Overweight and obesity from childhood to adulthood: a follow-up of participants in the 1985 Australian Schools Health and Fitness Survey

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ABSTRACT

Objective: To examine overweight and obesity in Australian children followed through to adulthood.

Design and participants: A cohort study of 8498 children aged 7–15 years who participated in the 1985 Australian Schools Health and Fitness Survey; of these, 2208 men and 2363 women completed a follow-up questionnaire at age 24–34 years in 2001–2005.

Main outcome measures: Height and weight were measured in 1985, and self-reported at follow-up. The accuracy of self-reported data was checked in 1185 participants. Overweight and obesity in childhood were defined according to international standard definitions for body mass index (BMI), and, in adulthood, as a BMI of 25–29.9 and $\geqslant 30\,kg/m^2$, respectively, after correcting for self-report error.

Results: In those with baseline and follow-up data, the prevalence of overweight and obesity in childhood was 8.3% and 1.5% in boys and 9.7% and 1.4% in girls, respectively. At follow-up, the prevalence was 40.1% and 13.0% in men and 19.7% and 11.7% in women. The relative risk (RR) of becoming an obese adult was significantly greater for those who had been obese as children compared with those who had been a healthy weight (RR = 4.7; 95% CI, 3.0–7.2 for boys and RR = 9.2; 95% CI, 6.9–12.3 for girls). The proportion of adult obesity attributable to childhood obesity was 6.4% in males and 12.6% in females.

Conclusion: Obesity in childhood was strongly predictive of obesity in early adulthood, but most obese young adults were a healthy weight as children.

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Childhood obesity has become more common in Australia in recent decades. Key evidence for this comes from two national surveys: the 1985 Australian Schools Health and Fitness Survey (ASHFS), which measured 8498 children aged 7–15 years;[1,2] and the 1995 National Nutrition Survey, which measured 2962 children aged 2–18 years.[3] The prevalence of overweight and obesity, defined on the basis of standard international age-specific and sex-specific body mass index (BMI) cut-points,[4] increased substantially in 7–15-year-olds in the 10 years between surveys.[5] For boys, overweight increased from 9.3% to 15.3% and obesity increased from 1.4% to 4.7%, and, for girls, overweight increased from 10.6% to 16.0%, and obesity increased from 1.2% to 5.5%.

Evidence that childhood obesity persists into adulthood comes from large cohort studies conducted in the United Kingdom[6-8] and the United States[9,10] and from smaller studies in Australia and New Zealand.[11-13] Most observed moderate to strong correlations between childhood and adult BMI, but only a minority of obese adults had been obese or overweight in childhood. When population-attributable fractions were calculated,[11] they indicated that between 8% and 22% of adult obesity could be accounted for by obesity in childhood.

In this study of a large national sample of young adults, we present up-to-date Australian estimates of the risk of adult obesity associated with overweight and obesity in childhood.

METHODS

The 1985 ASHFS collected data from a nationally representative sample of Australian children aged 7–15 years. Details of the sampling strategies have been described elsewhere.[1,2] Electoral rolls, telephone listings, the National Death Index, and contact with classmates were used to trace participants in 2001 and 2002 for the Childhood Determinants of Adult Health (CDAH) study. Traced individuals were contacted in 2001–2005 and invited to participate in the follow-up study. Participants gave their informed consent and the study was approved by the Southern Tasmania Health and Medical Human Research Ethics Committee.

In 1985, participants' heights were measured with a KaWe height tape (KaWe Kirchner & Wilhelm, Asperg, Germany) or rigid measuring tape while they were bare-foot. Weight was measured with beam or medical spring scales with participants dressed in light clothing. Residential postcode was used to derive a measure of socioeconomic status based on the Australian Bureau of Statistics Socio-Economic Indexes for Areas Index of Relative Socio-Economic Disadvantage and the 1986 census data.[14]

At the time of consenting to participate in the follow-up study (2001–2005), participants completed a brief enrolment postal questionnaire or a telephone interview seeking selected demographic and health information, including height and weight. However, questions about height and weight were not included in the early months of data collection. Participants were informed that they would have an opportunity to attend a study clinic; these were held in 34 sites around Australia in 2004–2006; for those who attended, measurements of height and weight were made by trained staff using a Leicester height measure (Invicta, Leicester, UK) and Heine scales (Heine, Dover, NH, USA). An assessment of the accuracy of self-reported height and weight was made by asking a subsample of participants to report their height and weight before measurements were taken by clinic staff.

BMI (kg/m^2) was calculated from height and weight. For children, overweight and obese categories were defined according to international standard age-specific and sex-specific BMI cut-points.[4] These cut-points do not permit classification of very obese children. Children who were not overweight or obese were defined as being healthy weight. For adults, overweight was defined as a BMI in the range 25.0–29.9 kg/m^2, obese as a BMI of 30 kg/m^2 or more, and very obese (a subset of obese) as a BMI of 35 kg/m^2 or more. Healthy weight in adults was defined as having a BMI of less than 25.0 kg/m^2. Underweight was not defined as a separate category for the purposes of this study.

1 Correlation coefficients for associations of body mass index (BMI) in childhood with BMI in adulthood,* by age in 1985 and sex

Age in 1985 (years)	Rank correlation coefficient†	
	Male (*n*)	Female (*n*)
7	0.38 (223)	0.41 (257)
8	0.37 (250)	0.59 (266)
9	0.53 (244)	0.50 (285)
10	0.54 (261)	0.51 (267)
11	0.56 (265)	0.57 (286)
12	0.51 (240)	0.43 (272)
13	0.56 (238)	0.49 (250)
14	0.49 (264)	0.59 (243)
15	0.47 (223)	0.54 (237)

* BMI in adulthood corrected for self-report error.
† Spearman's rank correlation coefficients showing the strength of relationship between childhood BMI in rank order and adult BMI in rank order. ◆

Statistical analysis

Clinic BMI measures were used to predict the difference between self-reported and clinic BMI. A linear regression model was used to obtain a correction factor that gave estimates of clinic BMI from self-reported BMI. Confidence intervals were derived according to a previously described method.[15]

Relative risks (RRs) were obtained by means of the log binomial model, adjusting for age. Population-attributable fractions (PAFs) were obtained from RRs by the formula $PAF = P(RR-1)/[1+P(RR-1)]$, where P is the probability of exposure to the risk factor. Confidence intervals were obtained from the estimated distribution of the RRs from the log binomial distribution and a method previously described to obtain PAF confidence intervals from a logistic model,[16] extended for use with the log binomial model.

RESULTS

Of the original ASHFS participants, 6840 (80.5%) were traced and contacted, and 5170 (75.6%) agreed to participate in the follow-up study. Of these, 2208 men and 2363 women self-reported their heights and weights. The mean age of participants was 29.3 years for men and 29.2 years for women. Mean heights for men and women were 179.6 cm and 165.6 cm, and mean weights were 83.4 kg and 66.0 kg, respectively. Twenty-nine per cent of men and 23% of women reported current regular smoking.

A comparison of participants who did and did not enrol into the CDAH follow-up study, based on their characteristics at baseline in 1985, showed that men who enrolled had a significantly lower mean BMI at baseline than those who did not enrol (18.1 kg/m^2 v 18.2 kg/m^2), but were not significantly different in age or socioeconomic status. Women enrolled in the follow-up were significantly older at baseline (mean age, 11.4 years v 11.3 years), of lower mean BMI (18.2 kg/m^2 v 18.4 kg/m^2), and higher socioeconomic status (26% v 21% in the highest quarter by postcode of residence) than those who did not enrol. While these differences were statistically significant ($P<0.01$), they were small in absolute terms.

BMI at baseline and follow-up

For those with baseline and follow-up data, the 1985 prevalence of overweight was 8.3% in boys and 9.7% in girls, and the prevalence of obesity was 1.5% in boys and 1.4% in girls. In adulthood, based on corrected self-reported BMI values, 40.1% of men and 19.7% of women were overweight, 13.0% of men and 11.7% of women were obese, and 2.8% of men and 4.1% of women were very obese.

Self-reported and measured height and weight were obtained for 1185 participants at the time of clinic attendance. The agreement between self-reported and clinic BMI categories was high ($\kappa = 0.80$ for men, $\kappa = 0.82$ for women), but the error in self-reported BMI increased with increasing measured BMI, especially for women. After adjusting for these errors in self-reported BMI, the number of obese men increased from 265 to 288 and the number of obese women increased from 273 to 277. The number of very obese people increased from 51 to 62 in men and 85 to 97 in women.

Association of childhood and adult BMI

Box 1 presents the associations of childhood BMI with adult BMI for males and females by participants' age in 1985. Associations with adult BMI were weakest for the youngest boys, but otherwise associations were similar for males and females of all ages.

Overweight and obesity in childhood and adulthood

The proportions of participants in each weight category in childhood and adulthood are shown in Box 2. Most overweight and obese children became overweight or obese adults. Half of the healthy-weight boys and more than a quarter of healthy-weight girls became overweight or obese adults. Only 5.2% of obese men and 7.9% of obese women had been obese since childhood.

Box 3 presents the RRs for obesity in adulthood for children who were overweight or obese compared with those who were a healthy weight. The risk of becoming obese as an adult was significantly increased for boys and girls who were overweight or obese, irrespective of their age at baseline. The RR estimates were not significantly different across categories of marital status, highest level of education achieved or childhood socioeconomic status. Compared with those who were a healthy weight in childhood, obese children were at greater risk of becoming very obese (BMI $\geq$ 35.0 kg/m^2) in adulthood (RR = 27.9; 95% CI, 13.8–56.4 for males and RR = 16.8; 95% CI, 9.6–29.5 for females). Because self-reported heights and weights collected at clinics ($n = 1185$) may have been less prone to error than the self-reported heights and weights collected at enrolment ($n = 4571$), our correction factor may have been inaccurate. Reassuringly, when the analysis was restricted to individuals for whom we had both self-reported measures of height and weight at enrolment and clinic measures ($n = 2088$), there were no significant differences found in the RR estimates derived using the different BMI measures.

Calculating PAFs indicated that the obesity in adults that was attributable to childhood obesity was relatively modest (PAF = 6.4%;

2 Children in each weight category who became healthy-weight, overweight and obese adults*

Weight category in childhood	Weight category in adulthood					
	Male ($n = 2208$)			Female ($n = 2363$)		
	Healthy weight	Overweight	Obese	Healthy weight	Overweight	Obese
Healthy weight	998 (50.1%)	797 (40.0%)	196 (9.8%)	1546 (73.6%)	397 (18.9%)	158 (7.5%)
Overweight	29 (15.8%)	78 (42.4%)	77 (41.9%)	59 (25.7%)	74 (32.2%)	97 (42.2%)
Obese	3 (9.1%)	15 (45.5%)	15 (45.5%)	6 (18.8%)	4 (12.54%)	22 (68.8%)

* Adjusted for adult body mass index self-report error. ◆

3 Relative risks* (RRs) and 95% confidence intervals for becoming an obese adult by sex, childhood weight category and age

Age in childhood (years)	Childhood weight category			
	Males		Females	
	Overweight	Obese	Overweight	Obese
7–9	4.3 (2.8–6.6)	4.9 (2.2–10.8)	5.3 (3.5–8.2)	10.3 (6.4–16.5)
10–12	5.0 (3.3–7.5)	3.4 (1.2–9.6)	6.0 (4.0–9.0)	9.2 (5.2–16.3)
13–15	3.6 (2.4–5.4)	5.1 (2.9–9.1)	5.5 (3.8–8.0)	8.1 (4.5–14.7)
All ages (7–15)†	4.2 (3.3–5.4)	4.7 (3.0–7.2)	5.6 (4.5–7.1)	9.2 (6.9–12.3)

* RR with healthy weight in childhood as the referent category. † Age-adjusted RR. ◆

95% CI, 3.5%–10.9% for males and PAF = 12.6%; 95% CI, 8.7%–17.7% for females). A greater proportion of adult obesity was attributable to childhood overweight (PAF = 24.0%; 95% CI, 18.4%–30.4% for males and PAF = 33.6%; 95% CI, 27.3%–40.4% for females). Greater proportions of severe obesity in young adult men and women were attributable to childhood overweight (PAF = 55.4%; 95% CI, 39.0%–70.1% for males and PAF = 39.9%; 95% CI, 27.8%–52.4% for females) and obesity (PAF = 33.6%; 95% CI, 18.8%–51.6% for males and PAF = 21.8%; 95% CI, 12.4%–34.7% for females).

DISCUSSION

Our follow-up of children who participated in the 1985 ASHFS has confirmed that overweight and obesity in Australian children are strong predictors of obesity in early adulthood. However, most of those who were obese and overweight at follow-up were a healthy weight in childhood.

This study has important strengths in its size, national sampling and the quality of height and weight measurements at baseline. It also has some limitations in that not all children were followed up and we were unable to measure height and weight objectively in all adult participants. Compared with the general population of Australian adults aged 25–34 years,[17] participants in this study had a higher socioeconomic status and lower mean BMI. However, these differences were modest and are unlikely to have substantially influenced estimates of the association between childhood and adult obesity. The prevalence of current smoking in our sample (29% in men and 23% in women) was similar to that in the general population (31% in men and 24% in women).

The use of self-reported height and weight at follow-up may have resulted in some misclassification of overweight and obesity in adulthood. We, like others,[18] found that participants tended to overestimate their height and underestimate their weight. However, because we had objectively measured height and weight in a large sub-sample of participants at follow-up, we were able to account for these errors and estimate true BMI values, thus improving the accuracy of our findings. RR estimates derived from clinic-measured heights and weights were not significantly different to those derived from adjusted self-report measures taken at enrolment, providing further reassurance that bias was minimal.

While the prevention of overweight and obesity in childhood is an important public health priority, our findings serve as an important reminder that most obese young adults in our community were not obese as children. The period from adolescence to early adulthood is associated with major life-stage transitions. These are likely to be important considerations in the search for effective strategies to engage young people in the healthy diet and physical activity behaviours that are the key to preventing obesity.

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COMPETING INTERESTS

None identified.

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