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ORIGINAL ARTICLE

Prevalence of obesity, overweight and thinness in Australian children and adolescents by socioeconomic status and ethnic/cultural group in 2006 and 2012

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Abstract
Objectives To study the prevalence of obesity, overweight and thinness, by sex, SES and ethnic background in 2006 and 2012.
Methods Large national surveys of school students were conducted. Height/weight was measured. The outcomes were height, weight, BMI, thinness, overweight and obesity (IOTF), SES and ethnicity.
Results Obesity in 2006 and 2012 in boys and girls was 7.5 and 7.1 %, and 5.8 and 5.6 %; being overweight was 17.7 and 18.5 %, and 18.9 and 18.7 %; thinness was 3.8 and 4.6 %, and 5.0 and 6.0 %. Independent predictors of obesity in 2006 and 2012 were being Pacific Islander (OR 5.03, 5.66), Middle Eastern (OR 3.64, 1.50), aboriginal (OR 2.43 in 2012 only), African (OR 1.99 2012 only), Southern European (OR 1.75, 1.72), low SES (OR 2.22, 2.20), middle SES (OR 1.52, 1.60), female (OR 0.77, 0.82) and adolescent (OR 1.08, 2012 only). Predictors of thinness in 2006 and 2012 were ethnicity: Indian (OR 5.29, 1.96), African (OR 2.71, 2006 only), Asian (OR 1.69, 1.57) and female (OR 1.30, 1.27).
Conclusions The predictors of obesity and thinness were ethnically based, suggesting culturally appropriate interventions in socially and economically disadvantaged communities.

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Introduction

The prevalence of overweight and obesity in children and adolescents increased throughout the world in the 1980s through to the late 1990s (Bundred et al. 2001; Troiano et al. 1995; World Health Organisation 2000), but is now reported to have plateaued in many Westernized countries (Aeberli et al. 2010; Ogden et al. 2010; Olds et al. 2011).Two recent reviews found no significant increase in the prevalence of childhood overweight and obesity during the past two decades in nine countries including the USA, Australia, Netherlands, China, England, France, New Zealand, Sweden and Switzerland (Olds et al. 2011; Rokholm et al. 2010). In particular, Australian data suggest a significant plateau in the prevalence of both overweight and obesity since the late 1990s (Hardy et al. 2011; Morley et al. 2012; O'Dea et al. 2011; Ogden et al. 2010).

Evidence regarding childhood obesity trends is somewhat inconsistent, because while the decline in prevalence of overweight and obesity might have been observed in some studies from Westernized countries, some other studies report an increase. The Health Behaviours among School-aged Children (HBSC) surveys (Currie et al. 2012), for example, show increases in several European and North American countries, with an overall increase in overweight according to body mass index over the last decade across all countries.

We previously published comparative cross-sectional data in this journal (O'Dea and Dibley 2010; O'Dea et al. 2011) outlining the stable prevalence of obesity and overweight in Australian children and adolescents, with the

exception of increases among those of low socioeconomic status (SES) (O'Dea and Dibley 2010). Global surveillance studies also indicate age, sex, ethnic and socioeconomic disparities in the prevalence of obesity among children and adolescents, and that these disparities are similar across Westernized countries (Li et al. 2007; Mikolajczyk and Richter 2008; Morley et al. 2012; Stamatakis et al. 2010; Wardle et al. 2006).

Our Australian study using the 2006 national database found a significantly greater prevalence of obesity and overweight among children from low SES schools and those students of Pacific Islander, Middle Eastern or aboriginal descent (O'Dea 2008) and this led to the development of a new research initiative to examine whether the prevalence of childhood and adolescent obesity is influenced mostly by SES or ethnicity or both. The research to date identifies socioeconomic status and cultural/ethnic background as important determining factors in adult and childhood obesity prevalence, but the current studies do not specifically examine these factors together over time.

Further, thinness is a relatively unstudied weight variable (Cole et al. 2007) that is important to include in prevalence studies, because it may indicate malnutrition and/or height stunting (Bogin 2006), ethnic variation in weight status or eating disorders.

The research questions addressed in the current study were:

1. What was the prevalence of obesity, overweight and thinness in two large nationally representative studies of children and adolescents in 2006 and 2012?
2. Was the prevalence of obesity and overweight in low SES children observed in 2006 also observed in 2012?
3. Was cultural background or ethnic group a greater influencing factor on obesity than SES?

Methods

Study population

The 2006 data for this study were collected as part of the "National Youth Cultures of Eating Study" (O'Dea 2008) a 3 year, Australian government Research Council-funded study of health, weight, culture and eating among schoolchildren. The description of study recruitment and sampling has been given in previous reports (O'Dea and Wilson 2006). The 2012 data were collected from the same schools as those included in 2006 as part of the Australian Government Research Council-funded study "Ethnicity, socio-economic status and social networks as drivers of childhood obesity".

The same schools that participated in 2000 and 2006 also participated in 2012 ($N = 81$). The schools were randomly selected in 2000 (O'Dea and Wilson 2006) from a widely dispersed sample representative of the Australian population. The participant's ethnicity was self-reported and included possible categories of Caucasian/Northern European, aboriginal, Southern European, Asian (Chinese/Southeast Asian), Middle Eastern/Arabic, Pacific Islander, Indian or Sri Lankan and African.

The SES of schools was categorized as low SES, middle SES or high SES using a combined indicator based on five individually self-reported categories of father's and mother's educational level as well as the national government school socioeconomic index (Australian Curriculum and Assesement Reporting Authority (ACARA) 2011). The school SES category variable of low, middle or high school SES was significantly correlated with both the national government school socioeconomic index (Spearman alpha $= 0.82$, $p < 0.01$) and the individual level of parental education (Spearman alpha $= 0.62$, $p < 0.01$) and this variable was therefore used in the analyses. Further description of the SES variable is given in previously published reports (O'Dea 2008; O'Dea and Dibley 2010; O'Dea et al. 2011; O'Dea and Wilson 2006). The schools maintained their SES, so their category did not change.

Participation was high in both studies (82 % in 2006 and 89 % in 2012) with an average of 86 % of the students agreeing to complete the questionnaires and have their anthropometric measurements taken.

The study design and protocol were approved by the University of Sydney Human Ethics Committee and each of the six state and two 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 anonymous questionnaire collected demographic details of the students' gender, age, school type (primary, 6–12 years of age; secondary, 13–18 years of age), school grade/year (primary school, years 3–6, secondary school, years 7–12), ethnicity, eating patterns, nutritional quality of breakfast, body image and several other nutrition and physical activity-related variables. Several reports have been previously published (O'Dea 2008; O'Dea and Dibley 2010; O'Dea et al. 2011; O'Dea and Wilson 2006).

Height and weight were measured by the first author and trained research assistants using standardized anthropometric procedures with height measured to the nearest 0.5 cm without shoes or socks, using a portable free-

standing Harpenden stadiometer and weight 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 then entered to produce an SPSS 21 database (Meyers 2013). Descriptive statistical analyses were undertaken to provide descriptive details of the prevalence of overweight, obesity and thinness in 2006 and 2012 using the International Obesity Task Force (IOTF) 0.5 year body mass index (BMI) cutoffs (Cole et al. 2000, 2007). Prevalence between weight categories of obese, overweight and thinness within years were compared using Pearson's Chi-square tests.

To examine the relationships between overweight, obesity, thinness and gender, SES and ethnicity, adjusted odds ratios and their 95 % CIs were calculated in multivariate logistic regression analyses. In computing the adjusted odds ratios, children in each of the obesity, overweight or thinness categories were compared to those in the normal weight category. Factors that were univariate predictors were added to the model using a forward sequential approach and were retained if $P < 0.01$ to obtain a parsimonious model with only significant independent risk factors.

Analyses were conducted using SPSS 21 database (Meyers 2013; George and Mallery 2012) and were adjusted for the cluster survey design.

Results

A description of the characteristics of the participants including gender, age, SES, class grade/year (years 3–10) and ethnicity is presented in Table 1. The mean difference in age between 2006 and 2012 was not statistically different at 0.26 years (95 % 0.19, 0.33).

The mean and 95 % confidence intervals for weight, height and BMI of surveyed children in 2006 and 2012 by gender, age, SES and ethnicity are given in Table 2. Boys and girls had a very similar BMI, but the BMI in low SES groups was over 1 point higher than in the high SES groups. Students from Middle Eastern or Pacific Islander/Polynesian cultural backgrounds also had a higher mean BMI.

Table 3 shows the percent of children in the thinness, overweight and obese weight categories by gender, age, SES and ethnic/cultural background. The *P* values indicate a significant difference in weight categories between genders, SES and ethnic/cultural background in both 2006 and 2012 and between age groups in 2012.

Logistic regression was used to assess the independent predictors for obesity, overweight and thinness in 2006 and 2012. The adjusted odds ratios are shown in Table 4. In both years, being of low or middle SES was a significant predictor for obesity and for overweight compared to being of high SES. Being female was a protective factor against obesity, but was a significant predictor of thinness. In 2012 but not in 2006, being in the older age category was also a risk for being obese or overweight. In addition, being of Southern European, Pacific Islander or Middle Eastern background was a significant risk factor for obesity or overweight in both years. Being of African origin was protective against overweight in 2006, but predicted obesity and overweight in 2012. Similarly, being of aboriginal background was a predictor of obesity and overweight in 2012, but not in 2006. Children of Southeast Asian or Indian inheritance were at risk for thinness as

Table 1 Characteristics of a national sample of Australian school children in 2006 and 2012

Characteristic	2006		2012	
	N	%	*N*	%
Sex	8,805		1,2869	
Boys	4,236	48.1	6,818	52.9
Girls	4,569	51.9	6,078	47.1
Age (years)	8,889		13,006	
≤8	566	6.4	1,210	9.3
9	806	9.1	726	5.6
10	907	10.2	720	5.5
11	882	9.9	803	6.2
12	1,184	13.3	1,666	12.8
13	1,301	14.6	2,734	21.0
14	1,293	14.5	2,193	16.9
15	1,174	13.2	1,683	12.9
≥16	776	8.7	1,271	9.8
Socioeconomic status (SES)	8,945		13,006	
High	2,012	22.5	2,648	20.4
Middle	5,067	56.6	7,921	60.9
Low	1,866	20.9	2,437	18.7
Ethnic/cultural background	8,755		12,913	
White/Caucasian	6,294	71.9	7,634	59.1
Southern European	775	8.9	1,625	12.6
Southeast Asian/Chinese	623	7.1	1,651	12.8
Middle Eastern/Arabic	169	1.9	411	3.2
Pacific Islander/Polynesian	198	2.3	300	2.3
Aboriginal	500	5.7	696	5.4
African	57	0.7	178	1.4
Indian/Sri Lankan	130	1.5	418	3.2

Table 2 Mean weight, height and BMI of Australian schoolchildren in 2006 and 2012 by gender, age group, socioeconomic status (SES) and ethnic/cultural background

Characteristic	2006			2012		
	N	Mean	(95 % CI)	*N*	Mean	(95 % CI)
Sex						
Boys	4,194			6,661		
Weight (kg)		51.8	51.3, 52.3		53.7	53.2, 54.1
Height (cm)		157.4	156.9, 157.8		159.6	159.2, 160.0
BMI (kg/m^2)		20.4	20.2, 20.5		20.5	20.4, 20.6
Girls	4,508			5,926		
Weight (kg)		49.3	48.8, 49.7		50.1	49.7, 50.5
Height (cm)		153.5	153.1, 153.9		154.3	153.9, 154.6
BMI (kg/m^2)		20.5	20.4, 20.6		20.6	20.5, 20.7
Age						
6–12 years	4,304			5,023		
Weight (kg)		40.6	40.3, 41.0		39.8	39.4, 40.2
Height (cm)		144.9	144.6, 145.3		144.3	144.0, 144.7
BMI (kg/m^2)		19.0	18.9, 19.1		18.7	18.6, 18.8
13–18 years	4,483			7,671		
Weight (kg)		60.1	59.7, 60.5		60.1	59.7, 60.4
Height (cm)		165.5	165.2, 165.7		165.5	165.3, 165.7
BMI (kg/m^2)		21.8	21.7, 21.9		21.8	21.7, 21.9
Socioeconomic status (SES)						
Low SES	1,959			2,551		
Weight (kg)		49.6	48.9, 50.4		53.7	53.0, 54.4
Height (cm)		153.4	152.7, 154.0		157.5	156.9, 158.0
BMI (kg/m^2)		20.6	20.4, 20.8		21.2	21.0, 21.3
Middle SES	5,021			7,712		
Weight (kg)		52.8	52.3, 53.2		53.3	52.9, 53.7
Height (cm)		157.9	151.5, 158.3		158.6	158.3, 159.0
BMI (kg/m^2)		20.8	20.6, 20.9		20.7	20.6, 20.8
High SES	1,861			2,431		
Weight (kg)		45.4	44.7, 46.1		46.1	45.5, 46.7
Height (cm)		150.8	150.2, 151.5		151.9	151.3, 152.5
BMI (kg/m^2)		19.5	19.3, 19.6		19.4	19.3, 19.6
Ethnic/cultural background						
White/Caucasian	6,151			7,399		
Weight (kg)		50.6	50.2, 51.0		51.4	51.0, 51.8
Height (cm)		155.8	155.5, 156.2		157.2	156.8, 157.5
BMI (kg/m^2)		20.3	20.2, 20.4		20.3	20.2, 20.4
Southern European	763			1,584		
Weight (kg)		52.1	51.0, 53.2		53.4	52.6, 54.2
Height (cm)		155.9	155.0, 156.9		157.5	156.8, 158.2
BMI (kg/m^2)		21.1	20.8, 21.4		21.1	20.9, 21.3
Southeast Asian/Chinese	610			1,610		
Weight (kg)		48.0	46.8, 49.1		49.8	49.0, 50.6
Height (cm)		154.0	152.9, 155.0		155.0	154.3, 155.6
BMI (kg/m^2)		19.8	19.5, 20.1		20.2	20.0, 20.4
Middle Eastern/Arabic	156			382		
Weight (kg)		55.6	53.0, 58.1		56.6	55.1, 58.1

Table 2 continued

Characteristic	2006			2012		
	N	Mean	(95 % CI)	*N*	Mean	(95 % CI)
Height (cm)		156.0	154.2, 151.7		160.8	159.6, 161.9
BMI (kg/m^2)		22.6	21.8, 23.4		21.7	21.3, 22.1
Pacific Islander	192			284		
Weight (kg)		59.1	55.9, 62.3		65.6	63.1, 68.2
Height (cm)		157.3	155.3, 159.4		162.9	161.4, 164.5
BMI (kg/m^2)		23.1	22.3, 24.0		24.2	23.5, 24.9
Aboriginal	485			649		
Weight (kg)		50.5	49.0, 52.0		55.5	54.1, 56.9
Height (cm)		154.5	153.2, 155.7		158.5	1,575, 159.5
BMI (kg/m^2)		20.7	20.3, 21.1		21.6	21.2, 22.0
Indian/Sri Lankan	129			412		
Weight (kg)		44.3	42.0, 46.7		46.5	45.0, 48.0
Height (cm)		150.8	148.6, 153.0		152.0	150.6, 153.5
BMI (kg/m^2)		19.1	18.4, 19.8		19.6	19.2, 19.9
African	55			174		
Weight (kg)		46.6	43.0, 50.3		52.6	50.2, 55.1
Height (cm)		152.9	149.5, 156.6		157.2	155.1, 159.4
BMI (kg/m^2)		19.4	18.5, 20.4		21.0	20.3, 21.6

were children of African inheritance in 2006. The size of the adjusted odds ratios suggests that ethnicity was the largest independent predictor of obesity or overweight, followed by SES, gender and age group.

The prevalence of obesity in 2012 by gender, SES and cultural/ethnic group using the International Obesity Taskforce (IOTF) BMI cutoffs at 0.5 age intervals (Cole et al. 2000) are illustrated for females in Fig. 1, males in Fig. 2 and all students combined in Fig. 3. In general, the ethnic trends in obesity can be observed within all SES groups, with participants from Pacific Islander, Middle Eastern and Southern European backgrounds generally being more likely to be obese and those from Asian, Indian and Caucasian background tending to be less at risk.

Discussion

The results of our study found that the prevalence of overweight and obesity did not increase in this child and adolescent population overall or between genders between 2006 and 2012, respectively, with the prevalence of obesity being 7.5 and 7.1 % in boys and 5.8 and 5.6 % in girls and of overweight being 17.7 and 18.5 % in boys and 18.9 and 18.7 % in girls. These findings support the recent literature from various countries in the developed world that child and adolescent obesity and overweight may have plateaued in recent decades (Aeberli et al. 2010; Ogden et al. 2010; Olds et al. 2011).

We found clear graded SES associations between the prevalence of obesity in both study years, with low SES schoolchildren in 2006 being 2.22 times as likely to be obese compared to their high SES counterparts and 2.20 times more likely to be obese in 2012. Conversely, the differences in thinness appear to be more gender and ethnic-based than socioeconomically determined, with Asian, Indian and African children more susceptible to thinness in 2006 and 2012, with the exception of Africans whose risk of thinness decreased and risk of obesity increased during the 6 year study period.

The finding that obesity is greatest among children from Pacific Islander/Polynesian, Middle Eastern, Southern European and aboriginal backgrounds and those from low SES communities is concerning, because of the likelihood of future health risks such as type 2 diabetes among these particular population groups. This finding suggests a need for suitable obesity prevention interventions among low socioeconomic groups as well as among sub-groups of ethnic populations including those of Pacific Islander/Polynesian, Middle Eastern, Southern European and aboriginal backgrounds. The increased risk of type 2 diabetes among Polynesians (Utter et al. 2012), aboriginal Australians and refugees of African descent is also noteworthy and relevant to future research studies and health promotion interventions.

The consistent gender difference in obesity is an interesting finding to further investigate as a more focused and specific research question, as the consistently greater BMI

Table 3 Prevalence of thinness, overweight and obesity in Australian schoolchildren in 2006 and 2012 by gender, age, socioeconomic status (SES) and ethnic/cultural background

Characteristic			Thinness		Overweight		Obese			
	2006 *N*	2012 *N*	2006 % (95 % CI)	2012 % (95 % CI)	2006 % (95 % CI)	2012 % (95 % CI)	2006 % (95 % CI)	2012 % (95 % CI)	2006 *P* value*	2012 *P* value*
Sex										
Boys	4,157	6,630	3.8 (3.2, 4.4)	4.6 (4.1, 5.1)	17.7 (16.5, 18.9)	18.5 (17.6, 19.4)	7.5 (6.7, 8.3)	7.1 (6.5, 7.7)	0.001	<0.0001
Girls	4,393	5,813	5.0 (4.4, 5.6)	6.0 (5.4, 6.6)	18.9 (17.7, 20.1)	18.7 (17.7, 19.7)	5.8 (5.1, 6.5)	5.6 (5.0, 6.2)		
Age										
6–12 years	4,239	4,985	4.4 (3.8, 5.6)	5.5 (4.9, 5.1)	17.8 (16.6, 19.0)	17.2 (16.2, 18.2)	6.7 (5.9, 7.5)	5.4 (4.8, 6.0)	0.60	<0.0001
13–18 years	4,311	7,559	4.5 (3.9, 5.1)	5.1 (5.4, 6.6)	18.9 (17.7, 20.1)	19.5 (18.6, 20.4)	6.5 (5.8, 7.2)	7.0 (6.4, 7.6)		
Socioeconomic status (SES)										
Low SES	1,896	2,523	3.9 (3.0, 4.8)	4.6 (3.8, 5.4)	19.0 (17.2,20.8)	20.3 (18.7,21.9)	9.4 (8.1, 10.7)	9.1 (8.0, 10.2)	<0.0001	<0.0001
Middle SES	4,832	7,601	4.7 (4.1, 5.3)	5.4 (4.9, 5.9)	18.8 (17.7, 19.9)	18.5 (17.6, 19.4)	6.4 (5.7, 7.1)	6.3 (5.8, 6.8)		
High SES	1,822	2,420	4.3 (3.4, 5.2)	5.3 (4.4, 6.2)	16.3 (14.6, 18.0)	17.1 (15.6, 18.6)	4.4 (3.5, 5.3)	3.7 (2.9, 4.5)		
Ethnic/cultural background										
White/ Caucasian	6,019	7,375	4.2 (3.7, 4.7)	5.1 (4.6, 5.6)	18.3 (17.3, 19.3)	17.5 (16.6, 18.4)	5.7 (5.1, 6.3)	5.0 (4.5, 5.5)	<0.0001	<0.0001
Southern European	752	1,581	2.9 (1.7, 4.1)	3.3 (2.4, 4.2)	20.6 (17.7, 23.5)	22.1 (20.1, 24.1)	8.8 (6.8, 10.8)	8.0 (6.7, 9.3)		
Asian/ Chinese	596	1,604	7.0 (5.0, 9.0)	7.7 (6.4, 9.0)	14.1 (11.3, 16.9)	16.9 (15.1, 18.7)	4.5 (2.8, 6.2)	5.9 (4.7, 7.1)		
Middle East/ Arabic	153	381	1.3 (0.0, 3.1)	4.2 (2.2, 6.2)	24.2 (17.4, 31.0)	23.9 (19.6, 28.2)	17.0 (11.0, 23.0)	7.9 (5.2, 10.6)		
Pacific Islander	185	281	3.8 (1.0, 6.6)	3.6 (1.4, 5.8)	25.9 (19.6, 32.2)	29.9 (24.5, 35.3)	21.6 (15.7, 27.5)	21.7 (16.9, 26.5)		
Aboriginal	467	648	3.2 (1.6, 4.8)	4.0 (2.5, 5.5)	18.0 (14.5, 21.5)	19.4 (16.4, 22.4)	7.9 (5.5, 10.3)	12.2 (9.7, 14.7)		
Indian/Sri Lankan	128	412	18.0 (11.3, 24.7)	9.7 (6.8, 12.6)	18.0 (11.3, 24.7)	15.8 (12.3, 19.3)	4.7 (1.0, 8.4)	4.9 (2.8, 7.0)		
African	54	172	11.1 (2.7, 19.5)	4.1 (1.1, 7.1)	5.6 (0.0, 11.7)	23.3 (17.0, 29.6)	9.3 (1.6, 17.0)	9.3 (5.0, 13.6)		

* *P* value from Chi-square test for comparison of weight groups between characteristic groups in each year of the study

(and therefore prevalence of obesity) among males may be due to over-fatness, but may also be associated with the methodological limitations of using BMI and the lack of more specific measures of body composition as the correlations with indices of fatness are acceptable, but not perfect or racially specific (Mei et al. 2002).

The new variable that we aimed to investigate in this comparative study was thinness and this was clearly gender based with a much lower prevalence in boys (3.8 and 4.6 %) than girls (5.0 and 6.0 %) in both study years. These gender differences were similar to other Australian studies (Hardy et al. 2011; O'Dea et al. 2011) and studies from Iran (Kelishadi et al. 2008) and Italy (Lazzeri et al. 2008), but a new finding of our study is the apparent prevalence by ethnicity, with a higher prevalence among girls of South-east Asian, Chinese, Indian, Sri Lankan and African background who were more likely than their Northern or Southern European peers to be "thin". Similar limitations of BMI may account for these differences, although it was interesting to observe that African girls and boys, most of whom were newly arrived refugees in 2006, were less likely to be categorized as "thin" in 2012, suggesting a possible acculturation effect between 2006 and 2012. Other researchers have also noted the change in weight status among African refugees as they adopt a more westernized lifestyle and become more susceptible to obesity (Renzaho et al. 2013; Mellor et al. 2012). In addition, this obesity trend in refugees may reflect early childhood height deficits as described by Bogin (2006).

Alternately, the gender prevalence of thinness may be associated with weight loss dieting or a deliberate pursuit of slimness as reported among many girls in the developed world and is associated with their use of the Internet and social networks (Tiggemann and Slater 2013). The association between thinness may also pose a mental, physical and social health risk to girls, similar to the potential health

Table 4 Independent predictors of obesity, overweight and thinness in Australian schoolchildren in 2006 and 2012

Variable		Obese		Overweight		Thinness	
		Adjusted OR (95 % CI)	*P* value	Adjusted OR (95 % CI)	*P* value	Adjusted OR (95 % CI)	*P* value
2006							
SES	Low	2.22 (1.68, 2.93)	<0.0001	1.29 (1.09, 1.54)	0.004	–	
	Mid	1.52 (1.18, 1.96)	0.001	1.25 (1.08, 1.45)	0.003	–	
Sex	Female	0.77 (0.65, 0.92)	0.01	–		1.30 (1.05, 1.60)	0.01
Ethnicity	South European	1.75 (1.32, 2.30)	0.001	1.23 (1.02, 1.49)	0.03		
	SE Asian/Chinese	–		0.74 (0.58, 0.94)	0.013	1.69 (1.21, 2.36)	0.02
	Pacific Islander	5.03 (3.41, 7.42)	<0.0001	2.05 (1.43, 2.92)	<0.0001	–	
	Indian/Sri Lankan	–		–		5.29 (3.27, 8.56)	<0.0001
	African	–		0.29 (0.09, 0.94)	0.04	2.71 (1.14, 6.44)	0.02
	Middle Eastern	3.64 (2.32, 5.73)	<0.0001	1.62 (1.10, 2.40)	0.02	–	
2012							
Socioeconomic status (SES)	Low	2.20 (1.69, 2.85)	<0.0001	1.21 (1.05, 1.41)	0.01	–	
	Mid	1.60 (1.26, 2.04)	<0.0001	1.10 (0.97, 1.25)	0.14	–	
Sex	Female	0.82 (0.70, 0.95)	0.01	–		1.27 (1.08, 1.49)	0.003
Age	13–18 yrs	1.08 (1.05, 1.120	<0.0001	1.04 (1.02, 1.06)	<0.0001	–	
Ethnicity	South European	1.72 (1.40, 2.12)	<0.0001	1.37 (1.20, 1.57)	<0.0001	0.71 (0.53, 0.96)	0.02
	SE Asian/Chinese	–		–		1.57 (1.28, 1.94)	<0.0001
	Pacific Islander	5.66 (4.08, 7.83)	<0.0001	2.61 (1.97, 3.47)	<0.0001	–	
	Aboriginal	2.43 (1.87, 3.15)	<0.0001	1.22 (0.99, 1.50)	0.06	–	
	Indian/Sri Lankan	–		–		1.96 (1.39, 2.77)	
	African	1.99 (1.16, 3.40)	0.01	1.51 (1.04, 2.17)	0.03	–	<0.0001
	Middle Eastern	1.50 (1.01, 2.22)	0.046	1.45 (1.13, 1.87)	0.003	–	

risk of obesity, and this finding certainly warrants further investigation.

The significant prevalence of obesity among children from low SES schools, which was observed in our previous study using 2000 and 2006 data, was similarly consistent across both of the recent study years and both genders, which suggests a continuation of this socially determined health risk factor and a greater future risk of weight-related ill health among children and adolescents from socially disadvantaged, low-income communities and schools. The findings also suggest that the prevalence is likely to be largely explained by ethnicity and, perhaps, body composition.

The finding that obesity prevalence is greatest 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; Parsons et al. 1999; Romon et al. 2005; Saxena et al. 2004; Wardle et al. 2006) and 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), with 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 strengths of the current study include two large, widely dispersed samples of schoolchildren in Australia, including the same 81 schools in both years, use of objectively assessed 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 the use of BMI as a proxy for weight categories, which is not based on actual body composition or multi-ethnic population standards.

The results of the current study confirm our previous reports and those of other researchers that there is 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. A new finding that ethnicity is a greater predictor than SES suggests that the

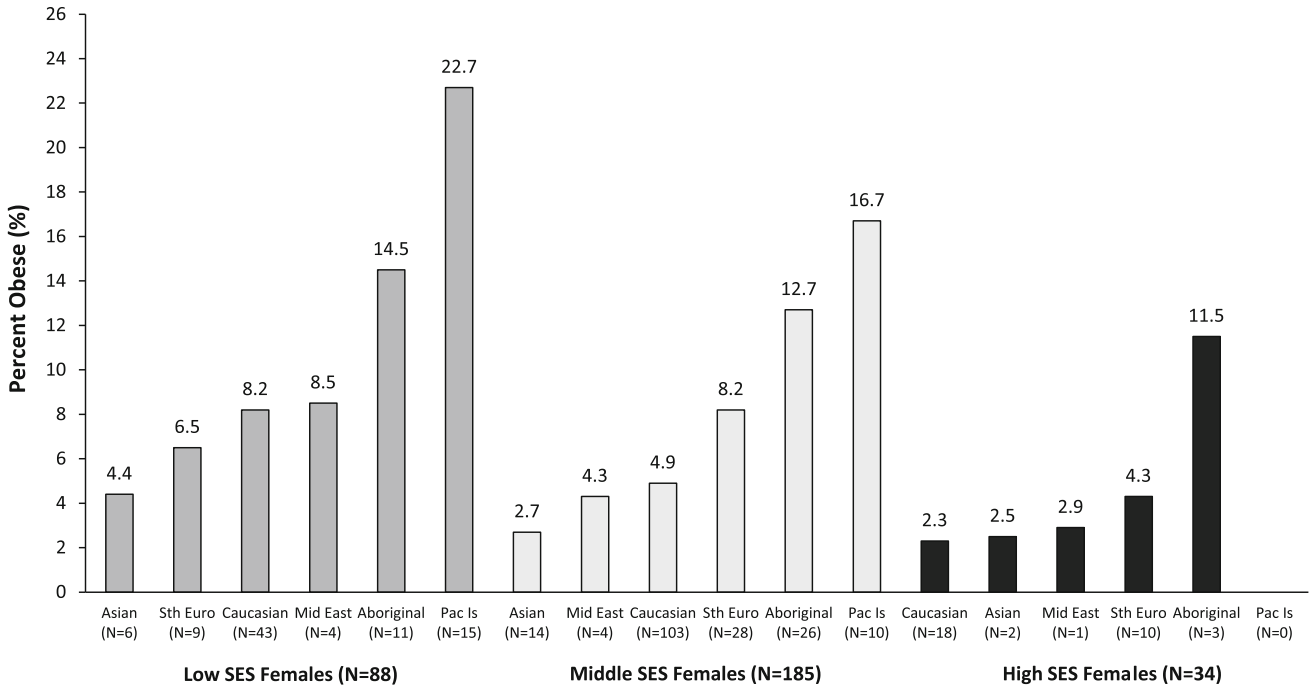

Fig. 1 Prevalence of obesity among ethnic/cultural groups of Australian schoolgirls from low, middle and high socioeconomic backgrounds in 2012, Chi square = 63.6***, Chi square = 83.7***, Chi square = 33.0**. ***$p < 0.000$, **$p < 0.01$

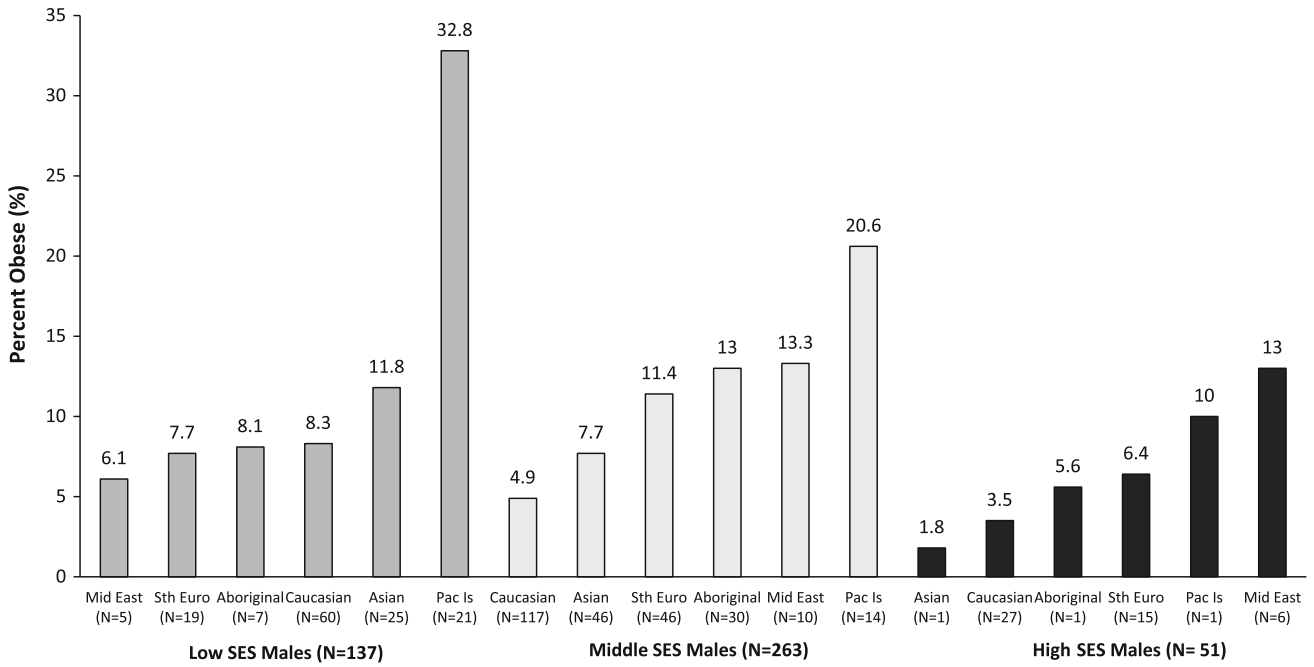

Fig. 2 Prevalence of obesity among ethnic/cultural groups of Australian schoolboys of low, middle and high socioeconomic backgrounds in 2012, $X^2 = 65.9$***, $X^2 = 91.1$***, $X^2 = 33.0$**. ***$p < 0.000$, **$p < 0.01$

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 and ethnic diversity.

The findings of the current study have implications for the prevention of childhood obesity in that the greatest predictor of obesity was ethnically and culturally based, suggesting the implementation of culturally appropriate

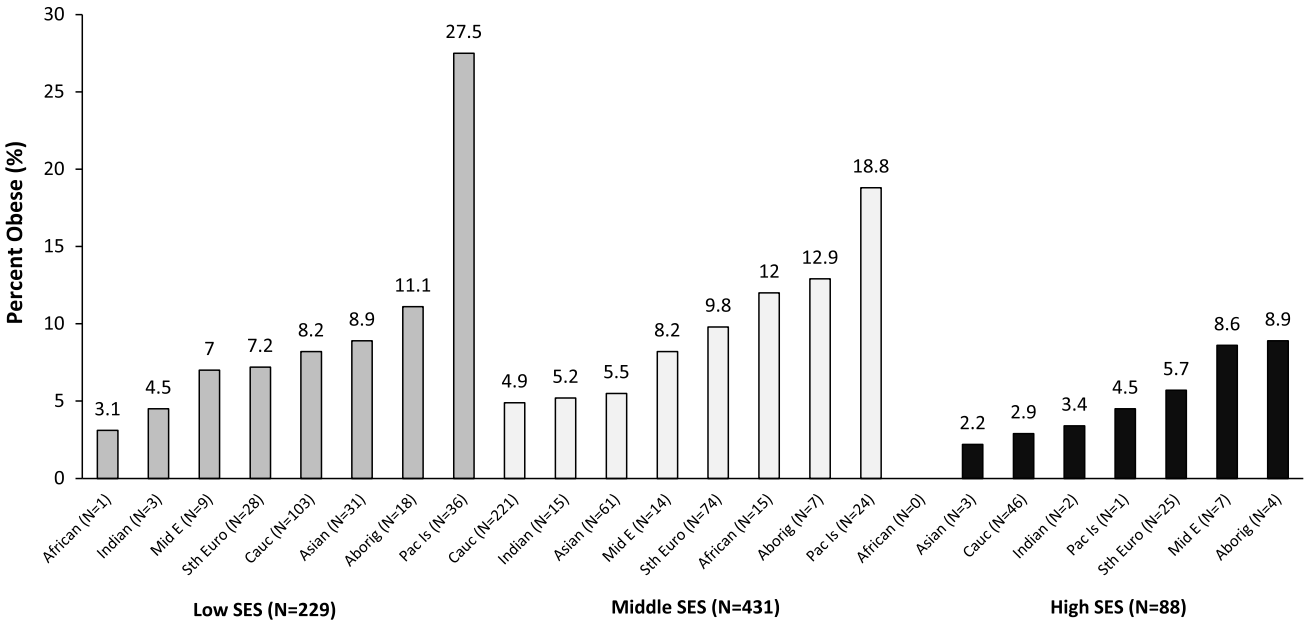

Fig. 3 Prevalence of obesity among ethnic/cultural groups of Australian children and adolescents of low, middle and high socioeconomic backgrounds in 2012, Chi square = 97.1***, Chi square = 132.4***, Chi square = 62.7***. ***$p < 0.000$

interventions to assist socially and economically disadvantaged communities and ethnically targeted areas.

We recommend the implementation of culturally appropriate physical activity and nutrition promotion interventions, which ought to "first, do no harm" and should be particularly targeted to assist socially and economically disadvantaged schools, communities and low SES ethnically diverse areas.

It may also be a prudent consideration for health professionals to further investigate the body image and dieting practices of young people whose BMI suggests a classification of "thinness", as this may potentially indicate a risk of eating disorders in both boys and girls.

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