

# Obesity increase among low SES Australian schoolchildren between 2000 and 2006: time for preventive interventions to target children from low income schools?

Jennifer A. O’Dea · Michael J. Dibley

Received: 19 February 2009 / Revised: 22 June 2009 / Accepted: 18 August 2009 / Published online: 29 September 2009  
© Birkhäuser Verlag, Basel/Switzerland 2009

## Abstract

**Objectives** To examine change from 2000 to 2006 in obesity and overweight by gender, school year and school socioeconomic status (SES) in a national sample of students from Australia.

**Methods** Survey of students aged 6–18 years from the same 32 schools in 2000 ( $N = 3,819$ ) and 2006 ( $N = 5,524$ ) with measured height and weight. All analyses were adjusted for the cluster survey design. Main outcome measures were height, weight, Z-score distribution of BMI, overweight and obesity [International Obesity Task Force (IOTF) cut-offs], school SES.

**Results** Obesity and overweight were similar to previous Australian findings with 5.2% and 6.1% obese in 2000 and 2006, respectively, and 16.3 and 19.0% overweight. Significant increase in obesity was observed in students from low SES schools which increased from 5.8 to 8.6% ( $P < 0.05$ ) compared to 5.5 to 6.3% ( $P = 0.32$ ) in middle SES and 3.3 to 4.2% ( $P = 0.92$ ) in high SES schools.

**Conclusions** Obesity increased significantly among children in low SES schools and preventive efforts should urgently and carefully target preventive efforts to assist schools, families and communities which are socially and economically, disadvantaged using culturally appropriate physical activity and nutrition promotion interventions.

**Keywords** Children · Schools · Obesity · Prevalence · Prevention · SES

## Introduction

During the past three decades, the prevalence of overweight and obesity in children and adolescents has increased throughout the world (Bundred et al. 2001; World Health Organisation 2000). Among Australian children and adolescents the rise in overweight and obesity began in the 1980s and continued into the 1990s (Magarey et al. 2001). In an analysis of data from two national surveys of schoolchildren aged 10–15 years in 1985 and 1995 (Magarey et al. 2001) using measured height and weight, a significant increase in obesity from 1.3% in 1985 to 5.0% in 1995 was found, as well as a significant increase in overweight from 10.0 to 16.0%, respectively.

However, there is now mounting evidence that this “tripling” of childhood obesity does not appear to have continued into the most recent decade. The findings of a large National study of Australian schoolchildren conducted in 2000 (O’Dea 2003; O’Dea and Wilson 2006), also using measured height and weight, reported a similar obesity prevalence to the 5% obese and 16% overweight found in 1995 with 6.3% obese and 17.3% overweight.

The suggestion that childhood obesity prevalence has not significantly increased since 1995 was also observed in a study conducted in 2004 (Booth et al. 2007) which reported an average of 6.2% obese and 18.0% overweight as well as more recent reports from a national survey conducted in 2007 (Commonwealth of Australia 2008) which also reported that on average, 6.0% of Australian children were obese and 17.0% were overweight.

---

J. A. O’Dea (✉)  
Faculty of Education and Social Work, University of Sydney,  
Building A35, Sydney, NSW 2006, Australia  
e-mail: j.o’dea@edfac.usyd.edu.au

M. J. Dibley  
School of Public Health and The George Institute,  
University of Sydney, Sydney, NSW 2006, Australia  
e-mail: mdibley@health.usyd.edu.au

In studies to date, the role of socioeconomic status (SES) in describing obesity prevalence has been reported in a few research studies but not extensively investigated (O'Dea and Caputi 2001; Li et al. 2007; Mikolajczyk and Richter 2008). In the national study conducted in 2000 (O'Dea 2003), students of both sexes from low socioeconomic (SES) schools were significantly more likely than their middle or higher SES school peers to be obese (9.0 vs. 5.8%) or overweight (19.0 vs. 16.8%) and low school SES predicted the risk of obesity (O'Dea and Wilson 2006). A significantly greater prevalence of obesity and overweight was found among children from low SES schools and those students of Pacific Islander, Middle Eastern or Aboriginal descent (O'Dea 2008).

A similar trend toward a greater prevalence of overweight and obesity among low SES children and adolescents to those Australian studies reported above has also been reported in London school students, with similar trends in socioeconomic and ethnic inequalities (Wardle et al. 2006), and German adolescents (Mikolajczyk and Richter 2008) and these findings also concur with those from several other studies from various countries (Li et al. 2007; Parsons et al. 1999; Romon et al. 2005; Saxena et al. 2004; Wang 2001).

The research to date identifies socioeconomic status as an important determining factor in adult and childhood obesity prevalence, but the current studies do not specifically examine the change in obesity by socioeconomic status over time. The research question addressed in the current study was "Is obesity still increasing among children and adolescents or is the increase only observed in those from low socioeconomic status schools?"

The major aim of the current study was to (1) assess changes in the prevalence of overweight and obesity among two samples of Australian schoolchildren in the same schools across the country between 2000 and 2006; (2) examine if any trends were associated with the children's gender, age or school SES and (3) examine whether obesity prevalence increased among all SES groups or only among the children and adolescents from low SES schools.

## Methods

### Study population

The 2000 data for this study were collected as part of the National Nutrition & Physical Activity Study (O'Dea 2003; O'Dea and Wilson 2006) and the 2006 data were collected as part of the National Youth Cultures of Eating Study (O'Dea 2008) a 3 year, Australian Research Council funded study of health, weight, culture and eating among schoolchildren. The description of study recruitment and

sampling are given in the references (O'Dea 2003; O'Dea and Wilson 2006) and the 2006 data were collected as part of the National Youth Cultures of Eating Study (O'Dea 2008) and are summarized below.

Participating schools ( $N = 32$ ) were randomly selected from a widely dispersed sample likely to be representative of the Australian population. School principals agreed to participate in both surveys in 2000 and 2006. One school withdrew from the 2006 survey due to time constraints so all data from that school were removed from the current analyses. The SES of schools was low SES, middle SES or high SES. School SES is determined by each state Department of Education using the Disadvantaged Schools Questionnaire (Commonwealth Department of Education, Science, Training 2005). Low SES represents the lowest quintile of total family income in Australia. This school SES questionnaire is administered to each school by the Department of Education and the school principal is responsible for ensuring that it is completed by all parents at the school. This questionnaire provides the Australian Department of Education with a non-biased, objectively and systematically measured aggregate of school SES based on family income, parental education, parental employment and parental occupation in the determination of school social disadvantage. The low SES school category was determined from the results of the questionnaire used by the federal government to determine school disadvantage by directly measuring combined family income in schools which more than 90% of children are from families are low SES. The school SES status of low, middle and high is thus objectively measured, systematically performed and measured using non-biased procedures each year by the Australian Department of Education and the methods for doing this are given in the government procedures report (Commonwealth Department of Education, Science, Training 2005). The school SES status was also officially corroborated by the government Director of Research in the Department of Education from each Australian state or territory and also corroborated in telephone interviews with each of the 32 school principals. There was complete agreement regarding school SES status from the three assessment sources, namely, the formal government survey of school parents; the assessment of each school SES from each State Department of Education and the assessment of school SES from each school principal. This procedure to determine school SES was repeated in 2006 to assess whether school SES status had changed over the 6 year period. School SES did not change between 2000 and 2006. Participation was high in both studies with an average of 82% of the students agreeing to complete the questionnaires and have the anthropometric measurements taken.

The study design and protocol were approved by the University of Sydney Human Ethics committee and each of the state or territory Departments of Education.

### Measurements

The questionnaire was completed by students during regular class times under the supervision of the first author and trained research assistants. Informed consent was obtained from parents and verbal consent was obtained at the time from students. The questionnaire collected demographic details of the students' gender, age, school grade/year (year 3–10), ethnicity, eating patterns, nutritional quality of breakfast, body image and several other nutrition and physical activity-related variables.

Height and weight were measured by the first author and trained research assistants using standardized anthropometric procedures. Height was measured to the nearest 0.5 cm without shoes or socks using a portable free standing Harpenden stadiometer. Weight was measured to the nearest 0.1 kg using portable Soelne digital scales. Students were weighed in light school uniform, after removing shoes, jackets and emptying their pockets.

### Statistical analysis

Completed questionnaires were “cleaned” before data entry by having them checked, having missing data labeled as such and data were then entered to produce an SPSS database. Descriptive statistical analyses were undertaken to provide details of the prevalence of overweight and obesity in 2000 and 2006 using the International Obesity Task Force (IOTF) 0.5 year body mass index (BMI) cut offs (Cole et al. 2000).

BMI was also expressed as Z-scores of the World Health Organization (WHO) 2007 Growth Reference (de Onis et al. 2007). The frequency of children in narrow ranges of BMI-for-age Z-scores from the WHO 2007 Growth Reference were plotted and smoothed with a Lowess function to construct BMI Z-score frequency distribution curves (Chambers et al. 1983).

In order to examine the relationships between overweight, obesity and gender, age, school SES and school grade/year, adjusted odds ratios and their 95% CIs were calculated in multivariate logistic regression analyses. The year of survey was included in these models to assess the statistical significance of the trends in prevalence. Logistic regression was used to assess trends after adjusting for differences across surveys of important cofactors including age, sex of student and type of school (primary or secondary).

To adjust for the effect of the school-based cluster sampling, the Stata survey ('svy') commands was applied, which adjusted for similarities within school clusters by Taylor linearized variance estimation. All analyses were

conducted using Stata version 10 and were adjusted for the cluster survey design.

### Results

A description of the characteristics of the participants including gender, age, school SES, class grade/year (years 3–10), type of school (primary or secondary) and state is presented in Table 1.

**Table 1** Characteristics of participants in 2000 and 2006

Characteristic	2000		2006	
	N	Percent	N	Percent
Gender				
Boys	1,928	50.5	2,725	49.3
Girls	1,891	49.5	2,799	50.7
Age (years)				
≤8	247	6.5	448	8.1
9	436	11.4	586	10.6
10	533	14.0	587	10.6
11	502	13.1	613	11.1
12	455	11.9	707	12.8
13	479	12.5	773	14.0
14	533	14.0	819	14.8
15	471	12.3	730	13.2
≥16	163	4.3	261	4.7
SES of school				
High	724	18.9	1,566	28.4
Middle	2,295	60.1	3,054	55.2
Low	800	21.0	904	16.4
Class year				
3	371	9.7	622	11.3
4	480	12.6	538	9.7
5	521	13.6	603	10.9
6	480	12.6	595	10.8
7	457	12.0	869	15.7
8	491	12.9	775	14.0
9	510	13.4	802	14.5
10	509	13.3	720	13.0
Type of school				
Primary	2,160	56.6	2,743	49.6
Secondary	1,659	43.4	2,781	50.4
State				
NSW and ACT	536	14.0	2,006	36.3
VIC	476	12.5	417	7.6
QLD	614	16.1	701	12.7
SA	677	17.7	777	14.1
WA	437	11.4	611	11.1
TAS	487	12.8	456	8.2
NT	592	15.5	556	10.0

The mean and 95% confidence intervals for weight, height and BMI of surveyed children in 2000 and 2006 by gender, age, school SES and class are given in Table 2. Overall, the boys had higher body weight and height than the girls but their BMI was the same.

The prevalence of overweight and obesity in 2000 and 2006 using the International Obesity Taskforce (IOTF) BMI cut-offs at 0.5 age intervals (Cole et al. 2000) is given in Table 3. There was a significant gradient of increasing obesity with decreasing school SES in both survey years (Fig. 1).

The results of the Logistic regression models of overweight and obesity for all children and subgroups of children by school SES and gender are given in Table 4. In summary, for all children both overweight and obesity increased from 2000 to 2006. Obesity significantly increased between surveys only in children from the low SES schools, although there was a significant increase in overweight in the children from middle SES schools. The gender analysis revealed significant increases between the surveys for both overweight and obesity for boys, but only overweight significantly increased for girls.

The graded effect of BMI by school SES is illustrated in Fig. 2 which compares plots of the distribution of BMI-for-age Z-scores of children from low and high SES schools in 2000 and 2006 using the WHO 2007 Growth Reference as a comparison. The BMI-for-age Z-score distribution for children from low SES schools was shifted to higher BMI values than the children from high SES schools. However, the BMI-for-age Z-score distribution for children from high SES schools was also shifted to higher BMI values than in the WHO 2007 Growth reference. Another feature of the BMI-for-age Z-score distribution for children from high SES schools is the shape of the curve, which is long-tailed and skewed to the right or higher BMI values compared to the growth reference. Finally the BMI-for-Age distribution for children from low SES schools in 2006 was shifted to higher BMI values compared to the curve for 2000, reflecting the significant increase in obesity for children from low SES schools from 2000 to 2006 reported in Table 4. The shape of the BMI-for-age Z-score distribution curve for children from low SES schools is long-tailed and shifted to the right, and furthermore the skewed shape of the curve increases from 2000 to 2006.

## Discussion

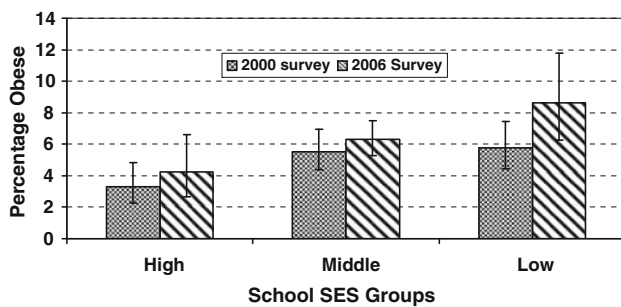
Overall we found that both overweight and obesity increased in this population but the increase in obesity was

**Table 2** Mean and 95% confidence intervals for weight, height and BMI of surveyed children in 2000 and 2006 by gender, age, school SES and type of school (primary or secondary)

Characteristics	Survey 2000 (N = 3,819)		Survey 2006 (N = 5,524)	
	Mean	(95% CI)	Mean	95% CI
<b>Gender</b>				
<b>Boys</b>				
Weight (kg)	48.9	(44.3–53.5)	50.2	(45.6–54.8)
Height (cm)	156.3	(150.9–161.6)	156.0	(150.9–161.0)
BMI (kg/m <sup>2</sup> )	19.5	(19.0–20.0)	20.1	(19.5–20.7)
<b>Girls</b>				
Weight (kg)	46.2	(42.9–49.5)	48.2	(44.5–51.8)
Height (cm)	151.9	(148.3–155.5)	152.4	(148.7–156.1)
BMI (kg/m <sup>2</sup> )	19.6	(19.1–20.2)	20.3	(19.6–20.9)
<b>Age</b>				
<b>6–12 years</b>				
Weight (kg)	39.4	(38.7–40.1)	40.0	(38.9–41.1)
Height (cm)	144.8	(143.7–146.0)	144.3	(143.2–145.4)
BMI (kg/m <sup>2</sup> )	18.5	(18.3–18.7)	18.9	(18.6–19.2)
<b>13–18 years</b>				
Weight (kg)	58.3	(57.2–59.4)	59.6	(58.8–60.5)
Height (cm)	166.4	(165.4–167.4)	165.4	(164.7–166.1)
BMI (kg/m <sup>2</sup> )	21.0	(20.7–21.2)	21.7	(21.4–21.9)
<b>Type of school and SES primary schools</b>				
<b>High SES school</b>				
Weight (kg)	39.3	(37.6–41.1)	38.2	(36.6–39.7)
Height (cm)	146.0	(143.8–148.2)	143.6	(142.1–145.1)
BMI (kg/m <sup>2</sup> )	18.2	(17.9–18.5)	18.2	(17.9–18.6)
<b>Middle SES school</b>				
Weight (kg)	39.6	(39.1–40.1)	39.7	(38.8–40.7)
Height (cm)	144.7	(143.7–145.7)	143.4	(142.1–144.7)
BMI (kg/m <sup>2</sup> )	18.6	(18.4–18.8)	19.0	(18.9–19.2)
<b>Low SES school</b>				
Weight (kg)	38.9	(37.8–40.0)	40.1	(38.2–42.0)
Height (cm)	143.4	(142.4–144.3)	143.2	(142.0–144.4)
BMI (kg/m <sup>2</sup> )	18.6	(18.3–18.9)	19.2	(18.6–19.7)
<b>Secondary schools high SES school</b>				
Weight (kg)	53.9	(53.0–54.8)	58.4	(55.8–61.1)
Height (cm)	161.2	(160.2–162.2)	163.9	(162.7–165.0)
BMI (kg/m <sup>2</sup> )	20.7	(20.0–21.3)	21.6	(21.0–22.3)
<b>Middle SES school</b>				
Weight (kg)	58.1	(57.0–59.3)	59.1	(58.0–60.1)
Height (cm)	166.4	(165.2–167.5)	165.2	(164.3–166.0)
BMI (kg/m <sup>2</sup> )	20.9	(20.7–21.1)	21.5	(21.2–21.8)
<b>Low SES school</b>				
Weight (kg)	60.3	(60.1–60.5)	59.0	(56.9–61.0)
Height (cm)	166.8	(166.5–167.1)	163.9	(163.1–164.7)
BMI (kg/m <sup>2</sup> )	21.5	(21.4–21.7)	21.8	(20.9–22.7)

**Table 3** Prevalence of overweight and obesity and 95% confidence intervals in 2000 and 2006 using IOTF 0.5 year BMI cut-offs

Characteristic	Overweight						Obesity					
	2000 ( <i>N</i> = 623)			2006 ( <i>N</i> = 1,050)			2000 ( <i>N</i> = 197)			2006 ( <i>N</i> = 336)		
	<i>N</i>	%	(95% CI)	<i>N</i>	%	(95% CI)	<i>N</i>	%	(95% CI)	<i>N</i>	%	(95% CI)
	623	16.3	(15.0–17.7)	1,050	19.0	(17.7–20.5)	197	5.2	(4.3–6.1)	336	6.1	(5.1–7.2)
Gender												
Boys	302	15.7	(14.1–17.3)	491	18.0	(16.5–19.7)	105	5.4	(4.6–6.5)	189	6.9	(5.9–8.2)
Girls	321	17.0	(15.3–18.8)	559	20.0	(18.3–21.8)	92	4.9	(3.8–6.2)	147	5.3	(4.2–6.5)
Age												
6–12 years	376	17.3	(15.4–19.4)	533	18.1	(16.5–19.8)	118	5.4	(4.2–6.9)	188	6.4	(5.1–8.0)
13–18 years	247	15.0	(13.5–16.7)	517	20.0	(18.0–22.2)	79	4.8	(3.8–6.1)	148	5.7	(4.6–7.1)
SES of school												
High SES	107	14.8	(11.9–18.2)	277	17.7	(14.4–21.5)	24	3.3	(2.3–4.8)	66	4.2	(2.7–6.6)
Middle SES	357	15.6	(14.3–17.0)	599	19.6	(18.0–21.3)	127	5.5	(4.4–6.9)	192	6.3	(5.3–7.5)
Low SES	159	19.9	(18.2–21.7)	174	19.3	(16.7–22.1)	46	5.8	(4.4–7.4)	78	8.6	(6.3–11.8)
Type of school												
Primary schools	373	17.3	(15.4–19.3)	499	18.2	(16.5–20.0)	115	5.3	(4.1–6.8)	174	6.3	(5.0–8.1)
Secondary schools	250	15.1	(13.6–16.7)	551	19.8	(17.8–22.0)	82	4.9	(3.9–6.3)	162	5.8	(4.7–7.3)

**Fig. 1** Percentage of obese children aged 6–18 years in Australia by school SES groups and 2000 versus 2006 surveys (IOTF criteria to define obesity)

only significant for children from low SES schools (see Table 4). These figures concur with those of other studies conducted among Australian children and adolescents in 2000 (O’Dea 2003, 2008; O’Dea and Wilson 2006), 2004 (Booth et al. 2007) and 2007 (Commonwealth of Australia, Department of Health, Ageing 2008) and the prevalence of obesity and overweight is similar to the overall number of 5.0 and 16.0% obese reported in a similarly designed nationally representative study from 1995 (Magarey et al. 2001).

We found a clear graded school SES association between the prevalence and 6-year increase in obesity, with the 2006 low SES youth 1.53 times as likely to be obese compared to low SES youth in 2000. Conversely, the change among children from middle SES schools was 1.14 times that of 2000 and 1.03 times among students from high SES schools.

The significant increase in obesity among children from low SES schools, was consistent across both genders, and suggests a greater future risk of weight related ill-health among children and adolescents from socially disadvantaged, low income communities and schools. This finding suggests a need for suitable obesity prevention interventions among this particular socio-economic group. The finding that obesity has increased only among children from low SES schools supports previous suggestions from similarly designed studies from around the world that low SES increases the risk of overweight and obesity among children and adolescents (Mikolajczyk and Richter 2008; O’Dea 2008; Wardle et al. 2006; Parsons et al. 1999; Romon et al. 2005; Saxena et al. 2004) and it also concurs with recent SES findings among children and adolescents from New Zealand (Goulding et al. 2007), Germany (Mikolajczyk and Richter 2008) and the USA (Ogden et al. 2008) the latter longitudinal study reporting no significant increase in childhood obesity since 1999. Our findings regarding school SES and obesity also concur with similar studies which included measured height and weight among adult populations (Freedman et al. 2002; Jebb et al. 2004).

The finding that obesity is increasing significantly among children from low SES communities and schools is concerning because of the likelihood of future health risks such as type 2 diabetes among this particular population group. The finding should not be interpreted as a non-risk situation for children from higher SES areas, as our results also show an increased BMI-for-age Z-score and wider distribution of scores among all three SES groups. The results indicate that while Australian children from all social groups have

**Table 4** Logistic regression models of overweight and obesity for all children and subgroups of children by school SES and gender

Characteristics	Overweight			Obesity <sup>a</sup>		
	OR <sup>b</sup>	(95% CI)	<i>P</i>	OR <sup>b</sup>	(95% CI)	<i>P</i>
All children						
Age in years	1.01	(0.98–1.04)	0.62	0.97	0.91–1.03	0.33
Year of survey						
2000	1.00			1.00		
2006	1.24	(1.09–1.42)	0.00***	1.26	1.02–1.55	0.03*
SES of school						
High SES	1.00			1.00		
Middle SES	1.14	(0.88–1.47)	0.32	1.64	1.05–2.55	0.03
Low SES	1.32	(1.04–1.67)	0.02	1.95	1.22–3.13	0.01
Gender						
Female	1.00			1.00		
Male	0.90	(0.81–0.99)	0.03*	1.23	1.05–1.44	0.01**
Children from low SES school						
Age in years	1.06	(0.93–1.22)	0.31	0.97	(0.80–1.17)	0.68
Year of survey						
2000	1.00			1.00		
2006	0.99	(0.71–1.39)	0.97	1.53	(1.05–2.23)	0.03*
Gender						
Female	1.00			1.00		
Male	0.85	(0.69–1.05)	0.12	1.28	(1.02–1.61)	0.04*
Type of school						
Primary schools	1.00			1.00		
Secondary schools	0.83	(0.44–1.56)	0.50	1.36	(0.58–3.17)	0.41
Children from middle SES school						
Age in years	1.01	(0.95–1.08)	0.69	0.99	(0.90–1.10)	0.89
Year of survey						
2000	1.00			1.00		
2006	1.34	(1.15–1.57)	0.00***	1.14	(0.87–1.50)	0.32
Gender						
Female	1.00			1.00		
Male	0.91	(0.77–1.06)	0.21	1.14	(0.91–1.43)	0.23
Type of school						
Primary schools	1.00			1.00		
Secondary schools	0.81	(0.58–1.13)	0.20	0.68	(0.43–1.08)	0.09
Children from high SES school						
Age in years	1.03	(0.97–1.09)	0.24	0.99	(0.71–1.39)	0.95
Year of survey						
2000	1.00			1.00		
2006	1.06	(0.81–1.39)	0.60	1.03	(0.48–2.21)	0.92
Gender						
Female	1.00			1.00		
Male	0.89	(0.74–1.06)	0.16	1.51	(0.82–2.81)	0.15
Type of school						
Primary schools	1.00			1.00		
Secondary schools	1.43	(0.82–2.49)	0.17	1.79	(0.47–6.83)	0.33

**Table 4** continued

Characteristics	Overweight			Obesity <sup>a</sup>		
	OR <sup>b</sup>	(95% CI)	<i>P</i>	OR <sup>b</sup>	(95% CI)	<i>P</i>
<b>Males</b>						
Age in years	1.04	(0.96–1.13)	0.30	1.01	(0.93–1.09)	0.84
Year of survey						
2000	1.00			1.00		
2006	1.23	(1.05–1.45)	0.02*	1.35	(1.04–1.73)	0.02*
SES of school						
High SES	1.00			1.00		
Middle SES	1.11	(0.82–1.50)	0.47	1.36	(0.90–2.06)	0.14
Low SES	1.29	(1.00–1.68)	0.05*	1.80	(1.17–2.75)	0.01**
Type of school						
Primary schools	1.00			1.00		
Secondary schools	0.92	(0.60–1.44)	0.72	0.97	(0.66–1.43)	0.87
<b>Females</b>						
Age in years	1.01	(0.95–1.07)	0.72	0.95	(0.82–1.10)	0.47
Year of survey						
2000	1.00			1.00		
2006	1.27	(1.08–1.49)	0.01*	1.18	(0.89–1.56)	0.25
SES of school						
High SES	1.00			1.00		
Middle SES	1.18	(0.88–1.59)	0.26	2.03	(1.12–3.67)	0.02*
Low SES	1.35	(1.03–1.75)	0.03*	2.12	(1.14–3.92)	0.02*
Type of school						
Primary schools	1.00			1.00		
Secondary schools	0.88	(0.69–1.13)	0.31	0.89	(0.47–1.67)	0.70

\*  $P < 0.05$  \*\*  $P < 0.01$  \*\*\*  $P < 0.001$

<sup>a</sup> Overweight and obesity were defined according to the International Obesity Task Force 0.5 year age references (Cole et al. 2000)

<sup>b</sup> Odd ratios and 95% CIs were calculated from logistic regression using STATA “svy” commands

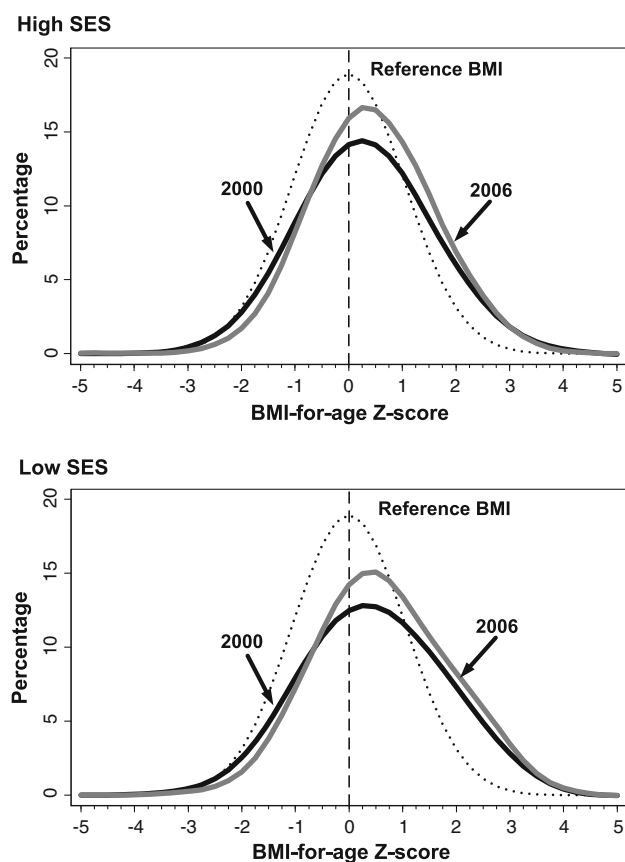
become bigger than previous norms, there is a significant and concerning increase in obesity among children from low SES schools.

The strengths of the current study include a large, widely dispersed sample of school children in Australia, including the same 32 schools in both years, use of objectively assessed school SES, measured height and weight, adequate statistical power, appropriate weighted analyses and a very good response rate in both survey years. A limitation of the study includes differing numbers of participants from 2000 and 2006 which was the result of greater sampling in 2006 to enable the inclusion of greater numbers of students from different ethnic groups and greater statistical power in this regard.

There appears to be a protective effect of higher SES on the weight status of children and adolescents and it is likely

that a wide range of socio-cultural factors influence the risk of obesity, including typical social determinants of health such as income, education, access to nutritious food, access to and affordability of sporting facilities, health literacy, outdoor environment, and cultural norms of eating, exercising and ideal weight. As such, the prevention of childhood obesity is most likely to succeed if these socio-cultural determinants are addressed in interventions targeting schools, communities and other areas of social and economic disadvantage.

We recommend the implementation of culturally appropriate physical activity and nutrition promotion interventions which ought to “First, do no harm” (O’Dea 2004) and should be particularly targeted to assist socially and economically disadvantaged schools, communities and low SES ethnically diverse areas. We also recommend that



**Fig. 2** Comparative plots of Lowess curves for the BMI-for-age Z-score distributions for children aged 6 to 18 years from high versus low SES schools in Australia, 2000 versus 2006 surveys and 2007 WHO growth reference

health professionals conduct regular clinical screening of obese young people for type 2 diabetes risk, particularly those who are inactive, ethnically at risk and those who have a family history of the disease (Goulding et al. 2007; Hotu et al. 2004).

## References

- Booth ML, Dobbins T, Okely AD, Denney Williams E, Hardy LL (2007) Trends in the prevalence of overweight and obesity in young Australians 1985, 1997, 2004. *Obesity* 15:1089–1095
- Bundred P, Kitchiner D, Buchan I (2001) Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies. *Br Med J* 322:326
- Chambers JM, Cleveland WS, Kleiner B, Tukey PA (1983) Graphical methods for data analysis. Duxbury Press, Boston
- Cole TJ, Bellizzi MC, Flegal KM, Dietz WH (2000) Establishing a standard definition for child overweight and obesity worldwide: international survey. *Br Med J* 320:1240–1243
- Commonwealth Department of Education, Science, Training (2005) Disadvantaged schools program: operational guidelines. Commonwealth Department of Education and Youth Affairs, Canberra
- Commonwealth of Australia, Department of Health, and Ageing (2008) 2007 Australian National Children's Nutrition and Physical Activity Survey: main findings. AGPS, Canberra
- de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J (2007) Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Org* 85:660–667
- Freedman DS, Kettel Khan L, Serdula MK, Galuska DA, Dietz WH (2002) Trends and correlates of class 3 obesity in the United States from 1990 through 2000. *J Am Med Assoc* 288:1758–1761
- Goulding A, Grant AM, Taylor RW et al (2007) Ethnic differences in extreme obesity. *J Pediatr* 151:542–544
- Hotu S, Carter B, Watson PD, Cutfield WS, Cundy T (2004) Increasing prevalence of type 2 diabetes in adolescent. *J Paediatr Child Health* 40:201–204
- Jebb SA, Rennie KL, Cole TJ (2004) Prevalence of obesity among young people in Great Britain. *Pub Health Nutr* 7:461–465
- Li M, Byth K, Eastman CJ (2007) Childhood overweight and obesity by socioeconomic indicators by areas. *MJA* 187:195
- Magarey AM, Daniels LA, Boulton TJ (2001) Prevalence of overweight and obesity in Australian children and adolescents: reassessment of 1985 and 1995 data against new standard international definitions. *Med J Aust* 174:561–564 (Erratum in: *Med J Aust* 175:392)
- Mikolajczyk RT, Richter M (2008) Associations of behavioural, psychosocial and socioeconomic factors with over- and underweight among German adolescents. *Int J Pub Health* 53:214–220
- O'Dea JA (2003) Differences in overweight, obesity among 4441 Australian Schoolchildren of low and middle/high socioeconomic status. *Med J Aust* 179:63
- O'Dea JA (2004) Childhood obesity prevention: first, do no harm. *Health Educ Res* 20:259–265
- O'Dea J (2008) Gender, ethnicity, culture and social class influences on childhood obesity among Australian schoolchildren: implications for treatment, prevention and community education. *J Health Soc Care* 16:282–290
- O'Dea J, Caputi P (2001) Socioeconomic, weight, age and gender interactions in the body image and weight control practices of 6–19 year old children and adolescents. *Health Educ Res* 16:521–532
- O'Dea JA, Wilson R (2006) Socio-cognitive and nutritional factors associated with body mass index in children and adolescents: possibilities for childhood obesity prevention. *Health Educ Res* 21:796–806
- Ogden CL, Carroll MD, Flegal KM (2008) High body mass index for age among US children and adolescents, 2003–2006. *J Am Med Assoc* 299:2401–2405
- Parsons TJ, Power C, Logan S, Summerbell CD (1999) Childhood predictors of adult obesity: a systematic review. *Int J Obes Relat Metab Disord* 23:S1–S107
- Romon M, Duhamel A, Collinet N, Weill J (2005) Influence of social class on time trends in BMI distribution in 5-year-old French children from 1989 to 1999. *Int J Obesity* 29:54–59
- Saxena S, Ambler G, Cole TJ, Majeed A (2004) Ethnic group differences in overweight and obese children and young people in England: cross sectional survey. *Arch Dis Child* 89:30–36
- Wang Y (2001) Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. *Int J Epidemiol* 30:1129–1136
- Wardle J, Henning Broderson N, Cole TJ, Jarvis MJ, Boniface DR (2006) Development of adiposity in adolescence: five year longitudinal study of an ethnically and socioeconomically diverse sample of young people in Britain. *Br Med J* 332:1130–1135
- World Health Organisation (2000) Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organization, Geneva