

The relationship between body mass index and health-related quality of life in urban disadvantaged children

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Abstract

Introduction The study’s aim was to establish, for children living in urban disadvantage, the nature and extent of the relationship between body mass index (BMI) and health-related quality of life (HRQoL), including the role of individual and family factors in influencing this relationship.

Methods Within the context of a longitudinal design, 255 children aged 7–12 years (50 % male) self-reported their HRQoL (Kidscreen-27) and had their height and weight measured at year one and two. One parent/guardian for each child was also assessed at year one with the OSLO Social Support Scale and Hospital Anxiety and Depression Scale. Regression analysis was also conducted.

Results BMI was weakly inversely associated with ‘total HRQoL’ ($r = -.15$, $p < .05$), ‘physical well-being’ and ‘autonomy and parent relations’. Significant differences were found between normal weight and obese children on all but the latter dimension. Neither weight group, however, fell below the average European HRQoL range. BMI predicted physical well-being a year later and vice versa, whilst autonomy and parent relations also predicted BMI a year later. In terms of ‘overweight’ children (38 %), those approaching adolescence had poorer physical and school well-being than younger children, and those whose parents had moderate-to-severe levels of depression fared worse on

school well-being than children whose parents were not depressed.

Conclusion The findings suggest that obesity programmes could aim to prevent/reduce obesity and optimise HRQoL in urban disadvantaged preadolescent children whilst also targeting parental mental health difficulties. Future research should examine mediators of the effect of BMI on HRQoL.

Keywords Health-related quality of life · Body mass index · Obesity · Children · Disadvantage · Urban · Moderation

Introduction

Obesity is now recognised as the most prevalent childhood disease worldwide [1]. In Ireland, one in four children is overweight [2]. Childhood obesity can have adverse psychosocial as well as medical consequences [3, 4] such as reduced health-related quality of life (HRQoL). HRQoL refers to a subjective evaluation of the quality of multiple life dimensions in terms of health [5] that is also affected by a complex interaction of other *person* factors, *processes* and *contexts* [6, 7]. For obese children from either clinical or general populations, the HRQoL dimensions of physical and social well-being are particularly affected [8–10]. The HRQoL of overweight children can also be negatively affected [i.e. the risk of HRQoL increases as body mass index (BMI) scores increase] [11, 12]. Notably, few studies have explored the risk to HRQoL over time [13, 14].

The risk of obesity [15, 16] and poor HRQoL [17] is much greater for children living in poverty such as those in densely populated urban disadvantaged areas. According to the family ‘investment’ and ‘stress’ models [18], a low income can adversely affect children’s health because it

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hinders parents' ability to purchase helpful materials, experiences and services [19, 20]. It can also negatively impact parental mental health [21], which can lead to dysfunctional parenting practices and in turn, poorer health outcomes for children [22]. However, we were unable to locate any studies, to date, which have explored the effect of BMI on the HRQoL of urban disadvantaged children.

Few studies have examined the factors that intensify or reduce the effect of obesity on children's HRQoL (i.e. moderator effects analysis) [11]. For example, there has been little or no research investigating the extent to which the negative effect of overweight BMI on children's HRQoL can be modified by the age and gender of the child or their parent's mental health and social support. Studies indicate that overweight adolescents and girls may be more likely to experience lower HRQoL than overweight children and boys [23, 24]. Indirect evidence suggests that parental mental ill health may also increase the risk of being overweight on children's HRQoL and that parents' social support may protect the HRQoL of overweight children. More specifically, children whose parents have mental health difficulties, particularly depression, are more likely to be overweight [25, 26] and to have poor HRQoL [27] than children whose parents have positive mental health. In addition, children whose parents have strong social support available to them (or living in a two-parent family) are less likely to be overweight [28, 29] and to have impaired HRQoL [30, 31] than their 'low social support' counterparts.

The objectives of this study were to determine in a sample of urban disadvantaged children: (1) whether BMI significantly negatively correlates with HRQoL; (2) between what weight groups do significant differences occur; (3) whether BMI predicts HRQoL a year later; and under conditions of high BMI, (4) whether those approaching adolescence, who are female or whose parents have high depressive symptoms, have a lower HRQoL than their counterparts; and (5) whether those whose parents have strong perceived social support or who live in a two-parent family have better HRQoL than their counterparts.

Methods

Sample

The study involved a prospective longitudinal cohort design. A total of 255 children aged 7–12 years (50 % male) were recruited using consecutive sampling across seven schools in highly disadvantaged urban districts located in the Greater Dublin Area in Ireland (according to the Government [32] and the Deprivation Index [33]). One of their parents/guardians ($N = 219$, 90 % mothers) was also invited to participate in the study. Children's HRQoL, height and weight were assessed in school at year one and

two. In addition, parents were administered a battery of measures over the phone at year one. Institutional ethical approval was obtained for this study.

Measures

Children's HRQoL was assessed using the Kidscreen-27, a generic 27-item self-report for children aged 8–18 years [34]. Using a five-point Likert scale, it assesses five dimensions of well-being: (1) physical well-being, (2) psychological well-being, (3) autonomy and parent relations, (4) social support and peer relations and (5) school environment. The t-score from each dimension ranges from 0 to 100, with a mean of 50 ($SD = 10$). Higher scores indicate better HRQoL. Items within the Kidscreen-10 were extracted from the Kidscreen-27 to calculate a total HRQoL score. The Kidscreen-27 and Kidscreen-10 are psychometrically robust with Cronbach's α satisfactorily over .73 [34–36]. Cronbach's alpha in the present study was satisfactory at over .73.

Children's body fat was determined by their BMI [weight/(height)²] as measured by children's nurses trained in anthropometric measurement [15]. The World Health Organisation's (WHO) AnthroPlus software [37] converted BMIs into age- and gender-specific standardised z-scores ranging between -3 and 3 and identified children's weight category using WHO (2007) thresholds for overweight (i.e. $+1$ SD or 25 kg/m^2) and obesity (i.e. $+2$ SD or 30 kg/m^2) [38].

The depressive symptoms of parents were measured with the Hospital Anxiety and Depression Scale (HADS), a brief 14-item self-report clinical objective measure of depressive and anxiety symptoms for adults over 16 years [39]. The HADS takes less than 10 min to complete and has been used widely in research [40] and in clinical practice [41]. Normative data from large non-clinical samples have been published [42, 43]. Each dimension has a cumulative total score between 0 and 21. Raw scores between 11 and 15 identify moderate cases, whilst scores of 16 or above identify severe cases [44]. The measure has good psychometric properties [45] with a Cronbach's α greater than .80 [46]. In the present study, α was .97.

The parent's perceived social support was assessed using the three-item Oslo Social Support self-report Scale [47]. Responses provided a cumulative total score (3–14 points) that reflected 'poor' (3–8), 'moderate' (9–11) or 'strong' (12–14) levels of social support. The measure has good psychometric properties [47] with Cronbach's α over .72 [48]. Cronbach's alpha in this current study was below satisfactory levels at .63, but closer examination of the results (i.e. corrected item-total correlation and Cronbach's α if item deleted) revealed that the items were measuring the same thing as the scale. Family structure was recorded within a profile questionnaire.

Statistical analysis

Pearson's r correlations were used to test the bivariate association between continuous variables, whilst the distributions of HRQoL were compared between the groups of categorical variables with two or more than two levels using independent t tests and one-way analysis of variance (ANOVA). Confounders were also explored. Linear regression determined whether BMI predicted HRQoL a year later. In order to determine whether five variables (gender, age, depressive symptoms, perceived social support and family structure) moderated the effect of BMI on HRQoL, HRQoL was regressed onto (a) BMI; (b) the potential moderator; and (c) the product of BMI and the potential moderator using hierarchical multiple regression (HMR) analysis [49]. Simple slope analyses were used to examine the direction and degree of moderation found, and regression lines were graphed. All analyses were conducted with SPSS (version 18). Notably, some HRQoL distributions were skewed and non-normal. However, this is common as most people experience a positive HRQoL. It was estimated that between 78 and 558 children were needed to conduct the HMR based on the probability of type I error of 0.05 alpha, power of 0.8, medium and small effect size (f^2) of 0.15 and 0.02, and attrition of 2 % [50].

Results

Sample descriptives

Table 1 presents a description of the children and their parents/guardians at year one of the study. The mean HRQoL scores were within the average range for the general population of Irish and European children [34], which was unexpected as children from low socioeconomic status (SES) populations tend to have poorer HRQoL. School well-being was ranked highest, which contrasts with the general population of Irish children and children living in socioeconomic disadvantage across Europe, where it was ranked as lowest and second lowest, respectively [17, 51]. Furthermore, over a third of children (38 %, 96/253) were considered either overweight (16 %) or obese (22 %), which is greater than the rate of 25 % observed in a nationally representative sample [2] as well as the 33 % rate in a socioeconomically disadvantaged sample [52] of Irish children.

Whilst a significant proportion of parents were single, most (60 %, 153/219) lived with their partner (i.e. another biological parent, step parent or foster parent). The ratio of two- to one-parent households in this study (60:40) was, as expected, lower than the ratio in Ireland more generally

Table 1 Description of the child and parent sample

Variables	<i>N</i> (%)	<i>M</i> (<i>SD</i>) range
Child age	255 (100)	9.73 (1.46) 7–12
<i>Child gender</i>	255 (100)	
Male	128 (50)	
Female	127 (50)	
<i>Child ethnicity^a</i>	249 (98)	
Caucasian	236 (95)	
Other	13 (5)	
<i>Child BMI z-scores</i>	253 (99)	0.84 (1.10) –2.21 to 4.41
Underweight	1 (4)	
Normal weight	156 (61.6)	
Overweight	41 (16)	
Obese	55 (22)	
<i>Child total HRQoL</i>	245 (96)	53.86 (12.0) 26.64–83.81
Below average total HRQoL	43 (18)	
Average total HRQoL	162 (66)	
Above average total HRQoL	40 (16)	
Physical well-being	253 (99)	53.57 (11.1) 20.70–73.20
Psychological well-being	252 (99)	53.56 (10.9) 20.55–75.53
Autonomy and parent relations	252 (99)	52.07 (12.9) 13.96–74.39
Social support and peer relations	251 (99)	53.26 (13.3) 11.24–66.34
School environment	251 (99)	55.47 (11.9) 16.28–71.00
<i>Family structure</i>	255 (100)	
One-parent family	102 (40)	
Two-parent family	153 (60)	
<i>Guardian's relationship to child^a</i>	219 (100)	
Mother	196 (90)	
Father	18 (8)	
Other	5 (2)	
Guardian age ^a	219 (100)	37.35 (7.29) 25–61
<i>Guardian marital status^a</i>	219 (100)	
Single	93 (42)	
Cohabiting	50 (23)	
Married	76 (35)	
<i>Guardian education completed^a</i>	219 (100)	
Up to junior certificate obtained	102 (47)	
Junior certificate and more obtained	117 (53)	
<i>Guardian employment status^a</i>	219 (100)	
Employed	114 (52)	
Other	105 (48)	

Table 1 continued

Variables	<i>N</i> (%)	<i>M</i> (<i>SD</i>) range
<i>Guardian perceived social support</i>	219 (100)	11.73 (2.34) 4–14
Poor	23 (11)	
Moderate	55 (25)	
Strong	141 (64)	
<i>Guardian depressive symptoms</i>	218 (99)	3.93 (4.14) 0–21
Non cases	182 (83)	
Moderate	19 (9)	
Severe	17 (8)	
<i>Guardian anxiety symptoms</i> ^a	218 (99)	6.70 (4.56) 0–21
Non cases	132 (60)	
Moderate	47 (22)	
Severe	39 (18)	

^a Descriptives are provided here for which analysis was not carried out on. They merely provide further context

(80:20), but slightly higher than the ratio in other urban disadvantaged areas in the country (40:60) [53]. Parents, on average, had strong social support ($M = 11.73$, $SD = 2.34$), which was higher than the average of a nationally representative sample of Irish adults in a randomised controlled trial (i.e. 10.70 or moderate social support) [48]; this was unexpected given that socioeconomically disadvantaged persons tend to have poor social support [54, 55]. Finally, parents had mean levels of depressive symptoms ($M = 3.93$, $SD = 4.14$) that fell within the normal range for general populations in the UK and the Netherlands [42, 43]. However, the 17 % ($N = 36$) of parents with moderate-to-severe symptoms is greater than the estimated prevalence of depressive disorders in general populations [56, 57] and similar to that in disadvantaged populations [22, 58].

Association between BMI and HRQoL

As expected, BMI was weakly inversely associated with total HRQoL ($r = -.15$, $p < .05$), physical well-being ($r = -.17$, $p < .01$), and autonomy and parent relations ($r = -.13$, $p < .05$), and marginally inversely associated with psychological well-being ($r = -.12$, $p = .054$) (Table 2). Statistically significant differences were seen only between those who were obese versus normal weight (on all aforementioned dimensions and total except for autonomy and parent relations). However, neither weight group fell below the average European HRQoL range.

Notably, none of the measured variables were found to confound the relationship between BMI and HRQoL (see supplementary Table 2). Other important (expected) bivariate associations included a weak negative correlation between age and school well-being and a weak positive

correlation between age and ‘autonomy and parent relations’. As expected, boys scored significantly higher than girls on ‘social support and peer relations’ and school well-being, but the magnitude of the differences in the means was small. Unexpectedly, parent’s perceived social support and depressive symptoms, and family structure did not correlate with children’s HRQoL. Finally, analysis revealed that BMI predicted physical well-being a year later (see Table 3) and vice versa, whilst autonomy and parent relations also predicted BMI a year later.

Moderator effect of the BMI to HRQoL relationship

Only the models testing the moderator effects of age, parent depressive symptoms and family structure in the relationship between BMI and HRQoL reached statistical significance and are presented here (child gender and parent perceived social support did not moderate the effect). In order to illustrate the interaction in Figs. 1, 2, 3, BMI, age and depressive symptoms were categorised into ‘low’ (1 SD below mean), ‘medium’ (mean) and ‘high’ (1 SD above mean). For example, low and medium BMI represents BMI at the lower and higher levels of the normal range, whilst high BMI represents overweight. The finding in Table 2 that for every point increase in BMI, HRQoL decreases by between .08 and .17 is also important to note when interpreting the figures.

Model 1: moderator effect of child age

The interaction between BMI and age made an independent contribution to children’s physical [$\Delta R^2 = .019$, $F_{inc}(1, 245) = 5.09$, $p = .025$] and school [$\Delta R^2 = .038$, $F_{inc}(3, 245) = 10.09$, $p = .002$] well-being. More specifically, under conditions of overweight status, children approaching adolescence (i.e. 12 years) reported significantly lower physical and school well-being than children aged between 7 and 11 years [see Fig. 1a and b, respectively]. Furthermore, the interaction between BMI and age made a marginal significant contribution to total HRQoL [$\Delta R^2 = .016$, $F_{inc}(1, 239) = 3.857$, $p = .054$] such that overweight children who were approaching adolescence reported marginally significantly lower total HRQoL than children aged 7–11 years (Fig. 1c). Total HRQoL, physical and school well-being did not differ by age when children were of normal weight.

Model 2: moderator effect of parent depressive symptoms

In addition, the interaction between child BMI and parent depressive symptoms made a significant contribution to children’s school well-being [$\Delta R^2 = .020$, $F_{inc}(3, 244) = 4.95$, $p = .027$]. In relation to ‘overweight’

Table 2 Relationship between BMI and HRQoL at year one (ANOVA and Pearson's correlation)

Independent variables	Dimensions of and total HRQoL in children					
	Physical well-being <i>M</i> (SD) <i>ES</i>	Psychological well-being <i>M</i> (SD) <i>ES</i>	Autonomy & parent relations <i>M</i> (SD) <i>ES</i>	Social Support & Peer Relations <i>M</i> (SD) <i>ES</i>	School Environment <i>M</i> (SD) <i>ES</i>	Total HRQoL <i>M</i> (SD) <i>ES</i>
<i>BMI</i> z-scores ^a	-.17**	-.12 ¹	-.13*	-.12	-.08	-.15*
Normal/underweight (ref)	55.07 (11.28)	54.98 (11.04)	52.93 (12.63)	54.16 (12.90)	56.11 (11.91)	55.29 (12.59)
Overweight	52.08 (11.50)	51.37 (10.96)	52.11 (13.93)	52.29 (12.74)	54.57 (11.11)	52.08 (11.79)
Obese	50.51 (9.48) .03*	51.20 (10.45) .03 ^b	48.92 (12.30)	50.94 (14.51)	54.30 (12.25)	50.78 (9.99) .03*

ANOVA effect size (*ES*) is small at 0.01, medium at 0.06 and large at 0.14

* $p < .05$, ** $p < .01$

¹ $p = .054$

^a Pearson's r correlation *ES* is small when $r = \pm .10$ to $\pm .29$; medium when $r = \pm .30$ to $\pm .49$; and large when $r = \pm .50$ to ± 1.0

^b ANOVA found a small significant difference between groups but post hoc test did not identify any

Table 3 Pearson's r correlation between BMI at year one and HRQoL in children at year two

Independent variables	HRQoL in children at year two					
	Physical well-being <i>r</i>	Psychological well-being <i>r</i>	Autonomy & parent relations <i>r</i>	Social support & peer relations <i>r</i>	School environment <i>r</i>	Total HRQoL <i>r</i>
<i>BMI</i> z-scores at year one	-.14*	-.04	-.04	-.10	.08	-.10

* $p < .05$

children, those whose parents had moderate-to-severe depressive symptoms as expected fared worse on school well-being than children whose parents were not depressed (Fig. 2). When children were of normal weight, school well-being did not differ between the different levels of parental depressive symptoms.

Model 3: moderator effect of family structure

Finally, the interaction between children's BMI and family structure made an independent contribution to their physical well-being [$\Delta R^2 = .015$, $F_{inc}(1, 247) = 3.89$, $p = .05$] and 'social support and peer relations' [$\Delta R^2 = .035$, $F_{inc}(1, 245) = 9.02$, $p < .003$]. Under conditions of overweight status, children from one-parent families reported significantly higher levels of physical well-being (Fig. 3a) and 'social support and peer relations' (Fig. 3(b)) than children from two-parent families. In contrast, when BMI was at the lower levels of the normal range, children from two-parent families reported significantly higher levels of physical well-being and 'social support and peer relations' than children of one-parent families. Physical well-being and 'social support and peer relations' did not differ by family structure when children had a BMI at the higher levels of the normal range.

Discussion

The results support the hypotheses that, in a sample of urban disadvantaged children, (1) BMI is weakly negatively correlated with HRQoL (weakly with 'total HRQoL', 'physical well-being', and 'autonomy and parent relations' and marginally with 'psychological well-being'); (2) the HRQoL of those categorised as obese is significantly worse than those of normal weight (on all aforementioned dimensions except for 'autonomy and parent relations'); and (3) BMI predicts physical well-being a year later and vice versa, whilst 'autonomy and parent relations' also predicts BMI a year later. The findings further support the hypotheses that the negative effect of high BMI on HRQoL intensifies as (4) children approach adolescence (12–13 years) and (5) as a parent's depressive symptoms become more severe (especially with respect to school and physical well-being and physical well-being, respectively).

The first two findings above are largely consistent with the HRQoL literature [8, 11, 59]. For example, Tsiros and colleagues (2009) in their meta-analysis reported that the risk to several dimensions of HRQoL increases as BMI increases and that HRQoL is significantly lower amongst those who were obese than those of normal weight, particularly with regards to total HRQoL and physical well-

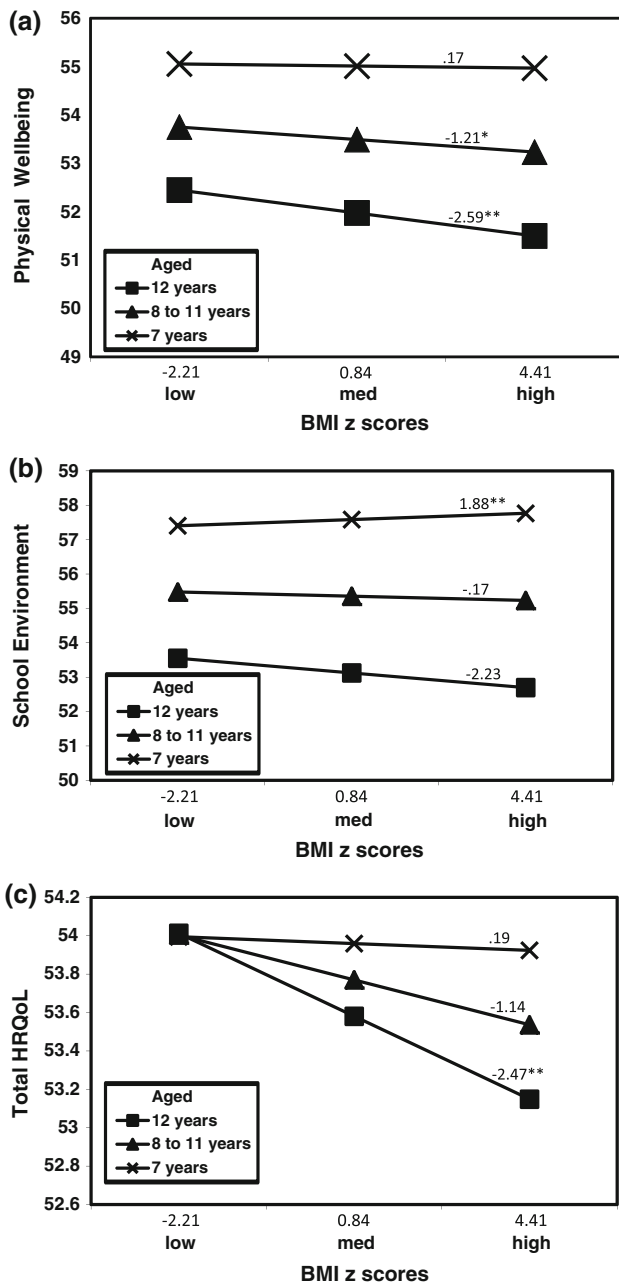


Fig. 1 a The relation between BMI z-scores and physical well-being for children aged 7, 8–11 and 12 years [*T* value indicates how slope differs from zero (***p* < .01, **p* < .05)]. b The relation between BMI z-scores and school environment for children aged 7, 8–11 and 12 years [*T* value indicates how slope differs from zero (***p* < .01)]. c The relation between BMI z-scores and total HRQoL for children aged 7, 8–11 and 12 years [*T* value indicates how slope differs from zero (***p* < .01)]

being. Physical well-being may be affected because obesity is associated with a range of adverse physical consequences from dermatological to functional health problems [60]. The impairment to ‘autonomy and parent relations’ and even ‘psychological well-being’ may be due to the

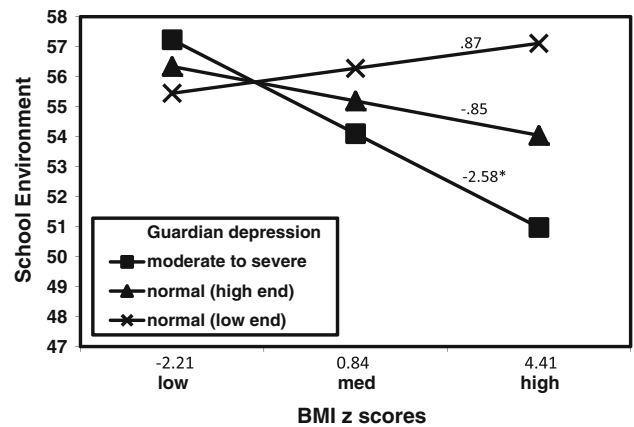


Fig. 2 The relation between BMI z-scores and school environment in children whose parent/guardian has normal and moderate-to-severe depressive symptoms [*T* value indicates how slope differs from zero (**p* < .05)]

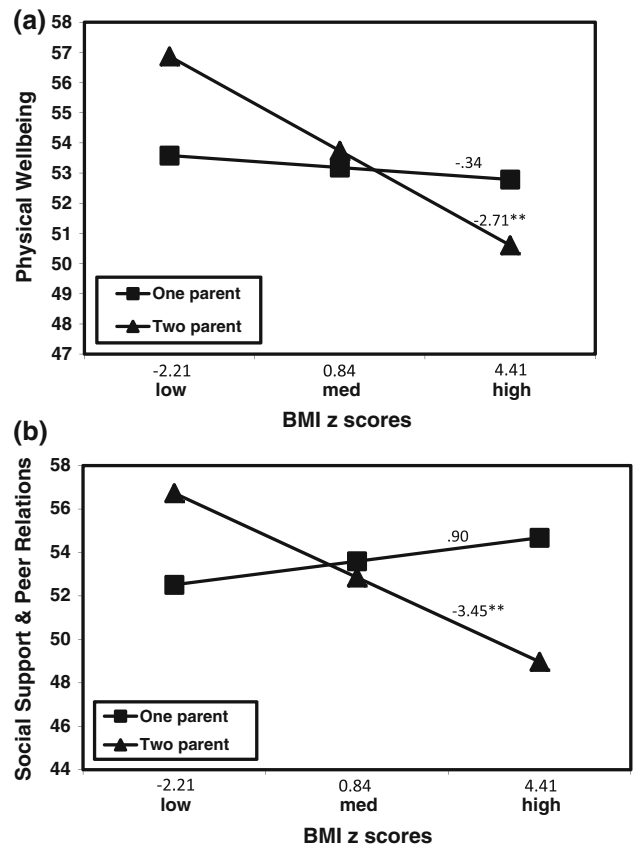


Fig. 3 a The relation between BMI z-scores and physical well-being for children from one-parent and two-parent families [*T* value indicates how slope differs from zero (***p* < .01)]. b The relation between BMI z-scores and social support and peer relations for children from one-parent and two-parent families [*T* value indicates how slope differs from zero (***p* < .01)]

psychosocial consequences of obesity such as body image concerns [61], weight-related teasing [62], low self-esteem, depression and interpersonal difficulties [63, 64]. Conversely, however—unlike numerous other studies [see 11]—there was no inverse association between children's BMI and their 'social support and peer relations'. Evidence from elsewhere to show that Irish children generally score above average on social support HRQoL [34] may explain why adiposity did not affect it; perhaps having a high BMI has little effect on friendships in Irish children, although this warrants further research attention.

It is noteworthy that the mean HRQoL for either weight group did not fall below the average European or Irish general population scores [34]. Typically, obese children have been found to have below average HRQoL scores although this is not always the case [24, 65]. As highlighted above, it was unexpected that the children in this study reported mean HRQoL scores within the published healthy range given that they are from low SES backgrounds. These findings may be explained by one or more factors including non-random sampling, social desirability responding, adaptation to deprived or overweight conditions, and/or a buffering effect as a result of these schools—amongst some of the most disadvantaged in the country—receiving additional health promoting resources (e.g. food provision programmes) as part of a Government scheme that is available only to schools designated as disadvantaged. However, further research is needed to properly explain these findings.

The third finding is somewhat consistent with the small number of longitudinal studies conducted in this area [e.g. 13; 14], which reported only weak evidence on the direction of causality between BMI and HRQoL in young people. For example, Herman and colleagues (2010) found significant negative correlations between BMI and a number of HRQoL dimensions during childhood, but young people's BMI only weakly predicted psychological well-being in adulthood. Similar to the first three findings reported here, small effect sizes are generally found in non-clinical studies investigating the effect of BMI on children's HRQoL [8, 11, 59]. This may be because children with high BMI who have not been screened as overweight tend to be less aware of their overweight condition and are less likely to view it as an issue for their HRQoL than children who are receiving treatment for their condition [7, 66].

The fourth finding is not consistent with the small number of studies investigating the moderator effect of age in the relationship between BMI and HRQoL that reveal no significant interactions with respect to these HRQoL dimensions [24, 31, 67]. However, indirect evidence supports the fourth finding. For example, overweight children tend to report lower physical and school well-being than their non-overweight peers [9, 24, 68], and, irrespective of

weight, children report poorer physical and school well-being as they get older [69–71]. These findings may be due to several puberty-related factors including greater changes to body composition [72], increased societal pressures to be thin [73] and greater susceptibility to depression and anxiety [74]. Notably, girls are more vulnerable than boys to the last two of these [74, 75].

Although up until now, there have been no studies investigating the moderator effect identified in this study (i.e. the fifth finding), it has been shown that depression in parents of overweight children can lead to parenting stress [76] which, in turn, has been found to intensify the negative effect of being overweight on children's school well-being [77, 78]. Further indirect evidence is that children whose parents are depressed are at a greater risk of being overweight [25, 26, 79] and of having poor school well-being [27, 80] when compared to children whose parents are not depressed, and that overweight BMI is inversely associated with children's school well-being [24, 68]. These relationships may exist because depressed parents with overweight children are more likely to engage in a parenting style that sets few household rules and responsibilities for children, and does not monitor children's healthy food choices, exercise or schooling [81, 82].

Unexpectedly, the hypotheses that the negative effect of elevated BMI on children's HRQoL is intensified for females and diminished for children whose parents have strong social support (or who live in two-parent families) were not supported by this study. Perhaps significant interactions may only be identified when the age and gender of the child are considered simultaneously; significant differences between genders in HRQoL are usually not seen until children reach the age of 12 [71, 83]. In terms of parent's social support, significant interactions may not have been observed because social support may only serve to protect parents from stressors and not children. Instead, the social support provided to children by their parents may be a moderator. The unexpected buffering effect of one-parent families on the 'physical well-being' and 'social support and peer relations' of those children with overweight status is difficult to explain. It may be because children living in greater disadvantage (e.g. one-parent families) are less likely to perceive themselves as overweight [84] and to negatively evaluate these dimensions. Alternatively, the identification of a greater proportion than expected of two-parent families and parents with strong social support suggests a potential source of bias in both the sampling and the results although it is difficult to be clear on this without further research.

The findings reported here represent an important addition to the literature in a number of ways. It addressed an important gap in knowledge and theory relating to the association between children's BMI and HRQoL by

extending the research into moderators of this relationship. It also involved a moderate sample of young urban disadvantaged children ($N = 255$), a cohort under-represented in the HRQoL literature. The use of self-report measures with good psychometric properties and the assessment of children's BMI by trained nurses helped to ensure that results were reliable and could be generalised to other urban disadvantaged populations. The use of a generic HRQoL measure further enhanced applicability to all population subgroups (e.g. obese or disadvantaged) [85]. Furthermore, this study generally used measures that generated continuous data and more can be learned from analysing such data [86]. Finally, the incorporation of a longitudinal element strengthened the research design and allowed for an exploration of causal relationships [87].

However, several limitations of the study should be considered when interpreting the findings. Firstly, participants were recruited using a non-randomised sampling method which may have increased the risk of selection bias [88] and caution should be taken, therefore, when generalising the results to populations other than those living in urban disadvantage. Secondly, Kidscreen was administered to children aged 7 ($N = 21$) despite not being psychometrically tested for children under 8 [34]. However, research shows that these children can reliably report on their HRQoL (see [89]) and several studies on the HRQoL of children aged 7 have been published (e.g. [90]). Thirdly, whilst some HRQoL distributions were skewed and non-normal, this study followed the tradition within HRQoL research of using parametric tests [91, 92] whilst confirming the robustness of these with nonparametric tests.

The findings from this study have important implications for policy and practice. With greater than expected prevalence of overweight and obesity, governments may need to prioritise urban disadvantaged children in their policy making [93, 94]. Perhaps the accessibility of food, the built environment or perceptions of safety of urban disadvantaged areas lead to poorer diets and more sedentary lifestyles [95]. Furthermore, preventions, interventions and treatments which aim to prevent or reduce obesity, traditionally by encouraging physical activity and healthy eating [96], may also need to aim to optimise the HRQoL of urban disadvantaged preadolescents. If, however, weight management methods fail to improve HRQoL, obesity programmes may have to intervene at the HRQoL level. For example, given that obese children have poorer, albeit not clinically poor, 'physical well-being' and 'autonomy and parent relations' than normal weight children, these programmes could aim to ensure easy mobility around the home and school, address any physical health and sleep complaints, provide opportunities for children to create their own social and leisure time, and improve parent-child interactions.

Obesity interventions and treatments that aim to improve HRQoL of overweight children may also need to prevent or treat parent's mental ill health possibly through the incorporation of parenting training, an approach that has proven to be effective at improving parenting skills, parent mental ill health and health outcomes for children including achieving and maintaining a healthy weight [97, 98]. Obesity programmes could also aim, for example, to improve children's perception of school and their abilities therein. Moreover, the findings of this study imply that obesity programmes may need to monitor children's HRQoL to help design or adjust programmes to improve aspects of life which really matter to a child and to determine their effectiveness [89].

This study could be replicated in the future, but with some adjustments to sampling, design, measures and analysis. These might include the use of random sampling of children to increase the generalizability of the findings to other urban disadvantaged populations and to children more generally. It might also be useful to include more fathers in view of the gender differences in the effect of paternal depression on children's health (see [99]). In addition, findings could be compared between studies that use different measures of HRQoL based on different constructs. Furthermore, the levels of social support actually received by parents and/or children should be measured in order to obtain a more accurate representation of this important variable. As BMI explained only a small amount of the variance in HRQoL, greater attention may need to be given to the process by which adiposity is influential in this regard. For example, research suggests that body image concerns or weight-related teasing may be the mechanisms by which obesity affects HRQoL [59]. To determine whether obesity causes poor HRQoL, further longitudinal analysis could also be conducted. Finally, the aspects of disadvantaged urban areas that may lead to greater levels of overweight and obesity than in disadvantaged populations more generally could also be explored.

In summary, an increasing BMI was associated with a decreasing HRQoL in urban disadvantaged children and when BMI reached overweight, children approaching adolescence and whose parents had high levels of depressive symptoms fared worse on HRQoL than younger children whose parents were not depressed. Obesity programmes could aim to prevent/reduce obesity and optimise HRQoL in urban disadvantaged preadolescent children whilst also targeting parental mental health difficulties. Future research should attempt to delineate the mechanism by which adiposity affects HRQoL.

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