

1 Weight status and health-related quality of life during childhood and adolescence: effects of age and
2 socioeconomic position

3 Running Title: Influences on weight and quality of life association in children

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21

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23 **Abstract**

24 **Background:** Overweight and obesity in children is associated with poor health-related quality of life
25 (HRQoL), but the nuances of this relationship across different age and socio-demographic groups are
26 not well-established. The aim of this study is to examine how the association between weight status
27 and HRQoL changes with age and socioeconomic position (SEP) throughout childhood and
28 adolescence.

29 **Methods:** We used data from the Longitudinal Study of Australian Children (LSAC); a cohort study in
30 which children were interviewed biennially from ages 4-5 to 16-17. Measurements of HRQoL (using
31 PedsQLTM), BMI, and sociodemographic characteristics were collected at each interview. Of the 4983
32 children recruited into the study, we included data from 4083 children (a total of 24 446
33 observations). We used generalised estimating equations to assess whether age and SEP modified
34 the association between weight status and HRQoL, after controlling for sex, long-term medical
35 condition, language spoken to child and maternal smoking status.

36 **Results:** Age was a significant modifier of the association between weight status and HRQoL, with
37 adjustment for known predictors of HRQoL ($P < 0.001$). At age 4, children with obesity had, on
38 average, a 0.99 (95% CI 0.02 to 1.96) point lower PedsQL total score than children at healthy weight.
39 This difference became clinically important by age 9 at 4.50 (95% CI 3.86 to 5.13) points and
40 increased to 6.69 (95% CI 5.74 to 7.64) points by age 17. There was no evidence that SEP modified
41 the relationship between weight status and HRQoL ($P > 0.05$).

42 **Conclusions:** Our results demonstrate that the relationship between overweight and obesity status
43 and poor HRQoL is strengthened with increasing age through childhood and adolescence, but is not
44 affected by SEP. Paediatricians, researchers and carers of children with obesity should acknowledge
45 HRQoL outcomes, particularly for older children and adolescents.

46

47 **Introduction**

48 Despite countless calls to action, commissions and government initiatives, tackling childhood obesity
49 remains one of the most daunting public health challenges of our time. One likely reason for the
50 limited success of existing approaches is an inadequate grasp of the complex drivers and
51 consequences of childhood obesity. For example, there is a growing body of evidence showing that
52 the consequences extend beyond physical health and that children and adolescents with overweight
53 or obesity have poorer quality of life than those at healthy weight (1-6). Adding to this complexity
54 are the indications that this relationship is sensitive to demographic factors such as age and
55 socioeconomic position. In two Australian studies, for instance, one following children through
56 primary school ages and the other combining three cohorts of children spanning ages 2 to 18 years,
57 the relationship between weight status and health related quality of life (HRQoL) only became
58 apparent from age 8 in the former study and age 6 in the latter (3, 6). However, in a German study of
59 children aged 8 to 16 years, the opposite effect was observed where the HRQoL impairment in
60 adolescents with obesity compared to those at healthy weight was not as severe as the impairment
61 in pre-adolescents (7).

62 In addition to the effects of age, there are indications that socioeconomic position (SEP) also
63 impacts the weight status-HRQoL relationship. In descriptive analyses of 9 to 12-year-old children
64 from Victoria, Australia, children of mothers with low education status had larger decrements in
65 HRQoL scores associated with higher weight categories than children of mothers with high education
66 (2). Furthermore, a cross-sectional study in English adults found a significant interaction between
67 weight status and SEP when assessing their impact on HRQoL, measured by the EQ-5D (8).

68 However, no study, to our knowledge, has used longitudinal analysis to examine the contributing
69 effects of age and SEP to the relationship between weight status and HRQoL throughout childhood
70 and adolescence. With the published cross-sectional analyses, the direction of the age effects, and
71 whether they are due to changes to the sample characteristics over time, rather than age itself, is

unclear. Furthermore, the impact of SEP on the relationship has not been formally assessed statistically in a childhood or adolescent population.

In this study, we use longitudinal analysis to investigate the relationship between weight status and HRQoL in a nationally representative community sample of children with twelve years of follow-up through the childhood and adolescent periods. Specifically, we formally investigated: first, how the association between weight status and HRQoL, including its physical and psychosocial components, changes through childhood and adolescence; and, second, if the association between weight status and HRQoL changes with SEP. This analysis will bring some clarity to the complex outcomes of children and adolescents with overweight or obesity.

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Subjects and Methods

Study Data

Data from the Longitudinal Study of Australian Children (LSAC) were used in this analysis with approval from the University of Sydney Human Research Ethics Committee. LSAC is an ongoing nationwide cohort study that has followed two cohorts of children since 2004. Here, data collected from the Kindergarten cohort were used to follow the transition from childhood to adolescence. These children and their families were interviewed biennially resulting in seven waves of data; the children were aged 4-5 years at wave 1, 6-7 years at wave 2, 8-9 years at wave 3, 10-11 years at wave 4, 12-13 years at wave 5, 14-15 years at wave 6 and 16-17 years at wave 7. Participants were selected using a two-stage clustered design to obtain a sample representative of all Australian children born between March 1999 and February 2000, except for those residing in remote areas. The sampling design is described in detail elsewhere (9).

Measures

Health-related quality of life. The primary outcome analysed was HRQoL measured using the Paediatric Quality of Life InventoryTM (PedsQL Generic Core Scales (GCS)) (hereafter PedsQL for brevity), a validated multidimensional scale that measures HRQoL in populations aged 2 to 18 years. PedsQL is a 23-item scale with four sub-scales: Physical Functioning (8 items), Social Functioning (5 items), Emotional Functioning (5 items) and School/Day care Functioning (5 items) (10). A five-point Likert scale is utilised for each item and the response is then reverse transformed to a number between 0 to 100 where a higher number corresponds to better HRQoL. The PedsQL demonstrates high reliability and validity, and the parent-proxy version exhibits strong concordance with the self-report version (10). In LSAC, the parent-proxy version was used and answered by the parent who knew the study child best, which was usually the child's biological mother (11). The total PedsQL score was calculated as the mean of all answered questions, with no total score calculated if more than 50% of items were missing, although missing item responses were minimal: of the interviews where any PedsQL questions were answered, 93% had all questions answered and only 0.03% had no total score calculated. In addition to total PedsQL score, we conducted secondary analyses on the physical health summary score (mean of Physical Functioning items) and the psychosocial health summary score (mean of Social, Emotional and School/Day care functioning items).

Weight status. The primary exposure was the child's weight status as a categorical variable. In LSAC, anthropometric measurements of the child's height and weight were taken at every wave (12). Height was measured using an Invicta stadiometer in waves 1-3 and a laser stadiometer in waves 4-7. Two measurements were taken at each wave and if they differed by 0.5cm or more, a third was taken. The mean of the two closest measurements was recorded. Weight was measured using Salter Australia glass bathroom scales in wave 1, HoMedics digital BMI bathroom scales in waves 2 and 3 and Tanita body fat scales in waves 4-7. Height and weight were converted to Body Mass Index (BMI) and top-coded to allow data to remain confidential. We categorised BMI into three groups: healthy and underweight, overweight and obese using World Health Organisation cut-offs for each age and

sex (13, 14). Healthy and underweight categories were combined due to small counts in the underweight category.

Demographic factors. The study child's age was calculated as the time between their date of birth and the date of their interview at each wave and was included as a continuous variable precise to the day. A composite measure of SEP, provided by the LSAC, was used which combined parents' education, parents' occupation and family income into a single variable, converted to a z-score (15). We categorised this variable into high and low SEP corresponding to a z-score of above or equal to 0, and a z-score below 0, respectively. For the primary analysis, SEP from the first wave was included as a permanent characteristic for each participant.

Predictors of HRQoL. The following known predictors of child HRQoL were included as controlling covariates: indigenous status (3), language other than English (LOTE) spoken to child (3, 16), mother's current smoking status (16), and child's long-term medical condition or disability (present, not present) (17). Indigenous status and LOTE spoken to child were included as permanent characteristics using baseline values. Information on mother's current smoking status was collected at every wave except the final wave and was included as a time-varying variable. A last observation carried forward approach was used to impute the mother's smoking status in the final wave as previous smoking status was likely the strongest predictor of current smoking status. Information on whether the study child had a long-term medical condition or disability (defined as lasting six months or longer) was collected at every wave and was also included as a time-varying variable.

139 *Statistical Analysis*

We fitted linear models with generalised estimating equations (GEE), with compound-symmetry working correlation matrix, to determine the association between weight status and each HRQoL outcome (total PedsQL score, physical health summary score and psychosocial health summary score), and if this association was modified by age or SEP. Fitting the models with GEE accounts for intra-individual correlation caused by the repeated measurement of each variable, collected for each

child over the seven waves of the study. Other benefits of this approach are that it can incorporate time-varying covariates and use partial information from participants who have missed some waves of data collection. We fitted a linear model for weight status and each outcome; first, unadjusted for covariates; second, adjusted for age, SEP, indigenous status, LOTE spoken to child, mother's current smoking status and child's long-term medical condition or disability; and third, adjusted for the same covariates with added interaction terms between weight status and SEP, and weight status and age.

Finally, we predicted the mean total PedsQL scores, physical health summary scores and psychosocial health summary scores from the third model with interactions by integer age (in years) and weight status using the *margins* command in STATA with mean values specified for all covariates. We also predicted mean total PedsQL scores by integer age, weight status and SEP. Except for mother's smoking status at Wave 7, imputation was not conducted as imputation of the exposure (weight status) or outcome (PedsQL) may have biased the results, and missingness of covariates among observations complete for weight status and PedsQL was less than 3%. All analyses were conducted in STATA version 15.0.

Sensitivity Analysis

We conducted sensitivity analyses to test whether certain analysis decisions and assumptions affected the results. Firstly, we reanalysed the data using CDC growth standards (18) rather than WHO growth standards for categorisation of BMI. We further reanalysed the data using population longitudinal weights provided in the LSAC dataset (19) to assess whether loss of participants over the seven waves of data collection was likely to have influenced the results. Finally, we reanalysed the data using a time-varying measure of SEP (high/low) at each wave, rather than using baseline SEP.

Results

General characteristics of the study population at baseline

At baseline (wave 1), the study sample comprised of 4983 children born between March 1999 and February 2000 and aged between 4-5 years (12) of whom 4171 (84%) had BMI and total PedsQL scores recorded (tables 1 and 2). Three hundred and sixty-eight (9%) of these children had obesity, 999 (24%) were overweight but did not have obesity, and the remaining 2804 (67%) were at healthy weight or underweight. As there were only 23 children who were underweight at baseline, underweight and healthy weight categories were combined (hereafter healthy weight for brevity). Among children with obesity there was a higher representation of those in low SEP, with a LOTE spoken to the child, with indigenous status, with mothers who were current smokers and with a long-term medical condition compared to those of lower weight status (Table 1). At baseline, unadjusted mean total PedsQL scores and the summary scores were slightly lower in children with obesity than the other weight status categories (Table 1).

Attrition and Missingness

With 4983 children recruited into the LSAC Kindergarten cohort, and seven waves of interviews, there were a possible 34 881 observations that could be entered into this analysis. Throughout the study, there has been a steady attrition of participants, but by Wave 7, 3089 of the original 4983 children were still participating (Table 2) and this corresponded to 28 529 administered interviews (82%). Of the participants that were interviewed in each wave, those with complete information on BMI and total PedsQL ranged between 77% and 96% (Table 2) corresponding to 25 103 observations (88% of interviews). Within observations that had complete data on BMI and total PedsQL, less than 3% had missing data for the covariates baseline SEP, sex, LOTE spoken to child, indigenous status, mother's smoking status, and long-term medical condition, leaving 24 446 observations included in each multivariate analysis.

Statistical Analysis

In the model adjusted for all covariates without interaction terms, HRQoL measured by the total PedsQL score was significantly associated with overweight and obese status ($P < 0.001$) (Table 3). As

shown by the model with interaction terms included (Table 4), age affected the association between weight status and total PedsQL score ($P<0.001$ for both age by overweight and age by obese interaction terms). As age increased, the relationship between weight status and total PedsQL score strengthened. Sex was not significantly associated with total PedsQL score ($P=0.50$) but was strongly associated with both the physical health summary score ($P=0.001$) and psychosocial health summary score ($P=0.005$) in opposite directions. On average, girls had lower physical health and higher psychosocial health scores than boys. Children of lower SEP had a slightly lower total PedsQL score (approximately 2 points) across all ages and weight classes, but SEP did not affect the association between weight status and total PedsQL score ($P=0.79$ for low SEP by overweight interaction and $P=0.61$ for low SEP by obese interaction). We found similar results when conducting analyses using physical and psychosocial health summary scores (Table 4). Overall, these results indicate that age, but not SEP, modifies the relationship between weight status and HRQoL.

The adjusted mean total PedsQL scores and summary scores by integer age and weight status, as predicted by the multivariate models with interactions, are presented in Figure 1. Children with healthy weight had total PedsQL scores that decreased slightly from age 4 to age 17 years (Figure 1a). The decrease in total PedsQL scores was steeper in children who were overweight and even steeper in those with obesity. At age 4 years, the difference in the predicted mean total PedsQL scores between those with healthy weight and those with obesity was 1.0 point (95% CI 0.0 to 2.0), by age 9 it was 4.5 points (95% CI 3.9 to 5.1) and by age 17 it was 6.7 points (95% CI 5.7 to 7.6). Similar trends were observed for children with overweight and obesity with regards to the summary scores (Figure 1b and Figure 1c), whereas children at healthy weight had slightly increasing physical health summary scores from age 4 to age 17 years. By age 17 years, the difference in physical health summary scores between those at healthy weight and those with obesity increased from 1.2 points (95% CI 0.1 to 2.5) to 10.4 points (95% CI 9.1 to 11.6). As shown in Figure 2, for children at all three weight statuses, those of low SEP had consistently lower total PedsQL scores than those of high SEP.

218 *Sensitivity analyses*

219 Separate analyses of the data using CDC growth standards (Supplementary Table 1), LSAC
220 longitudinal weights (Supplementary Table 2) and a time-varying measure of SEP (Supplementary
221 Table 3) did not alter the main results from this study. While the coefficients changed slightly, the
222 relationship between weight status and total PedsQL score was shown to strengthen with age in
223 every analysis ($P < 0.02$ for each interaction with age in each analysis), whilst there was no evidence
224 that SEP modified this relationship ($P > 0.1$ for each interaction with SEP).

225 **Discussion**

226 In this study, we used a very large dataset from a national longitudinal study to investigate how
227 demographic factors affect the relationship between weight status and HRQoL through childhood
228 and adolescence. Our results confirm that children with overweight and obesity have poorer HRQoL
229 than those at healthy weight and provide a strong indication that the age of the child modifies this
230 relationship (Table 3). Specifically, as children move into adolescence, the relationship strengthens
231 and small differences in HRQoL between those with obesity and those at healthy weight develop
232 into large decrements. While SEP has an independent impact on HRQoL, our results provide no
233 evidence that it affects the association between weight status and HRQoL.

234 To our knowledge, this is the first study to utilise longitudinal data following the same
235 children over a decade into late adolescence to examine how age and SEP affects the weight status-
236 HRQoL relationship. The study by Jansen, et al (3), for example, used the first four waves of LSAC
237 data capturing only the primary-school years. Furthermore, the study by Wake, et al (6) extracted
238 data for three different cohorts of participants, covering different age groups, and did not combine
239 the physical and psychosocial scores to examine overall HRQoL. Therefore, the study was not able to
240 disentangle age effects on the weight status-HRQoL association across the spectrum of childhood
241 and adolescent years. In contrast to both these studies where separate cross-sectional analyses
242 were conducted in different age groups, we used generalised estimating equations to collate over

24000 observations from seven waves of interviews. This technique accounts for correlation between repeated observations in the same individuals, allows adjustment for permanent and time-varying characteristics that can affect HRQoL, and facilitates formal assessment of the potential modifying effects of age and SEP through interaction analyses.

Our results support those of the study by Jansen, et al, which showed that the coefficients for BMI z-scores on PedsQL scores increased, and their corresponding P-values decreased in magnitude, with each progressive wave (3). Our study included six additional years of follow up and demonstrated that this trend continues into adolescence. However, the results of our study and those of the two earlier Australian studies (3, 6) contrast with those from a study of German children in which adolescent children with obesity had smaller impairments in HRQoL, compared to those of the same age at healthy weight, than pre-adolescent children. The authors of this study attribute the smaller relative effect in the older age group to the overall substantial decrease in HRQoL observed over the childhood to adolescent transition period; a trend that was barely detectable in children at healthy weight in our study (Table 2).

The significant age-weight status interaction found in our study may explain why studies in younger children often do not detect an association between weight status and HRQoL. For example, a recent study in the United Kingdom found no evidence of an association between weight status and outputs from a preference-based measure of HRQoL (CHU-9D) in a sample of over 1000 children between 5 to 10 years of age (20). Our secondary outcome analyses revealed that the age-weight status interaction is also present for the physical health and psychosocial health summary scores of the PedsQL, suggesting that the primary outcome effect is the result of the net effect of different aspects of HRQoL. Interestingly, the adjusted mean physical health scores for children at healthy weight or underweight gradually increased from ages 4-17 years, while those with overweight or obesity had decreasing scores and this decrease was particularly dramatic in those classified as obese (Figure 1). One possible explanation for this is that children with overweight or obesity have slower development of general motor skills or physical fitness than those at healthy

weight, which is consistent with findings from recent cohort studies investigating physical development in children and adolescents (21, 22)

Considering that the transition from childhood to adolescence coincides with major biological and social changes, it is not surprising that an overall decrease in psychosocial health was observed during this period. Adolescents are particularly susceptible to weight stigma and discrimination, which can lead to emotional distress and problematic social relationships (23, 24). In contrast to our results, a recent study found that psychosocial outcomes were stable, but still poor, in children with overweight or obesity aged 8-13 at baseline (25). However, the follow-up period was only two years in that study, so it's possible that the period of follow-up was not sufficient to observe an age-dependent relationship.

Another main finding of our study is that there is no evidence of an interaction between SEP and weight status. Although socioeconomic inequalities exist in both obesity prevalence (26) and HRQoL outcomes (27) in childhood, our results show that the *association* between weight status and HRQoL in 4 to 17-year-old children is not affected by SEP. This differs from previous descriptive analyses of 9 to 12-year-old children (2) and regression analyses in adults (8). This may be because the observed effects in children in the study by Williams et al were driven by predictors of HRQoL that were not controlled for (2) or that the interaction only exists in adults and not children.

The main limitation of our analysis is the loss of participants over the seven waves of data collection, which could potentially bias the results and our conclusions. However, when using the population longitudinal weights, which are calculated to increase the weighting of participants with similar characteristics to those who are lost, the coefficients only changed slightly and the overall conclusion remained unaffected (Supplementary Table 3); namely, there was strong evidence that age modified the relationship between weight status and HRQoL ($P=0.017$ for age by overweight and $P<0.001$ for age by obese interaction terms). Furthermore, while it is possible that the participants that were lost by the final wave had different outcomes at later waves than at baseline (and different to those that continued to be followed up), it is unlikely that the losses were biased

towards children with better health outcomes (i.e. low BMI and high PedsQL scores). Finally, by using GEE, we were unable to simultaneously account for the complex sampling strategy used in the selection process. While the study sample may not be considered representative of the whole Australian childhood population, the result still holds true for the almost 5000 children who participated. We used GEE because it allows all the observations from seven waves of data collection to be analysed together while controlling for repeated measurements in the same individual. This provided conservative estimates for our research questions and facilitated the formal assessments of interactions between age and weight status, which would not have been possible by conducting multiple cross-sectional analyses.

Our results show that the immediate health outcomes of overweight and obesity in childhood can change with the age of the child. While there are only small decrements in HRQoL in children with obesity at age four, this decrement reaches a clinically meaningful amount, according to validation of the PedsQL instrument (10), of 4.5 points by age nine compared to children at healthy weight, when adjusting for known predictors of poor HRQoL. By age 17, the mean total PedsQL score for a child with obesity is 72.2 which is comparable to the score of a child with chronic health conditions such as asthma, diabetes, ADHD, and juvenile rheumatoid arthritis (10).

Our results are relevant to clinicians, trialists and health economists whose work addresses childhood and adolescent obesity. Clinicians treating paediatric patients with obesity and researchers trialling obesity treatment or prevention strategies must consider the age of their target group when implementing their interventions. Interventions targeted at children under nine years may not have an immediate impact on HRQoL but may prevent severe impairments in HRQoL at later stages. If their interventions are targeted at adolescents, on the other hand, any weight loss that brings that individual into a lower weight status category may also result in a direct improvement in their HRQoL. Furthermore, impacts of interventions on weight should have the same relative impact on HRQoL regardless of SEP. However, the absolute HRQoL would likely be lower in children at lower SEPs so these sociodemographic contexts should still be accounted for.

Health economists who assess the cost-effectiveness and cost-utility of interventions addressing childhood obesity should consider the age of the child when applying health utility values derived from HRQoL measures to study participants of differing weight status. Further work is needed in this area to determine if the age-dependent effect on the weight status – HRQoL relationship continues into early adulthood.

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Competing Interests

The authors have no competing interests to declare.

Supplementary information is available at International Journal of Obesity's website.

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406 Figure Legends

407 **Figure 1 Association between weight status and each HR-QoL score strengthens with increasing**
408 **age.** Plotted values are the predicted mean a) Total PedsQL scores b) Physical Health Summary
409 Scores and c) Psychosocial Health Summary Scores with 95% confidence intervals by weight status
410 and age adjusted for sex, socioeconomic position, indigenous status, language other than English
411 spoken to child, long-term medical condition and maternal smoking status.

412 **Figure 2 Children at low socioeconomic positions have consistently lower HR-QoL than those at**
413 **higher socioeconomic positions.** Plotted values are the predicted mean Total PedsQL scores by
414 socioeconomic position, weight status and age with 95% confidence intervals adjusted for sex,
415 indigenous status, language other than English spoken to child, long-term medical condition and
416 maternal smoking status.

417

418

Table 1 General Characteristics by weight status at baseline (age 4-5)^

		Healthy and Underweight* (n=2804)	Overweight (n=999)	Obese (n=368)
		n(%)		
Socioeconomic Position	Low SEP	1425 (50.8)	549 (55.0)	226 (61.4)
	High SEP	1374 (49.0)	449 (44.9)	140 (38.0)
	Missing	5 (0.2)	1 (0.1)	2 (0.5)
Sex	Male	1375 (49.0)	549 (55.0)	204 (55.4)
	Female	1429 (51.0)	450 (45.1)	164 (44.6)
LOTE Spoken to Child	Yes	504 (18.0)	184 (18.4)	93 (25.3)
	No	2300 (82.0)	815 (81.6)	275 (74.7)
Indigenous Status	Indigenous	76 (2.7)	32 (3.2)	24 (6.5)
	Not Indigenous	2728 (97.3)	967 (96.8)	344 (93.5)
Mother's Smoking Status	Current Smoker	606 (21.6)	216 (21.6)	117 (31.8)
	Not current smoker	2139 (76.3)	767 (76.8)	246 (66.9)
	Missing	59 (2.1)	16 (1.6)	5 (1.4)
Long Term Medical Condition	Yes	539 (19.2)	202 (20.2)	97 (26.4)
	No	2265 (80.8)	797 (79.8)	271 (73.6)
		mean (SD)		
PedsQL scores	Total PedsQL score	81 (0.2)	81.5 (0.3)	79.1 (0.7)
	Physical Health Summary Score	82.8 (0.2)	83.3 (0.4)	81.1 (0.8)
	Psychosocial Health Summary Score	79.9 (0.2)	80.3 (0.4)	77.8 (0.7)

^Counts, proportions and means are within those with complete information on BMI and PedsQL

*23 children were underweight at baseline

Table 2 Attrition and missingness over seven waves of data collection in the Longitudinal Study of Australian Children

Wave	Age of children (years)	Children interviewed (n)	Children with complete information on BMI and PedsQL n(%) ¹	Children with complete information on all covariates (final analysis population) n(%) ²
1	4-5	4983	4171 (83.7)	4083 (97.9)
2	6-7	4464	3455 (77.4)	3410 (98.7)
3	8-9	4331	3775 (87.2)	3715 (98.4)
4	10-11	4169	3982 (95.5)	3880 (97.4)
5	12-13	3956	3740 (94.5)	3616 (96.7)
6	14-15	3537	3197 (90.4)	3101 (97.0)
7	16-17	3089	2783 (90.1)	2641 (94.9)
Total Observations		28529	25103 (88.0)	24446 (97.4)

¹Proportions are within the number of children interviewed

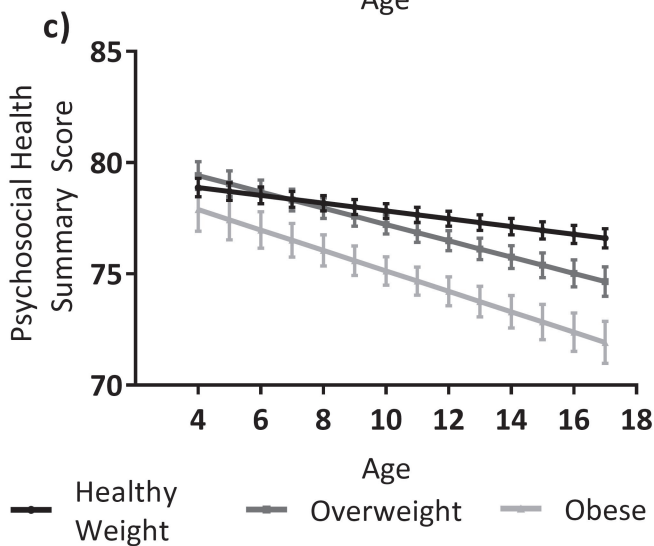
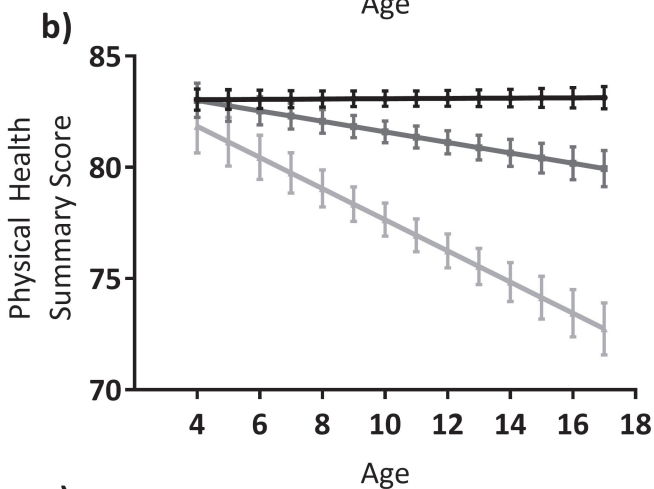
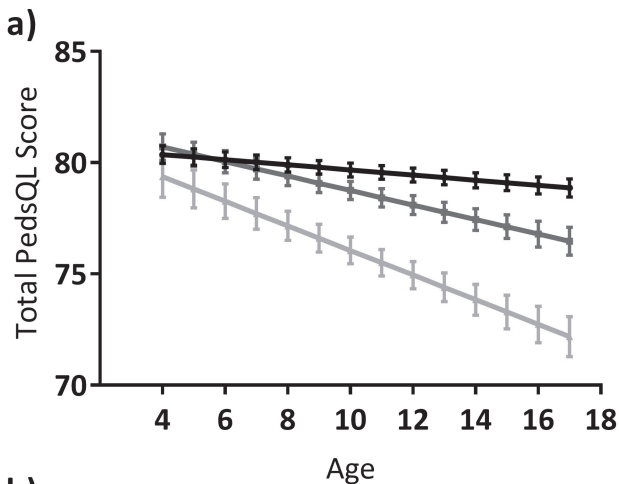
²Proportions are within the number of children with complete information on BMI and PedsQL

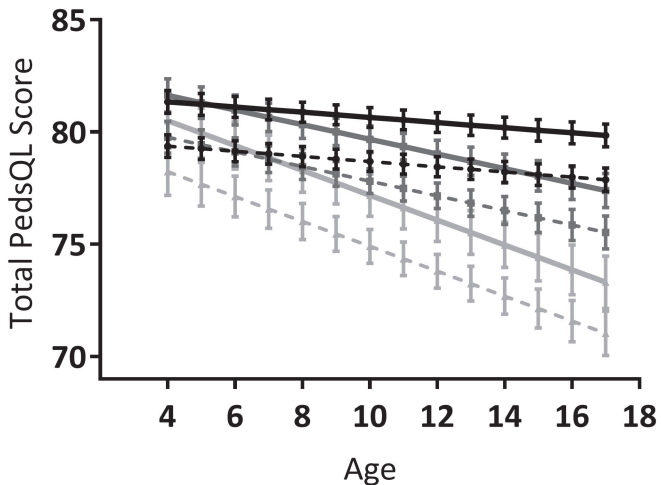
Table 3 GEE Adjusted analyses without interactions for total PedsQL score, Physical Health Summary Score and Psychosocial Health Summary Score.

	Total PedsQL Score		Physical Health Summary Score		Psychosocial Health Summary Score	
	Coefficient (95% CI)	P Value	Coefficient (95% CI)	P Value	Coefficient (95% CI)	P Value
Overweight	-0.97 (-1.36 to -0.58)	<0.001	-1.55 (-2.06 to -1.04)	<0.001	-0.64 (-1.05 to -0.23)	0.002
Obese	-3.93 (-4.54 to -3.33)	<0.001	-5.92 (-6.67 to -5.16)	<0.001	-2.92 (-3.55 to -2.28)	<0.001
Age	-0.20 (-0.23 to -0.17)	<0.001	-0.11 (-0.16 to -0.07)	<0.001	-0.24 (-0.28 to -0.21)	<0.001
Female	0.15 (-0.41 to 0.72)	0.593	-1.11 (-1.72 to -0.5)	<0.001	0.82 (0.21 to 1.43)	0.006
Low SEP	-2.00 (-2.57 to -1.42)	<0.001	-1.57 (-2.19 to -0.94)	<0.001	-2.22 (-2.84 to -1.59)	<0.001
Indigenous	-2.94 (-4.60 to -1.27)	0.001	-2.46 (-4.31 to -0.62)	0.009	-3.21 (-5.00 to -1.41)	<0.001
LOTE spoken to child	-2.65 (-3.37 to -1.93)	<0.001	-3.53 (-4.31 to -2.75)	<0.001	-2.26 (-3.03 to -1.48)	<0.001
Mother is a current smoker	-1.42 (-1.96 to -0.89)	<0.001	-1.74 (-2.4 to -1.09)	<0.001	-1.34 (-1.91 to -0.78)	<0.001
Has long-term medical condition	-3.19 (-3.67 to -2.71)	<0.001	-3.16 (-3.79 to -2.52)	<0.001	-3.44 (-3.94 to -2.94)	<0.001
Constant	83.75 (83.12 to 84.38)	<0.001	86.88 (86.13 to 87.62)	<0.001	82.04 (81.37 to 82.72)	<0.001

Table 4 GEE Adjusted analyses with interactions for total PedsQL score, Physical Health Summary Score

	Total PedsQL Score		Physical Health Summary Score		Psychosocial Health Summary Score	
	Coefficient (95% CI)	P Value	Coefficient (95% CI)	P Value	Coefficient (95% CI)	P Value
Overweight	1.13 (0.12 to 2.14)	0.029	1.11 (-0.25 to 2.47)	0.109	1.13 (0.07 to 2.19)	0.037
Obese	0.92 (-0.61 to 2.44)	0.238	1.88 (-0.12 to 3.89)	0.066	0.29 (-1.30 to 1.89)	0.720
Age	-0.12 (-0.15 to -0.08)	<0.001	0.01 (-0.05 to 0.06)	0.799	-0.18 (-0.22 to -0.13)	<0.001
Female	0.17 (-0.40 to 0.73)	0.562	-1.10 (-1.71 to -0.48)	0.001	0.83 (0.22 to 1.44)	0.007
Low SEP	-1.97 (-2.6 to -1.34)	<0.001	-1.41 (-2.11 to -0.7)	<0.001	-2.26 (-2.93 to -1.58)	<0.001
Indigenous	-2.96 (-4.62 to -1.29)	<0.001	-2.48 (-4.33 to -0.64)	0.008	-3.22 (-5.02 to -1.43)	<0.001
LOTE spoken to child	-2.68 (-3.39 to -1.96)	<0.001	-3.56 (-4.34 to -2.78)	<0.001	-2.28 (-3.05 to -1.5)	<0.001
Mother is a current smoker	-1.43 (-1.96 to -0.90)	<0.001	-1.75 (-2.41 to -1.10)	<0.001	-1.35 (-1.91 to -0.79)	<0.001
Has long-term medical condition	-3.22 (-3.69 to -2.74)	<0.001	-3.19 (-3.83 to -2.56)	<0.001	-3.46 (-3.95 to -2.96)	<0.001
Age*Overweight	-0.21 (-0.29 to -0.13)	<0.001	-0.24 (-0.35 to -0.13)	<0.001	-0.19 (-0.28 to -0.11)	<0.001
Age*Obese	-0.44 (-0.55 to -0.33)	<0.001	-0.71 (-0.86 to -0.55)	<0.001	-0.28 (-0.40 to -0.17)	<0.001
Low SEP*Overweight	0.10 (-0.68 to 0.88)	0.794	-0.35 (-1.36 to 0.67)	0.500	0.35 (-0.46 to 1.17)	0.395
Low SEP*Obese	-0.31 (-1.53 to 0.92)	0.622	-0.50 (-2.05 to 1.05)	0.526	-0.29 (-1.58 to 1.00)	0.661
Constant	82.84 (82.16 to 83.52)	<0.001	85.57 (84.75 to 86.39)	<0.001	81.36 (80.63 to 82.09)	<0.001





- Healthy Weight High SEP
- Healthy Weight Low SEP
- Overweight High SEP
- Overweight Low SEP
- ▲— Obese High SEP
- ▲- Obese Low SEP