 (24.4)	149 (25.0)	144 (23.8)	
3	283 (23.5)	142 (23.8)	141 (23.3)	
4	324 (27.0)	158 (26.5)	166 (27.4)	

*Percentages may not equal 100% due to rounding.
†Comparisons were made using the χ^2 test, except for the disadvantage index, which used the *t* test.
‡Percentages and *P* values are not based on a total of 1456 participants.
§Maternal refers to the biological mother or principal female guardian.
‖Lowest is 1 and highest is 4.

Table 2. Parent- and Child-Reported PedsQL Total and Subscale Scores by Weight Category

	Mean (SD)					
	Whole Sample	Not Overweight	Overweight	Obese	*P* Value	Severely Obese Clinical Sample,[1] mean (SD)*
Parent total score	82.1 (12.9)	83.1 (12.5)	80.0 (13.6)	75.0 (14.5)	<.001	63.3 (19.2)
Physical summary	86.2 (15.4)	87.8 (14.3)	82.6 (17.2)	76.3 (17.6)	<.001	63.6 (24.0)
Psychosocial summary	77.1 (14.5)	77.6 (14.5)	76.1 (14.4)	73.9 (15.3)	.09	63.1 (18.6)
Emotional	75.8 (16.5)	76.3 (16.6)	74.9 (15.8)	72.6 (17.8)	.15	60.9 (21.7)
Social	84.2 (16.2)	85.2 (15.9)	82.3 (16.1)	73.5 (17.3)	<.001	67.2 (26.1)
School	79.6 (16.4)	80.1 (16.2)	78.4 (17.1)	76.6 (17.0)	.11	61.4 (21.5)
Child total score	79.9 (12.5)	80.5 (12.2)	79.3 (12.8)	74.0 (14.2)	<.001	67.0 (16.3)
Physical summary	84.9 (13.0)	85.7 (12.4)	83.5 (13.0)	77.5 (17.9)	<.001	71.0 (18.8)
Psychosocial summary	77.3 (14.1)	77.7 (14.1)	77.0 (14.0)	72.1 (14.1)	.004	64.9 (17.7)
Emotional	72.9 (17.6)	73.2 (17.5)	72.6 (17.7)	68.6 (18.5)	.09	63.2 (20.1)
Social	81.8 (16.9)	82.7 (16.7)	80.2 (16.6)	72.6 (18.2)	<.001	67.5 (25.0)
School	77.2 (15.4)	77.1 (15.4)	78.3 (15.5)	75.0 (14.5)	.19	64.1 (20.4)

*This sample had a mean (SD) body mass index of 34.7 (9.3) and *z* score of 2.6 (0.5).

Table 3. Parent- and Child-Reported PedsQL Total Scores by Weight Category, Stratified by Potential Confounding Variables

	Total No. of Respondents*	Mean (SD)				*P* Value
		Total	Not Overweight	Overweight	Obese	
Parent-Proxy Total Score						
Sex						
Male	609	81.6 (12.7)	82.5 (12.0)	79.8 (13.5)	71.0 (15.7)	<.001
Female	620	83.0 (13.2)	84.0 (13.0)	80.7 (13.7)	76.5 (12.6)	.002
Age, y						
9	355	82.4 (11.3)	82.6 (11.3)	83.4 (11.0)	74.0 (11.4)	.05
10	287	81.5 (13.6)	82.9 (13.1)	78.9 (13.2)	73.8 (18.3)	.009
11	360	82.2 (13.4)	83.9 (12.7)	77.9 (14.2)	73.3 (13.6)	<.001
12	227	83.1 (13.9)	83.7 (13.4)	82.1 (15.6)	75.1 (14.3)	.21
Maternal education, y						
≤10	298	78.2 (15.0)	79.9 (14.4)	74.5 (15.9)	70.6 (15.1)	.002
11-12	609	82.9 (11.9)	83.6 (11.6)	81.7 (12.1)	75.1 (14.7)	.002
>12	281	85.7 (10.6)	85.8 (10.9)	86.0 (9.3)	81.2 (9.5)	.56
Socioeconomic disadvantage quartile						
1	301	81.2 (13.7)	81.9 (13.9)	79.1 (13.9)	78.6 (10.5)	.28
2	288	81.6 (14.0)	83.0 (13.5)	78.6 (13.9)	70.9 (16.6)	.002
3	282	82.4 (12.2)	83.5 (11.8)	79.6 (13.1)	77.5 (11.7)	.03
4	324	84.2 (11.3)	84.6 (10.7)	84.2 (11.9)	66.3 (16.6)	<.001
Child Self-report Total Score						
Sex						
Male	734	81.0 (11.9)	81.2 (11.7)	81.1 (11.8)	75.5 (14.7)	.05
Female	718	79.5 (12.8)	80.3 (12.5)	78.2 (13.5)	74.2 (13.4)	.008
Age, y						
9	407	78.4 (12.9)	79.0 (13.1)	76.9 (12.3)	76.4 (11.3)	.37
10	335	78.9 (13.0)	79.8 (12.3)	77.0 (14.1)	73.5 (17.1)	.06
11	427	81.5 (12.0)	82.1 (11.7)	81.2 (12.4)	74.7 (12.6)	.02
12	283	82.6 (10.8)	82.6 (10.4)	83.4 (11.1)	74.7 (16.6)	.09
Maternal education, y						
≤10	300	79.3 (13.3)	80.8 (12.2)	77.0 (14.8)	70.7 (16.6)	.001
11-12	610	79.8 (12.6)	79.9 (12.8)	80.0 (11.9)	77.0 (12.5)	.57
>12	283	82.9 (10.9)	83.0 (11.2)	82.8 (9.4)	79.7 (13.0)	.77
Socioeconomic disadvantage quartile						
1	301	79.6 (12.8)	79.8 (13.2)	78.6 (11.4)	76.4 (12.2)	.62
2	293	79.7 (12.9)	80.5 (12.7)	78.1 (12.8)	75.0 (15.5)	.18
3	283	81.2 (12.7)	81.9 (12.6)	80.2 (13.2)	75.9 (11.3)	.21
4	323	80.9 (11.6)	81.3 (10.7)	80.0 (13.7)	71.2 (21.1)	.09

*Numbers may not add up to 1456 because of missing data.

Table 4. Estimated Marginal Mean PedsQL Scores by Weight Category, Adjusted for Age, Sex, Maternal Education, and Socioeconomic Disadvantage Index*

	Estimated Mean (SD)				
	Not Overweight	Overweight	Obese	F Score	*P* Value
Parent total score	83.3 (12.3)†‡	80.8 (12.3)¶	75.6 (12.3)	11.3	<.001
Physical summary	88.0 (14.4)‡§	83.5 (14.4)¶	76.5 (14.5)	20.5	<.001
Psychosocial summary	77.8 (14.2)	76.7 (14.2)	75.2 (14.2)	1.1	.35
Emotional	76.4 (16.3)	75.6 (16.3)	74.3 (16.4)	0.6	.58
Social	85.5 (15.6)‡	83.5 (15.6)¶	73.7 (15.7)	13.0	<.001
School	80.5 (15.7)	79.1 (15.7)	77.1 (15.7)	1.6	.21
Child total score	80.8 (12.2)‖	79.7 (12.2)¶	75.6 (12.3)	4.5	.01
Physical summary	85.9 (12.4)‡	84.3 (12.4)¶	79.5 (12.4)	6.7	.001
Psychosocial summary	78.2 (13.9)‖	77.3 (13.9)	73.5 (14.0)	2.6	.07
Emotional	73.6 (17.3)	72.8 (17.3)	70.5 (17.3)	0.8	.44
Social	83.1 (16.7)†‡	80.6 (16.7)¶	73.5 (16.8)	8.4	<.001
School	77.8 (15.2)	78.6 (15.2)	76.4 (15.3)	0.5	.61

*Marginal means were estimated using generalized linear models (see statistical analysis in "Methods" section). All F tests had 2 degrees of freedom.
†Significant difference between participants who were not overweight and those who were overweight: $P<.05$.
‡Significant difference between participants who were not overweight and those who were obese: $P<.001$.
§Significant difference between participants who were not overweight and those who were overweight: $P<.001$.
‖Significant difference between participants who were not overweight and those who were obese: $P<.05$.
¶Significant difference between participants who were overweight and those who were obese: $P<.05$.

Scores were lowest for children in the obese category. For illustrative purposes, the published total PedsQL scores from the clinical sample of severely obese children and adolescents reported by Schwimmer et al[1] are also reproduced in Table 2. Our community sample of obese children reported PedsQL scores that were between the children who were not overweight and the severely obese clinical sample.

Mean scores for both parent-proxy and child self-reported total PedsQL scores across the 3 weight categories were stratified by sex, age, maternal education, and disadvantage index (TABLE 3). PedsQL scores were inversely related to weight category for both sexes according to responses from both children and parents. Low maternal education was associated with a significant decrease in total PedsQL score by higher weight category. Although parents and children reported lower QOL with increasing weight status in children of highly educated mothers, these decreases were not statistically significant. Similar trends held across all quartiles of the disadvantage index, with obese children having lower QOL scores than those who were not overweight, but the strength of association varied. Parents reported a significant decrease in total PedsQL score by weight category for all age groups except the oldest, while only children aged 11 years reported significant decreases in scores, although decreases were present in all age groups.

TABLE 4 shows estimated marginal mean (SD) PedsQL scores after adjustment for age, sex, maternal education, and disadvantage index. As in the univariate analyses, the decreases in total, physical, and social PedsQL scores with increasing weight category remained significant for responses from both children and parent-proxies even after multivariable adjustment. Pairwise comparisons between weight categories showed that parents reported a significant decline in total and physical PedsQL with each category increase. For children, the difference in total and physical PedsQL scores between not overweight and overweight were not significant; however, a significant decrease in the social functioning subscale across each increase in weight category was observed. Parents did not report significant differences in the psychosocial summary scores across weight categories, while children reported a significant decrease in the psychosocial summary score between the not overweight category and the obese category.

Relationships between total, physical, psychosocial, and social PedsQL scores and BMI *z* scores are shown in the FIGURE. The lines of best fit show that all of these scores decrease with increasing BMI, and in most cases the decline begins just above the mean BMI.

To ensure that definitions of weight category did not influence our findings, we reanalyzed all data using Centers for Disease Control and Prevention's age- and sex-specific cut points, under which 19.1% of the sample were classified as at risk of overweight and 11.5% as overweight. However, this did not alter the conclusions of the study. All statistically significant relationships remained significant, and all nonsignificant relationships remained nonsignificant.

COMMENT

In a large community-based sample, we demonstrated that children's health-related QOL measured by the PedsQL decreases across not overweight, overweight, and obese 9- to 12-year-old children in Victoria, Australia. The decrease was small for overweight children but more marked for those who were obese. These new observations are less dramatic than the much lower scores reported for children attending tertiary clinics,[1] but are consistent with those observed for adults.[21]

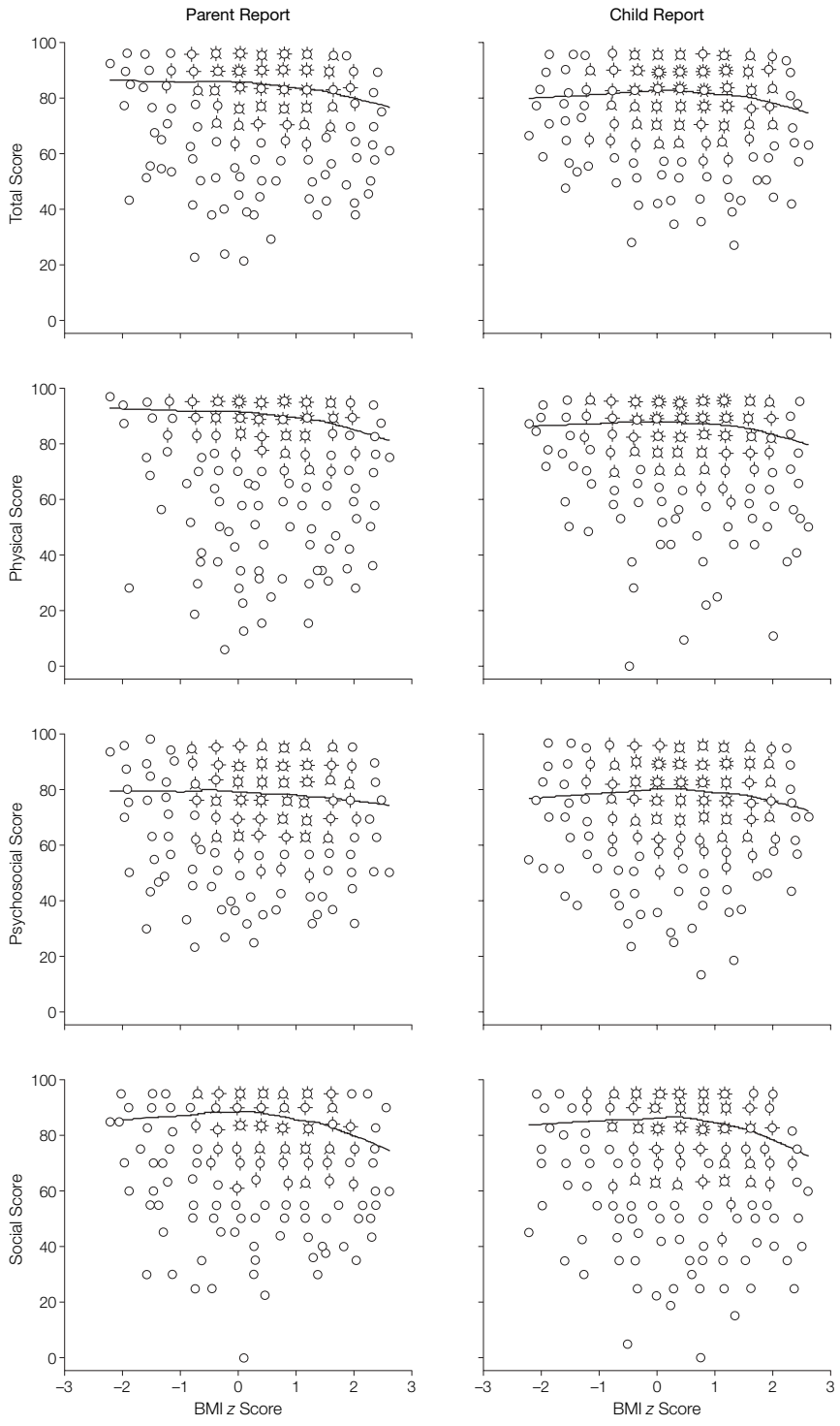
Because health and QOL are multidimensional, it is feasible that some dimensions may be more affected by overweight or obesity. Overweight and obese children differed from children who were not overweight most strongly on physical and social functioning scores, while emotional and school functioning seemed relatively unaffected. This study confirms and extends previous research restricted to reports by parent-proxies.[13,21,22] The child self-report and parent-proxy versions of the PedsQL are nearly identical, making it possible to show just how closely parents and children agree on aspects of child functioning across the gradi-

ent of BMI. This study has shown that in contrast to other observed health concerns, children's own subjective response to overweight and obesity is not more negative than that of their parents, at least for the broad domains measured herein. However, given that there is evidence of less agreement between parent and adolescent reports of health and well-being, future data collection from this cohort may demonstrate whether agreement dissipates as children age.[6,7] We have confidence in our results because the sample was drawn from a large, representative, population-based cohort with high response rates in which BMI had been accurately measured. In addition, the PedsQL conforms to the multidimensional conceptual framework of the World Health Organization's definition for health, has reliable population norms and good measurement properties, and has been used widely.

Despite the high response rates, studying the second wave of a longitudinal study limited our ability to generalize to the whole population of Victorian children. There is some evidence that heavier children may have been underrepresented in the 2000 study. If these children also had systematically better health-related QOL than those not followed up, our findings could have been erroneous. However, our results showed that heavier children were more likely to report lower QOL and if these children had remained in the study our findings probably would have been strengthened. Our study was limited to children aged 8 to 13 years. A study incorporating younger and older children and adolescents is needed to determine applicability of our findings to other age groups. Because of its generic nature, the PedsQL allows comparisons of health across whole populations but it may not tap into particular areas of concern experienced by overweight and obese children or other aspects of QOL.

Although there were sound reasons for using the PedsQL, debate continues regarding what constitutes health-related QOL and how it differs from

Figure. PedsQL Scale Scores Reported by Parent-Proxies and Children



Each data marker represents 5 cases; each line off of a data marker represents an additional 5 cases. Lines of best fit were generated using locally weighted regression techniques.

health and functional status. The PedsQL assesses "difficulties or problems with . . . " or ill-being. A consensus is emerging in the pediatric literature, which concurs with research on adults, that ill-being is not low well-being, and that the absence of ill-being does not necessarily equate with high well-being.[23] It is possible that overweight and normal weight children may differ little in ill-being but could experience a lower level of well-being, which the PedsQL would not capture. In addition, while we may expect that lower QOL is associated with lower functioning, functional status measures alone in children might be inadequate as a proxy for QOL because children may adapt to their current health state or may not have experienced a healthier state, which could result in high self-reported QOL scores despite obvious functional limitations.[24]

Our results indicate that health-related QOL, or functioning, begins to decline as soon as a child is above average weight, with a gradual steepening as BMI increases. To determine whether a specific BMI threshold must be reached to stimulate motivation to seek treatment (and whether this directly relates to perceived health), it would be necessary to conduct a separate study to investigate the issue of health care use and the associated clinical implications.

These findings have both positive and negative implications. As for any chronic condition, a relatively small effect of overweight on children's functioning across multiple domains is welcome. However, if neither children nor parents perceive a health effect, it seems unlikely that they will seek health care or initiate behavioral change that might lead to a healthier BMI, and consequently lessen the long-term health risk for the current generation of children. Our findings may explain why so few parents of overweight children express concern about their child's weight, yet with a quarter of all children now overweight or obese, even a minor reduction in health-related QOL at an individual level is still likely to have a major effect at a population level.

Further research is needed to determine if these findings can be replicated in different age groups and countries, and to investigate the temporal relationships between overweight and obesity and QOL in children. It is not known whether the health-related QOL in overweight and obese children decreases in response to their weight, whether children with lower health-related QOL from the outset are more likely to become overweight, or whether there is a transactional relationship mediated by the presence of comorbidities or by factors extrinsic to the child, such as parental mental health. These are complex questions that will require careful study.

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Study concept and design: Wake, Hesketh, Waters.
Acquisition of data: Wake, Hesketh.
Analysis and interpretation of data: Williams, Wake, Maher.
Drafting of the manuscript: Williams, Wake, Maher.
Critical revision of the manuscript for important intellectual content: Williams, Hesketh, Waters.
Statistical analysis: Williams, Hesketh.
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