Soc Psychiatry Psychiatr Epidemiol
DOI 10.1007/s00127-015-1101-7

ORIGINAL PAPER

Adiposity and psychosocial outcomes at ages 30 and 35

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Received: 16 December 2014 / Accepted: 4 August 2015

Abstract
Purpose To examine associations between adiposity and adult psychosocial outcomes (depressive symptoms, life satisfaction, self-esteem, household income, personal income, savings/investments) in a New Zealand birth cohort, by gender. Adiposity was assessed using Body Mass Index scores classified on a 3-point scale of BMI: <25.0, overweight (25.0–29.9) or obese (≥30).
Methods Data were gathered via face-to-face and telephone interviews for the Christchurch Health and Development Study (CHDS), comprising a birth cohort of 1265 children born in Christchurch, New Zealand, in 1977. BMI and psychosocial outcome information was collected in 2007 (30 years; $n = 977$) and in 2012 (35 years; $n = 923$).
Results Population-averaged regression modeling showed evidence of statistically significant ($p < 0.05$) associations between increasing adiposity and adverse psychosocial outcomes for females, but not for males. After adjustment for child and family background covariates the strength of the associations for females was reduced; with four associations (depressive symptoms, life satisfaction, equivalized household income and savings/investments) remaining statistically significant ($p < 0.05$). In contrast, for males there was a significant ($p = 0.008$) positive association between adiposity and higher personal net weekly income after covariate adjustment.
Conclusions The findings suggest evidence of gender differences in the associations between adiposity and psychosocial outcomes. For females, there were small but pervasive tendencies for increasing adiposity to be related to more adverse mental health, psychological well-being and economic outcomes; whereas for males adiposity was either unrelated to these outcomes, or in the case of personal income, associated with greater economic advantage. The implications of these findings are discussed.

Keywords Obesity · Adiposity · BMI · Depression · Psychosocial outcomes · Gender

Introduction

In recent years, there have been growing concerns about increasing rates of obesity in the OECD [1, 2]. One aspect of this research has focused on the psychosocial and economic consequences of obesity [3]. In particular, research and reviews of the evidence have shown that overweight and obese adults experience a range of adverse mental health, psychological and economic outcomes including: increased rates of depression and/or anxiety [4–10], lower life satisfaction [11], lower self-esteem [12], lower incomes [12, 13], higher rates of poverty [13] and lower socioeconomic status [14, 15].

However, a number of studies in this area have suggested that the associations between obesity and psychosocial outcomes are modified by gender [11, 14, 16,

Electronic supplementary material The online version of this article (doi:10.1007/s00127-015-1101-7) contains supplementary material, which is available to authorized users.

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Published online: 14 August 2015

17]; with females showing greater disadvantage than males [4, 5, 10, 12–14, 17]. For example, an analysis of the associations between obesity (BMI $\geq$ 30) and past-month depression in the U.S population was reported by Onyike et al. [4] using data from the Third National Health and Nutrition Examination Survey. This cross-sectional study of 8773 respondents (4028 males; 4745 females) showed that female obesity (BMI $\geq$ 30) was significantly associated with increased odds of past-month depression (assessed using DIS/DSM-III (Diagnostic Interview Schedule and the Diagnostic and Statistical Manual for Mental Disorders), while male obesity was not.

Previous research into the psychosocial consequences of adiposity (the World Health Organization defines BMI 25–29.9 as overweight, BMI $\geq$ 30 as obese [18]) has limitations including: the use of cross-sectional research designs and limited use of longitudinal prospective designs [4–9, 15] and limited control for confounding [6, 8, 11]. Many of these limitations are evident in the studies that have examined the impact of gender on psychosocial outcomes [4–9, 11, 15]. Potentially, these issues may have contributed to the mixed results that have been documented to date. Further, it is important to document the extent to which adiposity is associated with a wide-range of psychosocial adversities; as psychosocial adversity may make any interventions difficult to uptake or maintain by overweight/obese individuals.

Against this background, this paper presents the results of a 35-year longitudinal study of the associations between adiposity and a series of psychosocial outcomes in adulthood in a New Zealand birth cohort. The aims of the study were:

1. To document the associations between adiposity and psychosocial outcomes, assessed at ages 30 and 35.
2. To examine evidence for differences in these associations by gender.
3. To adjust the associations for a range of prospectively assessed childhood and family background factors correlated with adiposity.

Methods

Participants

Participants were members of the Christchurch Health and Development Study (CHDS) birth cohort. The CHDS is a longitudinal study of 1265 children (630 females) born in the Christchurch (New Zealand) urban region over a 4-month period during 1977. This cohort has been studied regularly from birth to age 35 using a combination of: interviews with parents and participants, standardized testing, teacher report and official record data [19, 20]. All phases of the study have been subject to ethical approval by the Canterbury Regional Health and Disabilities Ethics Committee. All data were collected with the signed consent of the study participants.

Adiposity

At ages 30 and 35, assessments of participants' height and weight were obtained. In 71 % of cases these estimates were obtained by trained research staff using standardized measurements taken in the respondent's home, using a Seca 214 portable stadiometer to measure height and Tanita HD-351 scales to measure body weight. However, in a minority (29 %) of cases direct assessment of height and weight was not possible, and for these participants information was based on self-report data obtained via telephone or Skype interview. Overall, height and weight estimates were available for 99.0 % (977/987) of those studied at age 30 and 95.9 % (923/962) of those studied at age 35.

Using this information, body mass index (BMI) scores were calculated for cohort members at ages 30 and 35. BMI was calculated as weight (kg)/height (m^2). BMI calculations were made using the direct assessments of height and weight where available, with the remainder based on self-report data. For the purposes of the present analysis, the participants' BMI scores at each age were then classified into a 3-level scale: BMI $<$ 25.0, BMI = 25.0–29.9 (overweight), BMI = 30 (obese) [18].

As a check on the validity of using self-report measures of height and weight for the calculation of BMI, at age 30 all participants with direct measurements of height and weight were also asked to provide self-report height and weight. To minimize contamination, self-reports were obtained prior to the direct assessments. Estimates of BMI calculated using self-report data only were compared with BMI calculated using standardized measurements for a subgroup of 692 participants with data on both self-report and direct assessments of height and weight. The correlation between the two estimates was $r = 0.96$.

Outcome measures

Mental health

Depressive symptoms At ages 30 and 35, respondents were questioned regarding symptoms of major depression in the 12 months prior to each interview. Questioning was based on the relevant component of the Composite International Diagnostic Interview (CIDI) [21] for the assessment of DSM-IV symptom criteria [22] for major depression: feeling sad/depressed; loss of interest; eating or weight

changes; sleep problems; feeling slowed-up/restless; fatigue/loss of energy; feeling worthless; trouble concentrating; or thoughts of death. Using this information, a measure of the severity of depression symptoms was derived based on a count of the number of depressive symptoms reported for each of the intervals 29–30 and 34–35 years.

Psychological well-being

Life satisfaction At ages 30 and 35, participants were questioned about their life satisfaction using a custom-written questionnaire. Participants rated their current satisfaction with eleven areas of their life: work, leisure time, partner relationships, relationships with people of the same sex, relationships with people of the opposite sex, social life, money, independence, daily interactions with others, the future and life as a whole. An example item is "All in all how satisfied do you feel about your social life?" Items were scored on a 4-point scale (1 = very unhappy to 4 = very happy); higher scores indicated greater life satisfaction. To represent overall life satisfaction, ratings from the eleven items were summed. The resulting scales were of moderate to high internal consistency ($\alpha = 0.84$ at age 30; $\alpha = 0.89$ at age 35).

Self-esteem At ages 30 and 35, self-esteem was assessed using the 10-item Rosenberg Self-Esteem Scale [23]. Items were scored on a 4-point scale (1 = strongly agree to 4 = strongly disagree). An example item is "On the whole I am satisfied with myself". Five of the items were reverse-coded; an example item is "At times I feel I am no good at all". The scale scores were calculated by summing the items; higher scores indicated higher self-esteem. This scale had high internal consistency ($\alpha = 0.91$ at 30 and 35 years).

Equivalized household income (weekly net NZD) At ages 30 and 35, respondents were questioned about their net (after tax) weekly income from all sources and (if applicable) that of their partner. From this information, estimates of total net weekly household income were obtained. Incomes reported in currencies other than New Zealand dollars were converted into New Zealand dollars (NZD) using Purchasing Power Parities [24, 25]. Incomes were truncated to a maximum of 3000 NZD to avoid the influence of outliers. These estimated incomes were then equivalized for household size and composition using the method described by Jensen [26]. This method provides a set of weights which were used to adjust for the effects of family size and composition within the respondent's household. The equivalized income value may be interpreted as the available household income per adult equivalent household member.

Personal income (weekly net NZD) At ages 30 and 35, respondents were questioned about their net (after tax) weekly income from all sources. Incomes reported in currencies other than New Zealand dollars were converted into New Zealand dollars using Purchasing Power Parities [24, 25]. Incomes were adjusted for inflation using the Consumers Price Index (CPI) to NZD 2012 [27]. Incomes were also truncated to a maximum of 2500 NZD to avoid the influence of outliers.

Savings and investments (,000 NZD). At ages 30 and 35, respondents were questioned about whether they had any savings or investments. Savings/investments included money in: savings or trading banks; superannuation schemes; stocks, shares, or debentures; rental properties or other real estate; secured loans; investment or finance companies; building societies or friendly societies; accounts held by lawyers or accountants; or any other investments. Those who had investments were asked for the total realizable value of their investments. Investments reported in currencies other than New Zealand dollars were converted into New Zealand dollars using Purchasing Power Parities [24, 25].

Covariates

To assess the extent to which associations between adiposity and psychosocial outcomes to age 35 were subject to confounding by childhood and family factors correlated with BMI, a series of covariate factors were chosen from the CHDS database. Potential covariates were initially identified based on the literature review and previous research. The following factors were then selected for study inclusion on the basis that they were significantly associated with adiposity in adulthood and at least one of the psychosocial outcomes: childhood family SES (at birth), family livings standards (0–10 years), parental BMI (at child's birth), child cognitive ability (8–9 years) and childhood sexual abuse (<16 years). See Online Resource 1 for a detailed description of these measures.

Statistical analysis

Bivariate associations

In the first instance the linkages between the repeated measures of adiposity (classified as BMI < 25.0; BMI 25–29.9; BMI ≥ 30) and psychosocial outcomes at ages 30 and 35 years were examined for females and males. A generalized estimating equation (GEE) modeling framework was used to fit a series of population-averaged regression models in which each outcome was modeled as a linear function of BMI, gender and age. For psychological well-being and economic outcomes a linear regression model was fitted of the form:

$$Y_{it} = B0 + B1^{G}\mathrm{BMI}_{it} + B2\ \mathrm{GENDER}_{i} + B3\ \mathrm{AGE}_{it} + U_{it}$$

where Y_{it} was the outcome for participant i at time t (30 and 35 years), BMI_{it} was the corresponding measure of BMI for participant i at time t, GENDER_{i} was a dichotomous (0/1) indicator representing the gender of participant i, AGE_{it} was the age of the participant at time t, and U_{it} was a random error term. For the depressive symptom count outcome, a Poisson regression model was fitted to model the log-rate of depressive symptoms in a similar manner. All models permitted the repeated measures of each outcome to be correlated. In these models the slope parameter B1 was permitted to vary with gender G (G = F female, G = M male). In particular, the coefficient $B1^{G}$ represents the effect of BMI on the outcome Y in gender group G pooled over the repeated assessments at ages 30 and 35 years, and the ratio of $B1^{G}$ to its standard error provides a z test of the significance of the association between BMI and the outcome for that gender group. From the fitted models, Wald Chi-square tests were conducted to test the hypothesis that the slope parameters $B1$ were equal for females and males (i.e., $B1^{F} = B1^{M}$). The strength of the association between BMI and each outcome in each group was summarized by the Pearson correlation coefficient (r). To test the linearity assumption for the effect of BMI on outcomes, the fit of a linear model was compared to the fit of an alternative categorical representation for BMI. In all cases a linear model was found to provide an adequate representation of the data, and no significant departures from linearity were detected.

Adjustment for confounding

In the second stage of the analysis, the regression models fitted in phase 1 were extended to control for possible confounding of the associations between adiposity and outcomes by a series of fixed childhood and family factors known to be correlated with adult BMI (see Online Resource Table 1). Again Wald Chi-square tests were conducted to test the equality of the regression parameters $B1$ for males and females after covariate adjustment. To illustrate the strength of the associations in each gender group after covariate adjustment, the parameters of the fitted models were then used to generate estimates of the marginal adjusted mean of each outcome for each level of BMI in each gender group pooled over the repeated measures at 30 and 35 years [28].

Supplementary analyses

Two supplementary analyses were conducted. First, the regression models were further extended to incorporate a series of time-dynamic measures of family structure; lifestyle and related factors assessed concurrently with BMI and the outcomes at ages 30 and 35. The results of these analyses were entirely consistent with the initial covariate adjustment (see Online Resource Table 2). Second, to test whether the findings were in any way influenced by the small number of participants with extremely low adiposity, the data were reanalyzed omitting all those who were underweight (BMI $\leq$ 18.5).

Sample size and sample bias

The analyses reported in this paper are based on data from respondents studied at age 30 ($n = 977$) and age 35 ($n = 923$) who also had BMI estimates. These samples represented between 79.4 and 75.4 % of the cohort members surviving to age 30 ($n = 1231$) and 35 years ($n = 1223$). The level of sample attrition raises issues regarding study validity. To examine this, all analyses were repeated using a two-stage process developed by Carlin, Wolfe, Coffey and Patton [29]. First, a sample selection model was constructed using data gathered at birth to predict inclusion in the analysis sample at each age. This analysis showed that there were statistically significant ($p < 0.05$) tendencies for the analysis samples to underrepresent children from more socially disadvantaged backgrounds (low parental education, single parent family, child of Māori/Pacific ethnicity, low socioeconomic status and maternal smoking during pregnancy). On the basis of the fitted selection models, the sample was then post-stratified into a series of groups and the probability of inclusion in the analysis sample was estimated for each group at each age. Second, the data were reanalyzed with the observations for each individual weighted by the inverse of the probability of sample inclusion. In all cases, the weighted analyses produced similar conclusions to the results reported here.

Results

Associations between psychosocial outcomes and adiposity of males and females at ages 30 and 35

Table 1 shows the associations between the repeated measures of adiposity classified into three levels (BMI < 25; BMI 25–29.9; and BMI $\geq$ 30) assessed at ages 30 and 35 and a series of outcome measures spanning: mental health, psychological well-being and economic circumstances, measured at the same ages. The data are shown separately for males and females at each age, and pooled over the two assessments. The data in the table were

Table 1 Associations between adiposity and psychosocial outcomes by gender at age 30 and 35; and pooled across observations

Outcome	Body mass index			*B* (SE)	*p*	*r*
	<25.0	25.0–29.9	≥30.0			
Mental health						
Mean (SD) depressive symptoms						
Male (years)						
30	1.23 (2.82)	0.97 (2.44)	1.22 (2.81)			
35	0.57 (1.94)	0.89 (2.41)	0.64 (2.11)			
Pooled 30; 35	0.95 (2.50)	0.93 (2.42)	0.92 (2.47)	0.02 (0.05)	0.70	−0.00
Female (years)						
30	1.47 (2.96)	1.56 (3.17)	2.44 (3.70)			
35	1.25 (2.77)	1.53 (3.13)	1.86 (3.27)			
Pooled 30; 35	1.37 (2.88)	2.55 (3.14)	2.12 (3.47)	0.21 (0.03)	<0.001	0.10
Psychological well-being						
Mean (SD) life satisfaction						
Male (years)						
30	39.0 (4.8)	39.4 (4.5)	39.5 (4.7)			
35	39.7 (4.3)	39.3 (5.2)	39.1 (4.8)			
Pooled 30; 35	39.3 (4.6)	39.4 (4.8)	39.3 (4.7)	−0.14 (0.23)	0.54	0.00
Female (years)						
30	40.1 (4.6)	40.6 (4.8)	38.6 (5.0)			
35	40.2 (4.5)	39.9 (5.0)	39.3 (4.7)			
Pooled 30; 35	40.1 (4.6)	40.2 (4.9)	39.0 (4.8)	−0.44 (0.20)	0.03	−0.08
Mean (SD) self-esteem						
Male (years)						
30	33.2 (4.6)	33.1 (4.6)	33.0 (4.4)			
35	33.4 (4.4)	33.2 (4.5)	33.4 (4.5)			
Pooled 30; 35	33.3 (4.5)	33.1 (4.6)	33.2 (4.5)	0.06 (0.22)	0.78	0.00
Female (years)						
30	32.6 (4.4)	33.0 (4.6)	31.2 (4.9)			
35	33.3 (4.3)	32.3 (4.9)	31.9 (4.6)			
Pooled 30; 35	32.9 (4.4)	32.7 (4.8)	31.6 (4.8)	−0.46 (0.20)	0.02	−0.11
Economic circumstances						
Mean (SD) equivalized household income (weekly net NZD)[a]						
Male (years)						
30	784.0 (565.9)	893.2 (591.1)	797.6 (572.5)			
35	935.8 (634.1)	944.0 (584.9)	904.6 (560.2)			
Pooled 30; 35	847.8 (599.3)	919.2 (587.7)	853.4 (567.7)	14.2 (29.0)	0.63	0.00
Female (years)						
30	876.0 (585.7)	806.8 (562.0)	584.7 (395.2)			
35	942.9 (596.3)	832.4 (555.4)	700.7 (363.1)			
Pooled 30; 35	905.8 (590.8)	820.2 (557.5)	648.5 (381.3)	−102.9 (23.9)	<0.001	−0.18
Mean (SD) personal income (weekly net NZD)[b]						
Male (years)						
30	881.2 (550.0)	1052.4 (614.2)	948.7 (595.9)			
35	1078.5 (624.9)	1128.7 (629.0)	1090.2 (545.6)			
Pooled 30; 35	965.5 (590.4)	1091.6 (622.2)	1023.5 (572.7)	37.6 (29.1)	0.20	0.05
Female (years)						
30	772.4 (494.8)	689.4 (448.0)	552.8 (371.2)			
35	700.3 (571.5)	657.9 (503.5)	642.4 (437.4)			
Pooled 30; 35	740.2 (531.1)	673.0 (477.0)	602.6 (410.8)	−57.6 (21.5)	0.007	−0.11

Table 1 continued

Outcome	Body mass index			*B* (SE)	*p*	*r*
	<25.0	25.0–29.9	≥30.0			
Mean (SD) savings and investments (,000 NZD)						
Male (years)						
30	52.5 (118.1)	63.8 (128.5)	43.7 (109.4)			
35	102.3 (152.6)	96.5 (156.0)	75.4 (126.5)			
Pooled 30; 35	73.8 (136.0)	80.5 (144.0)	60.6 (119.5)	−6.9 (6.7)	0.30	−0.03
Female (years)						
30	64.7 (128.9)	59.9 (128.0)	15.4 (55.5)			
35	109.3 (157.4)	89.0 (148.2)	51.8 (114.0)			
Pooled 30; 35	84.8 (144.0)	75.0 (139.3)	35.6 (94.3)	−23.6 (5.7)	<0.001	−0.14

[a] Net weekly household income in NZD was equivalized for household size and composition

[b] Net weekly personal income in NZD was inflation adjusted using the Consumers Price Index to NZD 2012

Sample sizes: male 30 $n = 473$; BMI < 25 $n = 190$; BMI 25–29.99 $n = 194$; BMI > 30 $n = 89$

Male 35 $n = 445$; BMI < 25 $n = 141$; BMI 25–29.99 $n = 204$; BMI > 30 $n = 100$

Pooled male $n = 918$; BMI < 25 $n = 331$; BMI 25–29.99 $n = 398$; BMI > 30 $n = 189$

Female 30 $n = 504$; BMI < 25 $n = 296$; BMI 25–29.99 $n = 117$; BMI > 30 $n = 91$

Female 35 $n = 478$; BMI < 25 $n = 238$; BMI 25–29.99 $n = 126$; BMI > 30 $n = 114$

Pooled female $n = 982$; BMI < 25 $n = 534$; BMI 25–29.99 $n = 243$; BMI > 30 $n = 205$

analyzed by fitting population-averaged regression models in which the repeated measures of each outcome were modeled as a linear function of BMI, gender and age, with the effect of BMI permitted to vary for males and females (see "Statistical analyses"). The table reports the estimated regression coefficients and corresponding tests of significance for the effect of BMI on each outcome for each gender group, and the correlations between adiposity and each outcome in the pooled data for each group.

The table shows a highly consistent pattern of results in which, for males, all associations between adiposity and outcomes were negligible ($r = -0.03$ to 0.05) and statistically non-significant ($p > 0.05$). However, for females, there were consistent and significant tendencies for increasing adiposity to be associated with increasing adverse outcomes. Specifically, for females, increasing adiposity was associated with: increasing depressive symptoms ($r = 0.10$; $p < 0.001$), lower life satisfaction ($r = -0.08$; $p = 0.032$), lower self-esteem ($r = -0.11$; $p = 0.020$), declining family income ($r = -0.18$; $p < 0.001$), declining personal income ($r = -0.11$; $p = 0.007$); and declining savings/investments ($r = -0.14$; $p < 0.001$).

The findings in Table 1 are strongly suggestive of an interactive model in which increasing adiposity was associated with more negative outcomes for females but unrelated to these outcomes for males. This issue is examined in Table 2 which reports Wald Chi-square tests of equality of the regression parameters for BMI for males and females for each outcome. The left-hand column reports tests from the unadjusted models fitted to the data in Table 1. The right-hand column reports the same tests for a model extended to control for confounding by a range of childhood and family factors known to be correlated with later adiposity (see Statistical methods and Online Resource Table 1). These covariates included: childhood family socioeconomic status, averaged family living standards, parental BMIs, child cognitive ability and childhood contact sexual abuse.

For the unadjusted associations, the table shows evidence of statistically significant gender differences in slope for three outcomes (depressive symptoms $p < 0.001$, equivalized household income $p = 0.002$, personal net weekly income $p = 0.002$), and marginally significant differences for two other outcomes (self-esteem $p = 0.09$, savings/investments $p = 0.06$). The differences in slope and tests of significance were largely unaffected by covariate adjustment. These findings are generally consistent with the suggestion of an interactive model in which the BMI outcome associations were stronger for females.

Covariate-adjusted associations

Table 3 shows the regression parameters and tests of significance for the effect of BMI on each outcome for males and females estimated from the covariate-adjusted model described above. In addition, to illustrate the covariate-adjusted effect size differences between males and females, the table also reports estimates of the marginal adjusted

Table 2 Wald Chi-square tests of equality of BMI regression parameters for males and females before and after adjustment for covariates

Outcome	Unadjusted		Adjusted for covariates[a]	
	χ^2 (1df)	p	χ^2 (1df)	p
Depressive symptoms	13.2	<0.001	6.2	0.013
Life satisfaction	1.0	0.31	0.7	0.41
Self-esteem	2.8	0.09	1.4	0.23
Equivalized household income	10.0	0.002	9.3	0.002
Personal income	9.9	0.002	8.6	0.003
Savings and investments	3.6	0.06	3.0	0.09

[a] Adjusted for the following childhood and family factors: family socioeconomic status (at birth), averaged family living standards (0–10 years), maternal BMI (at child's birth), paternal BMI (at child's birth), child cognitive ability (8–9 years) and childhood contact sexual abuse (<16 years)

Table 3 Associations between adiposity psychosocial outcomes pooled across observations at ages 30 and 35, adjusted for a series of childhood family covariate factors

Outcome	BMI			B (SE)[a]	p
	<25	25.0–29.9	≥30		
Mental health					
Mean depressive symptoms					
Males	0.90	0.90	0.90	0.003 (0.05)	0.95
Females	1.40	1.63	1.90	0.15 (0.03)	<0.001
Psychological well-being					
Mean life satisfaction					
Males	39.4	39.3	39.1	−0.16 (0.24)	0.50
Females	40.2	39.8	39.6	−0.42 (0.21)	0.048
Mean Self-esteem					
Males	33.2	33.2	33.3	0.06 (0.23)	0.79
Females	32.8	32.5	32.2	−0.29 (0.20)	0.15
Economic circumstances					
Mean equivalized household income (weekly net NZD)[b]					
Males	843.8	886.3	928.8	42.5 (27.9)	0.13
Females	881.4	813.7	746.1	−67.7 (24.7)	0.006
Mean personal income (weekly net NZD)[c]					
Males	969.4	1041.8	1114.2	72.4 (27.2)	0.008
Females	720.5	689.5	658.5	−31.0 (23.9)	0.20
Mean savings and investments (,000 NZD)					
Males	80.3	74.4	68.4	6.0 (6.8)	0.38
Females	87.4	65.9	44.8	−21.1 (6.0)	<0.001

[a] Statistically adjusted for: childhood and family background covariates of: socioeconomic status (at birth); averaged family standard of living (1–10 years); maternal and paternal BMI (at child's birth); child cognitive ability (8–9 years); childhood contact sexual abuse (<16 years)

[b] Net weekly household income in NZD (New Zealand Dollars) was equivalized for household size and composition

[c] Net weekly personal income in NZD was inflation adjusted using the Consumers Price Index to NZD 2012

means for each outcome across levels of BMI in each gender group for the data pooled over observations at age 30 and 35 years. Examination of the table shows:

1. For females, the strength of the associations between adiposity and all outcomes was reduced somewhat after covariate adjustment. However, for four of the six outcomes the associations remained statistically significant (depressive symptoms $p < 0.001$, life satisfaction $p = 0.048$, equivalized household income $p = 0.006$, savings/investment $p < 0.001$). Further, all associations remained in the direction suggesting more adverse outcome with increasing adiposity (i.e., more depressive symptoms, reduced life satisfaction and self-esteem, lower income and savings/investments).
2. For males a somewhat different pattern emerged. For the measures of mental health, psychological well-being and savings/investments, covariate adjustment had no impact on the association with BMI; all associations remained small and statistically non-significant. However, for the measures of income (equivalized household income, personal net weekly income) both associations became more positive and, in the case of personal net weekly income, statistically significant ($p = 0.008$). Thus, in contrast to the results for females, increasing adiposity in males appeared to be related to increasing income.

Supplementary analyses

Adjustment for time-dynamic covariates The above analyses did not take into account the effects of any time-dynamic family structure, lifestyle or related factors that may be correlated with adult BMI and outcomes. To examine this issue, the covariate-adjusted models above were extended to include a range of time-dynamic measures assessed concurrently with the measures of BMI and outcomes at ages 30 and 35 years (see Online Resource 2). These factors included measures of: highest educational qualification attained, household socioeconomic status, duration of unemployment, cohabiting partner relationship,

number of dependent children, number of adverse life events, daily cigarette smoking and daily alcohol consumption. The inclusion of these additional factors resulted in minimal differences to the results in Table 3 (see Online Resource Table 3). Specifically, for females all of the adjusted effects were in the direction of more negative outcomes with increasing adiposity, and the associations remained significant for three of the six outcomes (depressive symptoms, life satisfaction and savings/investments). For males the majority of the adjusted associations were small and statistically non-significant; however, there remained a significant positive association ($p = 0.020$) between increasing adiposity and personal net weekly income.

Exclusion of respondents who were underweight (BMI ≤ 18.5) The previous analyses included both underweight (BMI ≤ 18.5) and healthy weight (BMI 18.6–24.9) respondents into the first BMI category (BMI < 25). To examine whether the findings were in any way influenced by the inclusion of those with very low adiposity, the data were reanalyzed excluding the small number of participants who were underweight ($n = 13$ at age 30; $n = 7$ at age 35). The analyses produced results that were similar to the analyses where all respondents with a recorded BMI at ages 30 and 35 were included.

Discussion

This study examined the associations between adiposity at 30 and 35 years and a series of psychosocial outcomes assessed concurrently, in a longitudinal birth cohort. In general, the findings were consistent with an interactive model in which the associations between adiposity and outcomes varied by gender. Specifically, for females, there was evidence of small but pervasive negative associations in which increasing adiposity was associated with more adverse mental health, psychological and economic outcomes. The majority of these associations were resilient to control for confounding. In contrast, for males, adiposity was either unrelated to these outcomes or, in the case of personal income, positively associated with the outcome after covariate adjustment. These findings are generally consistent with previous research showing linkages between increasing adiposity and greater psychosocial adversity among females [4, 5, 12–14, 17], but a general lack of association with similar outcomes among males [4–10, 12–14, 17]. The study findings raise interesting questions about the social, economic and personal factors that lead adiposity in women to be related to psychosocial adversity; while the same is not the case for men. Here, a number of issues may be relevant.

First, it is important to recognize that the associations between adiposity and psychosocial outcomes for women are not strong and explain only a small amount of the variance in the outcomes. For this reason it would be misleading to conclude that adiposity has large impacts on the psychosocial well-being of women. Nonetheless, the fact that adiposity had small but pervasive associations with a range of outcomes suggests that these associations should not be dismissed as being inconsequential. The factors that give rise to the associations between adiposity and adverse psychosocial outcomes for women are likely to be complex and to reflect a mix of social and related factors which make women more vulnerable to the adverse consequences of adiposity [3, 30–34].

A factor which no doubt contributes to this is cultural values and attitudes of Western societies that depict female adiposity as being socially undesirable and unattractive [30, 33]. These views have resulted in media and related industries focused on promoting the view that being overweight is particularly undesirable for women [3, 31, 35] which perpetuates the issue. It is probably these attitudes and values that contribute to the lower personal incomes and poorer economic outcomes of overweight women [3, 17, 30–32].

However, other gender-specific factors may also be involved in the association. In particular, there is growing evidence to suggest that women are more responsive to life course adversities than are men [36, 37]. This greater responsivity of women may explain why overweight/obese women report higher rates of depression, lower life satisfaction and lower self-esteem. Not only is there more stigma attached to weight and body composition for women [31, 32, 38], but women may also be more likely to perceive overweight/obesity as a source of stress or adversity in their lives [3, 38], which in turn may have consequences for their psychosocial well-being.

An interesting finding to emerge from the analysis was the significant positive-adjusted association between adiposity and personal income for males, in contrast to the negative association found for females. Obese males (BMI ≥ 30) on average had net weekly incomes that were approximately 140 NZD (New Zealand Dollars) per week higher than the incomes for males of normal adiposity (BMI < 25) after covariate adjustment. In contrast, the incomes for obese females were on average 60 NZD per week lower than those of normal adiposity. The reasons for the positive-adjusted association for males are unclear. However, it may be a reflection of the previously observed correlation between larger body size and higher incomes in males [39–41]. Alternatively it may reflect a reverse causal association in which higher incomes lead to greater consumption and hence higher BMI among those males [39, 42].

While the present study largely replicates the findings from previous research, it has a number of strengths that have been absent from the literature. These advantages include the use of a well-studied birth cohort with high response rates, repeated measures of both obesity and psychosocial outcomes and the availability of a wide-range of prospectively gathered covariate factors. These research design features provide strong reassurance that the study findings are unlikely to be influenced by non-observed sources of bias.

At the same time, the study is not without limitations. The findings relate to outcomes for a specific cohort, studied at specific ages in a specific social and cultural context. Therefore, the extent to which the findings generalize to other settings remains to be examined. In addition, there may be unmeasured sources of confounding that might explain the observed associations. For example, information on diet or physical activity was not collected as part of the study assessments. It is also possible that there are complex feedback mechanisms between adiposity and the psychosocial outcomes that are beyond the capacity of the present study to examine.

Notwithstanding these caveats, the findings of this study lead to the clear conclusions that while adiposity in males was largely unrelated to psychosocial adversity, there were small but pervasive tendencies for overweight/obese women to have higher rates of depression, lower psychological well-being and more disadvantaged economic circumstances. These findings have implications for future public health interventions. Specifically, clinicians and others working with overweight/obese people (especially obese females) may need to develop a more holistic approach to weight loss due to adverse mental health, psychological and economic circumstances that may make adhering to any interventions extremely difficult.

Acknowledgments This research was funded by grants from the Health Research Council of New Zealand (HRC 11/792), the National Child Health Research Foundation, the Canterbury Medical Research Foundation and the New Zealand Lottery Grants Board.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

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