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INFLUENCE OF ADIPOSITY ON HEALTH-RELATED QUALITY OF LIFE IN THE GATESHEAD MILLENNIUM STUDY COHORT: LONGITUDINAL STUDY AT 12 YEARS

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What is already known on this topic

- Being overweight or obese in childhood is associated with self-reported impaired quality of life, especially for physical well-being.
- The evidence for impaired quality of life is limited because it is predominantly based on cross-sectional samples using generic quality of life instruments.

What this study adds

- In this general population of adolescents current body fatness was associated with impaired quality of life, using both generic and weight-specific measures.
- Cross-sectional associations between childhood overweight and poorer psychological health by late childhood are proving to be consistent across measures and samples.
- Change in body fatness over time was not independently associated with future impaired quality of life.

ABSTRACT

Objective: To examine whether adiposity is associated with an impaired quality of life (an individual's perception of their life) in general population samples in early adolescence.

Design and methods: Relationships between a direct measure of adiposity (fat mass index from bioimpedance) and a proxy measure (waist circumference), and both a generic (KIDSCREEN-27) and a weight-specific measure of health-related quality of life (IWQOL-Kids) were examined in a longitudinal population-based cohort of young adolescents aged 12 years (n=519). The effects of change in adiposity over time (from 7 years and 9 years) were also examined (n=331-445 in longitudinal analyses).

Results: Impairment in HRQoL was associated with current adiposity but it was not predicted by earlier adiposity. At 12 years, higher adiposity was associated with lower *Physical Well-Being* on KIDSCREEN-27, and with lower *Total Scores* on the weight-specific IWQOL-Kids instrument, the latter particularly in girls.

Conclusions: Health and education professionals need to be aware in their clinical practice that higher adiposity impairs HRQoL in general populations of young adolescents. Further research would be useful to determine whether or not children of primary school age self-reporting lower HRQoL are more likely to develop higher adiposity later in adolescence or early adulthood.

INTRODUCTION

Overweight and obesity in adulthood are associated not only with adverse health outcomes[1] but also with impaired quality of life.[2] In view of the high prevalence of overweight and obesity among school age children,[3] it is important to examine whether it is also associated with an impaired quality of life in this age group, preferably in general population samples to avoid the selection biases found in clinical samples.

Quality of life is defined by the World Health Organisation (WHO) as an individual's perception of their life associated with their physical, mental and social well-being[4] implying that it should be self-reported whenever possible. A number of cross-sectional studies have examined health-related quality of life (HRQoL) using self-reported instruments in unselected community samples of children across the range of body mass index (BMI),[5-11] showing that higher adiposity is associated with overall lower HRQoL and lower physical well-being. A recent meta-analysis of studies and a review report that higher degrees of obesity in children and adolescents is associated with greater impairment in HRQoL.[12 ,13] However, there is a lack of longitudinal research[12 ,13] on community samples.

The BMI is a measure of weight adjusted for height, rather than of fatness *per se*. It is valuable, therefore, to examine HRQoL using alternative measures of fatness. Fat mass estimated from bioimpedance, for example, is a direct measure of adiposity and has been shown more sensitive to change in adiposity than BMI.[14] Waist circumference, although a proxy measure, may be more meaningful and salient to children and adolescents as it is directly observable.[15] The first aim of this study was to investigate in a general population sample of young adolescents potential relationships between both a generic and a weight-related HRQoL measure and these two measures of adiposity. The second aim was to explore the effects of change in adiposity over time. Pubertal status and sex were also examined.

METHODS

Participants

The data reported are from the United Kingdom longitudinal Gateshead Millennium Study (GMS). All infants born to mothers resident in Gateshead, northeast England, in pre-specified weeks in 1999/2000 were eligible, and 1029 infants (82%) were recruited.[16] At each datasweep since recruitment, all the families that have not previously asked to leave the study are eligible to participate. Full details are published.[16 ,17]

For the present study, assessments of the young adolescents were taken at 11-13 years (median 12, referred to as 12 years in this paper) and previously at 8-10 years (median 9, referred to as 9 years) and at 6-8 years (median 7, referred to as 7 years).

Favourable ethical opinions were granted by Newcastle University Ethics Committee (9 and 12 years) and by Gateshead and South Tyneside Local Research Ethics Committee (7 years). Parents gave written consent for their child’s participation in the study and the children were asked for written assent.

Procedure

The data were collected by researchers trained in the study procedures. At each data sweep all eligible children/young adolescents were visited at school or home. Anthropometric and questionnaire data were collected from those assenting.

Measures

Body measurements (12 years, 9 years and 7 years):

i) Height to 0.1 cm with the head in the Frankfurt plane using a Leicester portable height measure.

ii) Bioimpedance using TANITA scales TBF 300MA. The fat mass was estimated by applying constants for the hydration of fat-free-mass,[18] having first estimated total body water using sex- and age-specific prediction equations.[19]

iii) Waist circumference to 0.1 cm using a standard tape measure to obtain the minimum circumference between the suprailiac crest and lower ribs at the end of normal expiration without compressing the skin.

On each occasion the body measurements were conducted in the same order: height then bioimpedance then waist, and then repeated. Further repeats were taken, if necessary, to achieve limits between the two measurements of 1 cm (height and waist) and 20 ohms (bioimpedance). The means of the duplicate measurements were used.

Health-related quality of life (12 years):

i) Generic HRQoL using KIDSCREEN-27, which assesses subjective health and well-being in children and adolescents aged 8-18 years. This measure has excellent psychometric properties.[20-22]. It has 27 items and measures five dimensions: Physical Well-Being; Psychological Well-Being; Parent Relations & Autonomy; Social Support & Peers; School Environment. Within each dimension, item scores are summed and transformed to Rasch person parameters by an algorithm that gives children/adolescents in the reference population a mean score of 50 with a standard deviation of 10.[22] Higher scores indicate better HRQoL and well-being.

ii) Weight-specific HRQoL using Impact of Weight on Quality of Life-Kids (IWQOL-Kids) designed to differentiate self-perceptions across the entire weight spectrum for children and adolescents aged 11-19 years.[23] It is validated on clinical and community samples.[23] The IWQOL-Kids has 27 items comprising four sub-scales of weight-related HRQoL[24]: Physical Comfort; Body Esteem; Social Life; Family Life. The *Total Score* is calculated as an unweighted sum of all of the items, and then rescaled from 0 to 100. The score on each sub-scale is calculated as an unweighted sum of that scale's constituent items and then similarly rescaled. Higher scores indicate better quality of life.

Pubertal status (12 years):
The Pubertal Development Scale (PDS), a self-report measure of pubertal status for young adolescents with good reliability and validity.[25] Five items for girls and boys are combined into a mean total score. The scale indicates the range of development from prepubertal to postpubertal (high scores).

Socio-demographic characteristics (parent reported at recruitment):

Three variables (employment status; home ownership, car ownership) were used to create a binary measure of family economic status. Families with higher economic status were those with at least one wage earner in the household, and owning their home and a car.

Statistical methods

The fat mass estimate was used to create a fat mass index (FMI: fat mass [kg]/height[m]^2). For FMI and waist measures, three 'change over time' scores were calculated: by subtracting 9 year from 12 year scores, and 7 from 9 year, and 7 from 12 years. The former two 'change over time' scores were used in the main analyses reported. The latter score was used to check whether change in adiposity over a longer period of time was more predictive of HRQoL than the shorter time periods.

The family economic status variable was used to assess possible bias due to differential attrition rates using Chi-square.

Data analysis was conducted on all participants for whom waist measurement at 12 years was available. The data were not normally distributed for all variables, so medians are presented as descriptive statistics. Internal consistency of the HRQoL questionnaires was assessed using Cronbach's α.

Regression methods were used to test for associations between the outcome measures (HRQoL domains) and the body composition measures (FMI and waist circumference). Each individual outcome variable was examined in the same way. The outcome variable was regressed onto FMI at 12 years in the first step, then in the same regression the change in FMI between 12 years and 9 years was added in the second step, and then the change in FMI between 9 years and 7 years in the third and final step. The above regressions were repeated substituting waist circumference for FMI. In cases where the outcome variable was significantly associated with both FMI and waist circumference in the separate regressions, a further regression was run with the two entered together to examine which, if any, had stronger explanatory power. The above analyses were re-run with the change in FMI and waist between 12 years and 7 years to check if change over the longer time period was more predictive of HRQoL. All models were adjusted for sex and pubertal status. Missing data were handled in the regression analyses using listwise deletion. A significance level of $p<0.01$ was used to account for multiple significance testing.

The assumption of regression analysis (that the residuals are normally distributed) was met for each of the KIDSCREEN-27 dimensions, so these outcome variables were analysed with linear regression. The distributions of the *Total Score* on the IWQOL-Kids showed a ceiling effect, with 226 (45%) scoring the maximum of 100. This is as expected for a normal weight range sample.[23] For this reason, logistic regression was used for the IWQOL-Kids outcome variables (dichotomised into scores of 100 and scores <100).

SPSS version 19 (SPSS Inc, Chicago, IL, USA) was used for statistical analysis.

RESULTS

Attrition from the original cohort

Differential attrition from the original GMS cohort was assessed using the economic status data. A total of 1011 mothers (18 with twins) joined the study, categorised as 495 (49%) of higher economic status and 514 (51%) as lower (missing data for 2 families). In the 12 year sample, there were 508 mothers (11 with twins), categorised as 296 (58%) of higher economic status and as 212 (42%) from lower economic status. Attrition since recruitment was significantly higher in families of lower economic status (χ^2=34.7, p<0.001).

Sample characteristics

519 children participated at the 12 year data sweep (49% males). Of these, 4.8% were 11 years, 89.8% were 12 years and 5.4% were 13 years. The mean for pubertal status was 2.1 (SD 0.5) for boys and 2.5 for girls (SD 0.6). Table 1 shows the anthropometric data for the sample.

Table 1. Anthropometric characteristics of study participants (N=519)

	Boys (n=256)		**Girls (n=263)**	
	n (%)	**Median (IQR)**	**n (%)**	**Median (IQR)**
12 years:				
Waist circumference (cm)	256 (100.0)	67.0 (12.1)	263 (100.0)	67.0 (11.7)
Fat mass index	234 (91.4)	4.4 (4.3)	221 (84.0)	4.9 (3.9)
9 years:				
Waist circumference (cm)	228 (89.1)	59.8 (7.4)	234 (89.0)	59.0 (8.4)
Fat mass index	190 (74.2)	4.1 (2.7)	193 (73.4)	4.6 (2.8)
7 years:				
Waist circumference (cm)	209 (81.6)	56.2 (5.4)	218 (82.9)	55.3 (7.2)
Fat mass index	213 (82.2)	3.7 (1.8)	216 (82.1)	3.5 (2.0)

IQR, interquartile range

HRQoL measures (descriptive statistics)

The internal consistency for both HRQoL instruments was high (Cronbach's α=0.91 for KIDSCREEN-27; 0.92 for IWQOL-Kids). The scores for the KIDSCREEN-27 dimensions were approximately normally distributed (Table 2). The scores for the IWQOL-Kids *Total Score* and sub-scales were negatively skewed.

Table 2. Descriptive results for the HRQoL variables at 12 years

	n	Median	Lower quartile	Range
KIDSCREEN-27				
Physical Well-Being	501	47.1	42.5	20.7 to 73.2
Psychological Well-Being	497	50.6	44.8	20.6 to 73.5
Family Relationships	501	51.2	45.2	26.6 to 74.4
Peer Relationships	502	53.2	46.9	11.2 to 66.3
School Environment	504	51.1	45.4	16.3 to 71.0
IWQOL-Kids				
Total Score	507	99.1	94.4	44.4 to 100.0
Sub-scales:				
Physical Comfort	507	100.0	100.0	45.8 to 100.0
Body Esteem	507	97.2	86.1	0.0 to 100.0
Social Life	507	100.0	100.0	29.2 to 100.0
Family Relationships	507	100.0	100.0	45.8 to 100.0

HRQoL, health related quality of life; IWQOL-Kids, Impact of Weight on Quality of Life-Kids

Regression analyses

KIDSCREEN-27

FMI and pubertal status were significantly negatively associated with HRQoL on the *Physical Well-Being* dimension (Table 3, part a). The 'change over time' FMI scores were not significant. The regressions were rerun replacing FMI with waist circumference, which showed a significant relationship for waist circumference at 12 years (Table 3, part b) but not for the change scores. Both these adiposity variables were used together in a final regression; they were non-significantly associated when adjusted for the other (Table 3, part c), showing that neither has significantly more explanatory power than the other (Pearson's *r*=0.85, p<0.001 between the two measures). None of the other KIDSCREEN-27 dimensions were significantly associated with adiposity.

Table 3. Linear regression of KIDSCREEN *Physical Well-Being* domain on (a) FMI at 12 years (n=331), (b) waist at 12 years (n=397), and (c) FMI at 12 years and waist at 12 years (n=438). All three models are adjusted for sex and pubertal status

	B	SE	p
(a) Sex (female)	-1.03	0.94	0.3
Pubertal status	-2.57	0.80	0.001
FMI at 12 years	-0.55	0.14	<0.001
(b) Sex (female)	-1.05	0.86	0.2
Pubertal status	-1.76	0.74	0.02
Waist circumference at 12 years	-0.20	0.05	<0.001
(c) Sex (female)	-1.18	0.87	0.2
Pubertal status	-1.76	0.70	0.01
FMI at 12 years	-0.39	0.23	0.09
Waist circumference at 12 years	-0.11	0.08	0.2

FMI, fat mass index; B, unstandardized regression coefficient; SE, standard error

IWQOL-Kids

In the logistic regressions examining the *Total Score*, significant negative associations (ORs <1) were found with FMI at 12 years and pubertal status, and with waist circumference at 12 years and sex (Table 4). Neither model showed significant 'change over time' associations. In the final model FMI and sex were significantly related to the outcome variable (with girls having lower scores), but there was not a significant interaction between the two variables.

Because the *Total Score* was significantly related to adiposity, each of the IWQOL-Kids sub-scales was examined individually. The pattern of results on the *Body Esteem* subscale was similar to those described above for the *Total Score* (Table 4). The *Physical Comfort* and *School Life* sub-scales were each negatively associated with the adiposity variables at 12 years (Table 4) but the ‘change over time’ adiposity variables were not significant. The *Family Relations* subscale was not significantly related to either adiposity measure at the $p<0.01$ level.

Table 4. Logistic regression of IWQOL-Kids *Total Score* and subscales (*Body Esteem, Physical Comfort, School Life, Family Relations*) on (a) FMI at 12 years (n=336), (b) waist at 12 years (n=402), and (c) FMI at 12 years and waist at 12 years (n=445). All models are adjusted for sex and pubertal status (for subscales, data shown in final models only)

	OR	95% CI	p
Total Score			
(a) Sex (female)	0.60	0.36-0.98	0.04
Pubertal status	0.53	0.34-0.82	0.004
FMI at 12 years	0.76	0.69-0.83	<0.001
(b) Sex (female)	0.42	0.27-0.66	<0.001
Pubertal status	0.76	0.51-1.12	0.2
Waist circumference at 12 years	0.92	0.89-0.95	<0.001
(c) Sex (female)	0.46	0.29-0.72	0.001
Pubertal status	0.72	0.50-1.05	0.09
FMI at 12 years	0.82	0.72-0.93	0.002
Waist circumference at 12 years	0.97	0.93-1.01	0.2
Sub-scales			
Body Esteem			
(a) FMI at 12 years	0.75	0.69-0.83	<0.001
(b) Waist circumference at 12 years	0.92	0.89-0.94	<0.001
(c) Sex (female)	0.42	0.27-0.66	<0.001
Pubertal status	0.62	0.43-0.91	0.01
FMI at 12 years	0.81	0.71-0.92	0.001
Waist circumference at 12 years	0.97	0.93-1.00	0.2
Physical Comfort			
(a) FMI at 12 years	0.79	0.72-0.87	<0.001
(b) Waist circumference at 12 years	0.93	0.90-0.95	<0.001
(c) Sex (female)	1.14	0.64-2.04	0.7
Pubertal status	1.03	0.64-1.65	0.9
FMI at 12 years	0.90	0.77-1.05	0.2
Waist circumference at 12 years	0.95	0.90-1.00	0.06
School Life			
(a) FMI at 12 years	0.77	0.70-0.84	<0.001
(b) Waist circumference at 12 years	0.92	0.89-0.95	<0.001
(c) Sex (female)	1.01	0.62-1.79	0.8
Pubertal status	1.12	0.73-1.72	0.6
FMI at 12 years	0.81	0.70-0.94	0.005
Waist circumference at 12 years	0.97	0.92-1.02	0.2
Family Relations			
(a) FMI at 12 years	0.9	0.81-0.97	0.01
(b) Waist circumference at 12 years	0.96	0.93-0.99	0.02

IWQOL-Kids, Impact of Weight on Quality of Life-Kids; FMI, fat mass index; OR, odds ratio; CI, confidence interval.

DISCUSSION

Impairment in HRQoL was associated with higher current adiposity but the prediction of impaired HRQoL was not improved by information on the change in adiposity from an earlier age. Cross-sectionally, higher adiposity was related to lower *Physical Well-Being* on the generic instrument, and higher adiposity and being female was related to the *Total Score* and the *Body Esteem* subscale on the weight-specific instrument; this sex difference was not due to differences in pubertal status as this was controlled for. Higher adiposity was also related to the *Physical Comfort* and *School Life* subscales. Overall, the fat mass index had more explanatory power than waist circumference.

The results of this study are consistent with previous literature reporting that lower physical well-being is related to higher adiposity in obese clinical samples of children and adolescents[26-28] and population samples in different cultures.[7-11] Once adiposity at 12 years was taken into account, there was no evidence that the change in adiposity from 7 years or 9 years predicted HRQoL at 12 years. The only other longitudinal study we are aware of using self-reported HRQoL data, is in an older age range of 8-13 year olds followed up at 13-19 years[29] which shows that the adolescents who changed from their BMI category at baseline to a higher one at follow-up tended to have more HRQoL impairment than those who remained in the same BMI category. Regression analyses showed no statistically significant relationships between earlier BMI and later HRQoL in the self-reports.[29]

The present study provides some new insights into how higher adiposity can impact on specific aspects of the lives of young adolescents; being fatter was related adversely to three domains of HRQoL measured by the IWQOL instrument. Of particular interest is that body esteem was impaired, especially in girls. A previous study using the IWQOL-Kids with adolescents drawn from weight loss programmes and community samples reported significant sex differences in the total score and body esteem sub-scale but not in any other sub-scales.[23] Our results replicate the results of this previous study in a general population sample.

This study has two main strengths. First, HRQoL was measured using newly developed generic and weight-specific instruments with good psychometric qualities. Although the analysis plan included multiple significance tests, a high threshold of $p<0.01$ significance level was used to account for this. Moreover the findings are plausible and consistent with previous research. Second, the study used a longitudinal design in a relatively large population sample.[17] As with other community-based studies[30 ,31] there is retention bias in this sample with higher attrition in the more deprived families. However, in this cohort because the most affluent families were under-represented at original recruitment the cohort has become more representative of northeast England over time.[17] It is acknowledged that there is potentially higher measurement error in waist circumference than height and weight, which may have led to the fat mass index having more explanatory power. This possibility is unlikely due to the training sessions the researchers received for body measurements and procedures used to reduce measurement error - taking duplicate measures of height, weight and waist consecutively reduces recall bias of the person taking the measuerments. A weakness of the study is that although it is longitudinal in terms of adiposity measures, data on HRQoL on the cohort was not available for the earlier datasweeps so it is not possible to report whether adolescents with lower HRQoL at 7 years or 9 years were more likely to become overweight subsequently.

Cross-sectional associations between overweight and poorer psychological health by late childhood are proving to be consistent across measures and samples. Further research is needed to determine whether young children with self-reported lower HRQoL are at risk from becoming overweight, perhaps by eating in response to emotional problems.[32]

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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