Future prevalence of overweight and obesity in Australian children and adolescents, 2005–2025

State Government Victoria
Department of Human Services

Future prevalence of overweight and obesity in Australian children and adolescents, 2005-2025

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Executive Summary

Background
The prevalence of overweight and/or obese children and adults is increasing in Australia, along with many countries in the world. However, the likely future trends have not yet been well quantified using measured body mass index (BMI). Although BMI does not account for the heavier weight of muscle mass compared to fat it provides the most useful, albeit crude, population-level measure of obesity because it is commonly collected in population health surveys, has high subject acceptance and good reliability and validity.

Objective
To predict current and future prevalence of overweight and/or obesity in Australian children and adults based on sex, age and year of birth (cohort).

Methods
Multiple linear regression analyses of measured log-transformed BMI (ln(BMI)) data were conducted to determine the independent effects of age and year of birth on ln(BMI) for males and females, respectively. The data for these analyses come from 11 cross-sectional national or state population surveys with measured height and weight. Regression coefficients for cohort obtained from these analyses were applied to the National Nutrition Survey 1995 data set to predict BMI and prevalence of overweight and/or obesity in 2005, 2015 and 2025. These prevalence rates were applied to the relevant population projection estimates to determine the absolute number of Australians and Victorians overweight and/or obese.

Results
These analyses have confirmed that, based on past trends and no effective interventions, BMI is predicted to continue to increase for both males and females and across the age span. This would result in around one third of 5-19 year olds being overweight and/or obese by 2025 as well as 83% of males and 75% of females aged 20 years and over. For Australia, this would represent 16.9 million people and for Victoria, 4.2 million.

How these data can be used
These results have application for policy-makers and planners to determine the need for obesity-related health services in years to come. And to assess whether the prevention programs being implemented now are having any impact in changing the predicted trajectory of BMI.

Conclusions
The increases in prevalence and mean BMI predicted in this study will have significant impacts on disease burden, health care costs and need for prevention and treatment programs. The increase in projected health care costs of type 2 diabetes, largely due to increases in obesity, of $5.6 billion between 2002-2003 and 2032-2033 alone is startling.

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Introduction

It is now well recognised that the prevalence of overweight and/or obese children and adults is increasing around the world [1-5]. However, the likely future trends have not yet been well estimated using measured body mass index (BMI). In Australia current data on measured BMI and prevalence of obesity is also lacking. The last survey in adults was conducted in 1999-2000 [6] and the most recent Australian survey in children was conducted in 1995 [7].

Estimates of both current and future numbers of people with overweight or obesity are needed for the planning of health services and obesity prevention programs and to help evaluate whether the obesity prevention programs being put in place are effective. Further, they will also give both policy makers and the community an idea of the potential scale of the obesity epidemic if effective interventions are not put in place and the growth in obesity prevalence remains unchanged.

Here we analysed a series of Australian surveys of measured BMI in children and adults to predict current and future BMI and prevalence of overweight and/or obesity. These predictions are based on past trends and assume no effective interventions will be put in place.

Methods

Body mass index

Body mass index (BMI) is the most common measure used for classifying weight. It is calculated as a person's weight in kilograms divided by the square of their height in metres. People aged 18 years and over are classified as overweight if they have a BMI of $25kg/m^2$ or above and obese if they have a BMI of $30kg/m^2$ or above. For children and adolescents up to the age of 18 years the International Obesity TaskForce age- and sex-specific BMI cut-offs developed by Cole et al were used [8].

A limitation of BMI as a measure of overweight and obesity is that it does not account for the heavier weight of muscle mass compared to fat. As a result, the relationship between BMI and body fat content varies according to body build and proportion, and it has been shown that a given BMI may not correspond to the same degree of fatness across populations. For example the percentage of body fat mass increases with age up to 60-65 years in both sexes and is higher in women than in men of equivalent BMI. Differences have also been shown across ethnic groups [5]. Despite these limitations BMI provides the most useful, albeit crude, population-level measure of obesity because it is commonly collected in population health surveys, has high subject acceptance and good reliability and validity [5, 9]. Other methods of measuring body fatness include underwater weighing, magnetic resonance imaging, waist circumference and waist-to-hip ratio but none of these are routinely measured in population health surveys, with the recent exception of waist circumference [5, 9].

Regression analyses

The data for these analyses come from 11 cross-sectional national or state population surveys with measured height and weight. The surveys were conducted in Australia between 1969 and 2004 (Table 1) and included 27,635 children and 43,447 adults with measured height and weight data.

The changes in BMI with age and year of birth (cohort) were determined using multiple linear regression analysis. The regression analyses were done separately for children and adults (due to the different relationship between age and BMI) and for males and females.

BMI was log-transformed for all analyses to make the data normally distributed and then anti-logged for display and reporting.

The use of multiple cross-sectional surveys, treatment of BMI as a continuous variable and the log-transformation of BMI values are strengths of the regression analysis approach used in this report [10]. Multiple cross-sectional surveys were used because this is the only way to separate out the effects of age and year of birth (cohort) on BMI and, thus, enable projections into the future. We chose to base our modelling on the full population distribution of BMI values (i.e. BMI is treated as a continuous variable) because obesity-related disease risks occur along a continuum and begin at BMIs as low as 20-21 kg/m^2, not at an arbitrarily defined cut-off of 25 kg/m^2 as use of overweight and obese categories imply [11]. Treatment of BMI as a continuous variable also makes more sense from a public health point of view where interventions are often aimed at shifting the population distribution of BMI rather than specifically targeting overweight or obese individuals [12]. Log-transformation of BMI was necessary to allow use of parametric statistical methods.

Table 1. Data sets used in the regression analyses

Survey	N	Age (years)	Response rate (%)	Adult or child analysis
National surveys				
1980 Risk Factor Prevalence Survey [13, 14]	5 603	25-64	≈ 75%	Adult
1983 Risk Factor Prevalence Survey [15, 16]	7 615	25-64	≈ 75%	Adult
1985 Australian Health and Fitness Survey [17]	8 498	7-16	≈ 68%	Child
1989 Risk Factor Prevalence Survey [18, 19]	9 279	20-69	≈ 75%	Adult
1995 National Nutrition Survey (NNS95) [7]	13 858	2+	61%	Adult & child
1999-2000 AusDiab Survey [6]	11 247	25+	37%	Adult
State surveys				
1969 Australian Schools Fitness and Physical Activity Survey [2] – only South Australian data available	1 004	12-18	72%	Child
1997 New South Wales Schools Fitness and Physical Activity Survey [20]	5518	5-17s	71-90%	Child
1997 Health of Young Victorians Growth Study [21]	3 365	5-13	75%	Child
2003 Western Australian Child and Adolescent Physical Activity and Nutrition Survey [22]	2 275	7-16	56%	Child
2004 New South Wales Physical Activity and Nutrition Survey [23]	5 407	4-17	65%	Child

Predicting future prevalence of overweight and/or obesity

Regression coefficients for cohort obtained from these analyses were applied to the National Nutrition Survey 1995 data set to predict BMI and prevalence of overweight and/or obesity in 2005, 2015 and 2025.

Full details of these methods can be found in Appendix A.

Predicting future numbers of Australians and Victorians overweight and/or obese

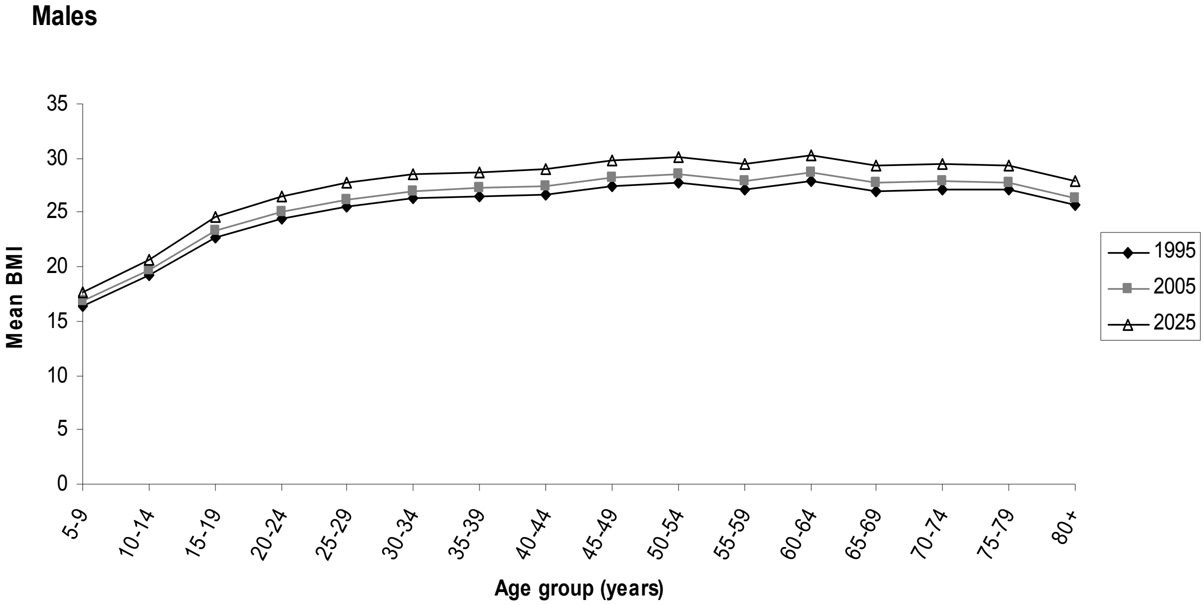
Applying the prevalence rates from the above analyses to the relevant population projection estimates allowed the absolute numbers of people overweight and/or obese to be derived. Population projections for Australia come from the ABS Series B projections [24]. These assume a total fertility rate of 1.7 from 2018; moderate net overseas migration of 110 000; and a life expectancy at birth from 2050-51 of 84.9 for males and 88.0 for females. This will result in a population of 28.2M in 2051. Population projections for Victoria come from Victoria in Future 2004 projections [25] and result in a population of 6.671M in 2051.

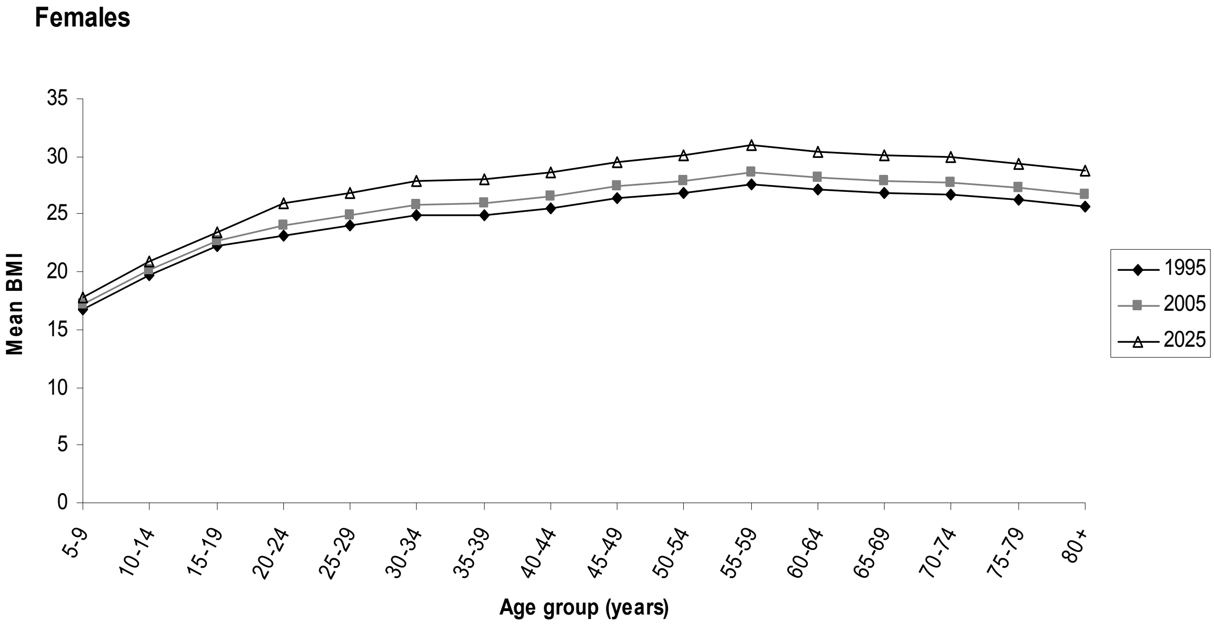
Results

Current and future body mass index

Based on past trends and assuming no effective interventions, BMI is predicted to continue to increase for both males and females and across the age span (Figure 1 and Table B1). The predicted increases in BMI due to year of birth (cohort) over the 30 year period between 1995 and 2025 are greater in males than females in children and adolescents (≈0.05 vs 0.04 kg/m^2 per year, for males and females, respectively) but the reverse is true for adults (≈0.07 vs 0.10 kg/m^2 per year, for males and females, respectively).

Figure 1. Predicted mean BMI (kg/m^2) for 2005 and 2025. Values for 1995 are actual values from the National Nutrition Survey 1995.





Current and future prevalence of overweight and/or obesity

The increases in BMI would result in increases in the prevalence of overweight and/or obesity such that by 2025 around one third of 5-19 year olds will be overweight and/or obese (37% in males and 33% in females), compared with 21% in both males and females in 1995 (Table 2). The absolute increase in prevalence for 5-19 year olds is 0.5% per year for males and 0.4% per year for females. For adults aged 20+ years 83% of males and 67% of females are expected to be overweight and/or obese by 2025, up from 65% of males and 50% of females in 1995 (Table 2). This represents an absolute increase in prevalence of 0.6% per year for males and 0.8% per year for females.

The prevalence figures for overweight and obesity separately can be seen in Figures 2 and 3 and Appendix B (Table B2).

Table 2. Predicted future prevalence (%) of overweight and/or obesity.

MALES Age group (years)	1995 *	2005	2015	2025	FEMALES Age group (years)	1995 *	2005	2015	2025
5-9	14.7%	19.7%	25.5%	33.8%	5-9	22.0%	27.0%	31.7%	36.6%
10-14	22.3%	26.0%	30.3%	34.9%	10-14	21.8%	24.4%	29.0%	31.4%
15-19	25.8%	29.3%	33.4%	41.0%	15-19	19.7%	23.1%	28.5%	30.2%
20-24	38.4%	44.3%	53.6%	62.9%	20-24	26.8%	34.0%	44.7%	53.5%
25-29	54.7%	61.1%	68.7%	75.2%	25-29	33.1%	41.1%	52.2%	61.8%
30-34	61.8%	72.1%	77.0%	82.5%	30-34	41.0%	51.1%	60.3%	66.5%
35-39	65.4%	71.9%	80.7%	84.7%	35-39	41.7%	53.1%	60.1%	69.0%
40-44	68.1%	75.1%	81.6%	87.1%	40-44	50.2%	60.3%	67.4%	78.2%
45-49	74.7%	80.4%	85.4%	89.4%	45-49	54.6%	64.0%	72.8%	78.9%
50-54	78.5%	84.6%	89.2%	91.9%	50-54	60.6%	70.2%	80.6%	87.0%
55-59	75.9%	81.8%	85.8%	89.8%	55-59	68.4%	78.4%	82.9%	88.7%
60-64	76.9%	83.0%	86.5%	90.9%	60-64	68.2%	78.0%	82.1%	88.2%
65-69	73.0%	80.2%	84.2%	87.3%	65-69	63.1%	71.8%	77.7%	84.1%
70-74	71.9%	79.1%	83.6%	89.0%	70-74	64.4%	73.7%	79.4%	85.4%
75-79	74.5%	78.3%	83.7%	89.9%	75-79	60.2%	72.8%	80.8%	85.4%
80+	57.1%	65.5%	71.3%	77.1%	80+	59.2%	68.0%	75.5%	78.7%
5-19	20.9%	25.0%	29.7%	36.6%	5-19	21.2%	24.9%	29.7%	32.8%
20+	65.0%	71.8%	77.9%	83.2%	20+	49.6%	59.1%	67.2%	74.6%

* Actual values from NNS95

Figure 2. Predicted future prevalence (%) of obesity

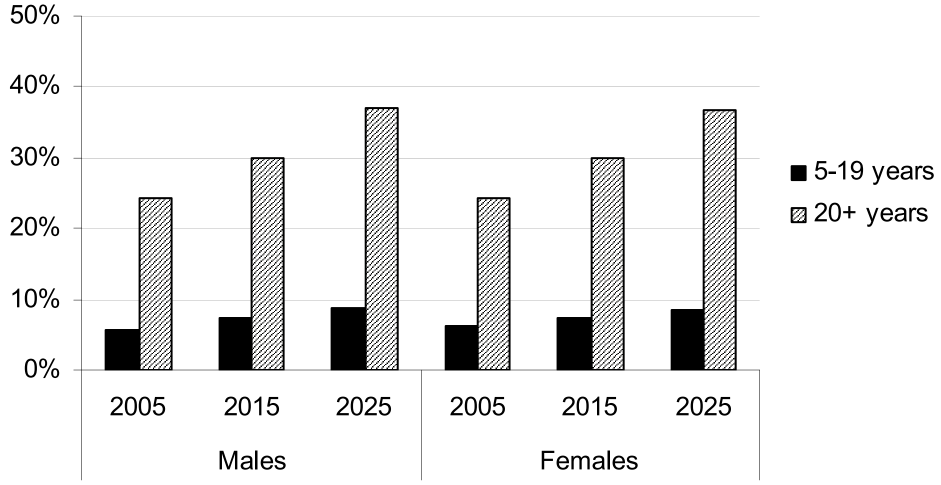
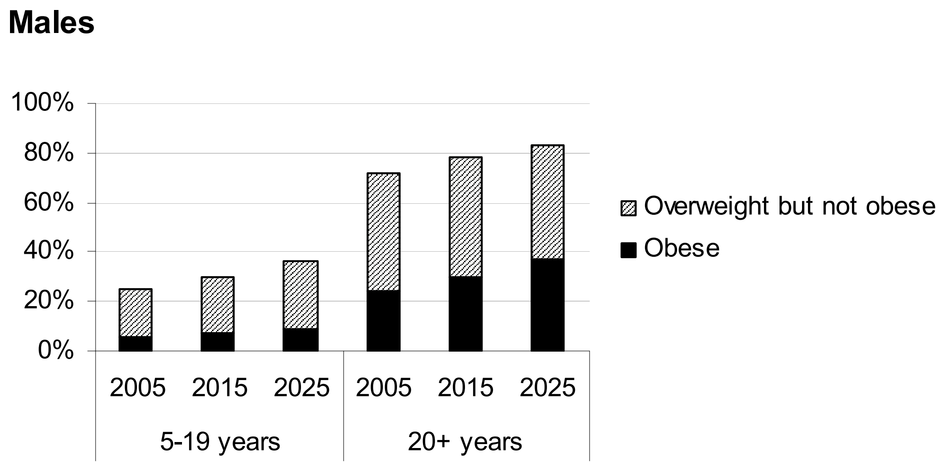
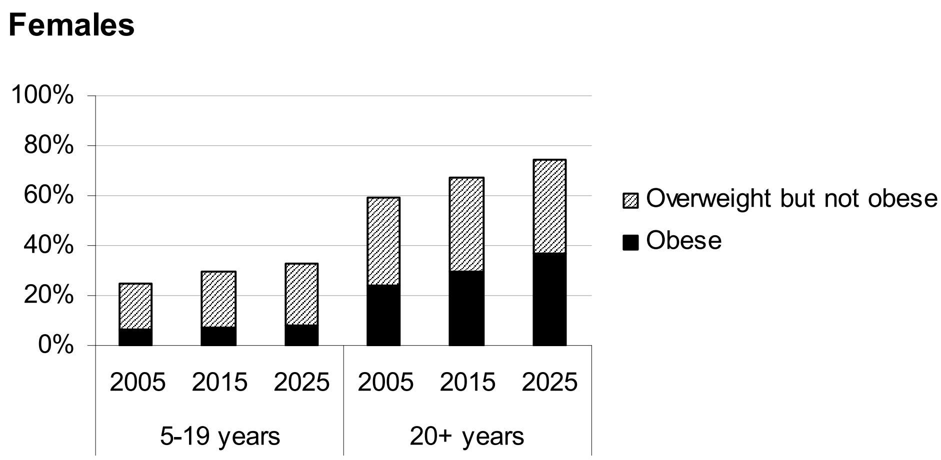


Figure 3. Predicted future prevalence (%) of overweight and obesity





Numbers overweight and/or obese

When the prevalence figures from Table B2 are applied to projected population numbers for Australia it would result in 16.9M Australians in 2025 (total population 23.3M) being overweight and/or obese, up from 10.2M in 2005 (total population 19.1M) – Tables 5 and 6. For Victoria it results in 4.2M Victorians in 2025, up from 2.5M in 2005 (Tables 5 and 7). See Tables B3 and B4 for 5-year age groups.

Table 5. Population numbers (millions) – Australia and Victoria (all ages)

	Australia			Victoria		
	2005	2015	2025	2005	2015	2025
Males	9.5	10.6	11.6	2.3	2.6	2.8
Females	9.6	10.7	11.7	2.4	2.7	2.9
Total persons	**19.1**	**21.3**	**23.3**	**4.7**	**5.2**	**5.7**

Table 6. Predicted future number of people overweight and/or obese (ages 5 years and over) - Australia

Age group (years)	2005	2015	2025
MALES			
5-19	527,149	625,772	781,954
20+	5,357,295	6,710,957	8,003,647
FEMALES			
5-19	422,223	593,082	663,761
20+	3,874,731	6,044,569	7,475,242
Total persons	**10,181,398**	**13,974,380**	**16,924,605**

Table 7. Predicted future number of people overweight and/or obese (ages 5 years and over) - Victoria

Age group (years)	2005	2015	2025
MALES			
5-19	127,025	147,188	176,076
20+	1,321,073	1,647,779	1,958,026
FEMALES			
5-19	102,179	138,987	149,370
20+	974,711	1,518,486	1,873,400
Total persons	**2,524,988**	**3,452,440**	**4,156,872**

Interpretation of results

The increase in BMI shown in these analyses would result in increases in the prevalence of overweight and/or obesity of between 0.4% and 0.8% per year, such that by 2025 83% of males and 75% of females aged 20 years and older will be overweight and/or obese. For children aged 5-19 years the corresponding figures are 37% for males and 33% for females. The impact is such that an extra 6.7M Australians would be overweight and/or obese in 2025 compared to 2005.

The increases in prevalence and mean BMI predicted in this study will have significant impacts on disease burden, health care costs [26] and need for prevention and treatment programs.

While predictions have been calculated to 2025 it is important to note that the further out the prediction, the greater the likelihood of variations from actual. Standard errors around the regression coefficients are shown in Tables A1 and A2 but confidence intervals around the future BMI and prevalence predictions have not been calculated or presented. However, it is important to note that the biggest threat to the predictions is the underlying assumption that past trends will continue into the future. Thus, the predictions assume that the current interventions being put in place will not have a significant impact on reducing BMI and that there will be no substantial changes to the environmental conditions that could accelerate or decelerate the growth in BMI seen over the past 20 years – this is unlikely to be the case.

The results from the National Children's Nutrition and Physical Activity Survey currently being conducted (http://www.kidseatkidsplay.com.au/) and the soon to be started National Health Survey 2007-08 will allow the predictions presented here to be validated and updated.

Comparison with other studies

These analyses are the first of their kind in Australia, and indeed the world, to predict future BMI and overweight prevalence using measured BMI in both children and adults. Previous analyses have been limited to showing current trends [1, 2, 5], have used self-reported BMI and/or limited the analyses to either adults or children [4, 27, 28]. Self-reported BMI data, while more frequently collected, is known to underestimate true BMI as people tend to overestimate height and underestimate weight [29, 30]. And it is important to include both children and adults because the age effects are different and, as these analyses show, so are the trends.

Comparison of the predictions shown here with other studies are consistent in that they all predict an increase in BMI and obesity [4, 11, 28], with the exception of data from Japan that show a decrease in adult females in some age groups [11]. However they differ in the size of the increase predicted. Other prevalence predictions for Australian children have been higher than shown here, at around 1% per year [4] and predicted to reach a prevalence of overweight and/or obesity of 60% by 2035 [28]. Comparisons of mean BMI in Australian adults have shown lower values than reported here [11], with the current analyses more consistent with values for the United States and Canada [11].

How these data can be used

The results of these regression analyses have already been used to predict future BMI in children and adolescents for the Assessing Cost-Effectiveness in Obesity (ACE-Obesity) project so that the effectiveness and cost-effectiveness of obesity prevention interventions could be assessed with greater accuracy [31]. They have also been used in the Australian Burden of Disease Study 2003 to determine expected changes in future diabetes incidence due to obesity and the subsequent impact on total disease burden [32] and health care costs [33].

The results, as presented here, also have wider application for policy-makers and planners to determine the need for obesity-related health services in years to come. And to assess whether the prevention programs being implemented now are having any impact in changing the predicted trajectory of BMI.

Impact on disease burden and health care costs

The combined effect of increasing BMI and decreasing case-fatality due to cardiovascular causes modelled in the Australian Burden of Disease Study 2003 was a considerable increase in the incidence of type 2 diabetes and an even greater increase in future prevalence. This will lead to a strong increase in disease burden (measured as disability adjusted life years or DALYs) due to diabetes, primarily as a consequence of the obesity epidemic. If current trends continue unabated, diabetes will account for around 9% of total burden in 2023, up from around 5% in 2003 [32]. In terms of specific causes of disease burden, type 2 diabetes is likely to rise from second place (after ischaemic heart disease) in 2003 for males to first place in 2023. For females it is set to increase from fourth place in 2003 to second place (after anxiety and depression) in 2023.

The increase in prevalence and incidence of diabetes, along with other factors such as ageing, population growth, excess health price inflation and increases in number of health services provided per case, will lead to a large increase in projected health expenditure for diabetes in Australia. For the period from 2002-2003 to 2032-2033 health expenditure for diabetes is expected to increase by 401% from $1.4 billion to $7 billion, largely owing to expected growth in the prevalence of obesity [33, 34].

Conclusions

These analyses show the degree to which the obesity epidemic will continue to get worse if left unchecked. By 2025 one third of children and three-quarters of adults will be affected in some way. The increase in projected health care costs of type 2 diabetes of $5.6 billion between 2002-2003 and 2032-2033 alone is startling.

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Appendix A. Methods in detail

We obtained unit record data from 11 surveys of Australian children and adults where weight and height had been measured (Table 1). These were combined into two datasets – one for children and adolescents, and one for adults – and analysed in Stata (Intercooled Stata, version 8.2, StataCorp). Children younger than 5 years old were excluded from analyses as were subjects with incomplete data for sex, weight or height, or for calculation of age or year of birth. Data from pregnant women were excluded. For the 1980 Risk Factor Prevalence Survey procedures for measuring height in Adelaide deviated from the study protocol and these data were excluded [35].

For adults, a person with a BMI of 25kg/m^2 or above was classified as overweight, while one with a BMI 30kg/m^2 or above was classified as obese. For children up to the age of 18 years the International Obesity TaskForce age- and sex-specific BMI cut-offs were used [8] and weight category calculated using the zbmicat function in Stata. Where exact age was not available or could not be calculated we used the mid-year BMI value (e.g. for those aged 11 years, we used the cut-off at 11.5 years). BMI was log-transformed for all analyses and then anti-logged for display and reporting.

Regression analysis
The changes in BMI with age and year of birth (cohort) were determined using multiple linear regression analysis of serial cross-sectional surveys. The regression analyses were done separately for children and adults (due to the different relationship between age and BMI) and for males and females. Data from the age group 15-19 years from the National Nutrition Survey 1995 were used in both the child and adult analyses. For children, data were combined from seven datasets (Table 1), with a final sample of 27,635 children contributing to the regression analysis. For adults, five datasets (Table 1) were combined, with a final sample size of 43,447. Survey weights were not consistent between data sets and were not applied for the regression analysis of the combined data. However, this is not a problem since the aim of the analyses was to look at relationships between variables. The outcome variable was the natural log (ln) of BMI, a continuous variable, as the regression diagnostics showed that the three main assumptions of linear regression i.e. linearity, normality, and homoscedasticity (constant variance) were not met for BMI but were acceptable for lnBMI.

Children and adolescents (age 5-18)
Plots of BMI and age (controlling for cohort) showed a linear relationship and therefore age was included in the model as a continuous variable. Year of birth (cohort) was tested as both a categorical (in 10-year groupings) and continuous variable. The best adjusted R^2 values were obtained with cohort as a continuous variable and plots of BMI and cohort (controlling for age) suggested a linear relationship was a reasonable assumption. Interactions of age and cohort showed a statistically significant but very small negative interaction in both males and females, such that in later cohorts the impact of age on BMI would have been slightly larger in younger children and lower in older children. The impact on BMI results of including the interaction was minimal and so, for simplicity, the interaction terms were not included in the final models (Table A1). While the models explain only about 28% of the variance in BMI this is not surprising because there are many other predictors of BMI than age and sex. These include genes, the environment, diet, ethnicity, parental obesity, birth weight and amount of physical activity, among others [9].

Adults (age 15+)
Plots of BMI and age (controlling for cohort) suggested a curvilinear relationship and therefore age was included in the model as a categorical variable, in 5-year age groups, represented by 13 dummy variables. The effect of year of birth was tested by classifying respondents into 10-year groupings according to their year of birth, i.e. born in the 1910s, 1920s etc. For adults in the National Nutrition Survey 1995, 10-year cohort was estimated from approximate year of birth by subtracting the middle age of the 5-year age group from the year of study (1995).

Thus, for those aged 25-29 years the middle age is 27 and the year of birth is 1968 (range 1966-1970). These participants were categorised as belonging to the 1960s cohort. Few adult participants were born before 1910 or after 1979 so these were categorised as belonging to the 1910s and 1970s cohorts, respectively. A plot of the coefficients for the dummy cohort variables, while controlling for age, suggested the relationship between ln(BMI) and 10-year cohort was linear (R^2>0.98). Thus, 10-year cohort was treated as a continuous variable, with 1 representing the 1910s, 2 the 1920s and so on. Interactions of age and cohort were tested but were not significant and were not included in the model. The best models obtained from the regression analysis are shown in Table A2. While the models explain only about 8-9% of the variance in BMI this is not surprising because there are many other predictors of BMI than age and sex. As for children and adolescents, these predictors include genes, the environment, diet, ethnicity, parental obesity, birth weight and amount of physical activity, among others. BMI in childhood also explains some, but not all, of the variance in BMI in adulthood.

Examination of the residuals for the regression models showed no major violations of the assumptions of linearity, normality, and homoscedasticity (constant variance). There was some evidence of greater variance in ln(BMI), suggesting increased skewing, at older ages and later cohorts in females, though not in males. This was not incorporated into the model.

Predicting future mean BMI and prevalence of overweight and/or obesity
The ln(BMI) values for people aged 5 and above from the National Nutrition Survey 1995 dataset were used as the starting population. The regression coefficient for year of birth (cohort) calculated from the linear regression analysis of the 11 data sets was added to (or subtracted from) individual BMI values to predict ln(BMI) in 1985, 2005, 2015 and 2025. The prevalence of overweight and/or obesity was calculated from the individual BMI values for 2005, 2015 and 2025. Since only one dataset was used for projections, mean ln(BMI) and prevalence of overweight and/or obesity for different years and age groups was calculated with the survey weights applied.

Table A1. Results of the regression analysis examining the associations with ln(BMI) in children

	Males		Females	
	Regression coefficient	SE	Regression coefficient	SE
Constant	-2.328402	0.2846313	-1.003343	0.3026616
Age (years)	0.0326239	0.0004521	0.0330519	0.0004775
Year of birth	0.0024643	0.0001423	0.001799	0.0001513
Number included in analysis	14,262		13,373	
R^2	0.2835		0.2903	
RSD	0.14475		0.14775	

RSD, Residual standard deviation – also known as root error mean square;
Age and cohort are treated as continuous variables
All coefficients are significant at the P<0.0001 level.
The following example, using a male aged 10 years, born in 1970, shows how the BMI for a particular age and year of birth is determined:
ln(BMI) = -2.328402 + (0.0024643 x year of birth) + (0.0326239 x age)
ln(BMI) = -2.328402 + 0.0024643 x 1970 + 0.0326239 x 10 = 2.852508
Mean BMI = exp(2.852508) = 17.33

Table A2. Results of the regression analysis examining the associations with ln(BMI) in adults

	Males		Females	
	Regression coefficient	SE	Regression coefficient	SE
Intercept	2.929024	0.0119	2.845304	0.0149
10-year cohort*	0.027062	0.0013	0.038308	0.0016
5-year age group (years):				
15-19†	0		0	
20-24	0.078245	0.0089	0.0394662	0.0114
25-29	0.1270929	0.0082	0.0838415	0.0105
30-34	0.1633883	0.0083	0.1161764	0.0106
35-39	0.1932166	0.0084	0.1601029	0.0107
40-44	0.2187721	0.0087	0.1966213	0.0110
45-49	0.2455203	0.0089	0.2390921	0.0113
50-54	0.2716139	0.0093	0.2903651	0.0118
55-59	0.2809381	0.0098	0.3142981	0.0123
60-64	0.2925906	0.0103	0.3345511	0.0129
65-69	0.3006244	0.0106	0.359082	0.0133
70-74	0.3085108	0.0114	0.37477	0.0142
75-79	0.3098339	0.0127	0.3598676	0.0154
80+	0.2802203	0.0141	0.3475031	0.0169
Number included in analysis	20,854		22,593	
R^2	0.0779		0.0942	
RSD	0.1397		0.1786	

RSD, Residual standard deviation – also known as root error mean square;
* 1910's has a value of 1, 1920's has a value of 2 etc.
† Reference category
All coefficients are significant at the P<0.0001 level.
The following example, using a male aged 40-44 born in the 1970's, shows how the BMI for a particular age and year is determined:

ln(BMI) = 2.929024 + (0.027062 x cohort) + age-group specific co-efficient

ln(BMI) = 2.929024 + 0.027062 x 7 + 0.2187721 = 3.3372

Mean BMI = exp(3.3372) = 28.14

Appendix B. Statistical tables

Table B1. Predicted mean BMI for 2005 and 2025.

MALES	Mean BMI			FEMALES	Mean BMI		
Age group (years)	1995 *	2005	2025	Age group (years)	1995 *	2005	2025
5-9	16.4	16.8	17.7	5-9	16.8	17.1	17.8
10-14	19.2	19.6	20.6	10-14	19.8	20.1	20.9
15-19	22.8	23.3	24.5	15-19	22.3	22.7	23.5
20-24	24.4	25.0	26.4	20-24	23.1	24.1	26.0
25-29	25.5	26.2	27.7	25-29	24.0	24.9	26.9
30-34	26.3	27.0	28.5	30-34	24.9	25.8	27.9
35-39	26.5	27.2	28.7	35-39	24.9	25.9	28.0
40-44	26.7	27.4	28.9	40-44	25.6	26.6	28.7
45-49	27.4	28.2	29.8	45-49	26.3	27.4	29.6
50-54	27.7	28.5	30.0	50-54	26.9	28.0	30.2
55-59	27.2	27.9	29.5	55-59	27.6	28.7	30.9
60-64	27.9	28.7	30.3	60-64	27.1	28.2	30.4
65-69	27.0	27.8	29.3	65-69	26.9	27.9	30.1
70-74	27.1	27.9	29.4	70-74	26.8	27.8	30.0
75-79	27.0	27.8	29.3	75-79	26.2	27.2	29.4
80+	25.7	26.4	27.9	80+	25.7	26.7	28.8
5-19 years	19.3	19.7	20.7	5-19 years	19.5	19.8	20.5
20+ years	26.5	27.2	28.7	20+ years	25.5	26.5	28.6

* Actual values from NNS95

Table B2. Predicted future prevalence (%) of overweight and obesity.

Age group (years)	Overweight but not obese*			Obese		
	2005	2015	2025	2005	2015	2025
MALES						
5-9	14.0%	18.4%	25.2%	5.8%	7.2%	8.6%
10-14	21.7%	24.6%	28.1%	4.3%	5.7%	6.9%
15-19	22.0%	24.5%	30.5%	7.3%	8.9%	10.6%
20-24	29.7%	38.0%	45.9%	14.6%	15.5%	17.1%
25-29	44.8%	48.5%	46.6%	16.2%	20.3%	28.5%
30-34	51.5%	51.1%	50.2%	20.5%	25.9%	32.4%
35-39	48.1%	50.8%	46.1%	23.8%	29.9%	38.6%
40-44	52.6%	49.5%	48.3%	22.4%	32.1%	38.7%
45-49	50.9%	49.7%	43.8%	29.5%	35.7%	45.6%
50-54	49.7%	47.4%	42.0%	34.9%	41.8%	49.9%
55-59	52.5%	51.6%	49.5%	29.3%	34.2%	40.3%
60-64	48.4%	45.7%	42.4%	34.6%	40.8%	48.5%
65-69	52.6%	49.3%	44.0%	27.6%	34.9%	43.3%
70-74	49.2%	47.8%	43.2%	29.9%	35.8%	45.7%
75-79	52.2%	46.6%	45.4%	26.1%	37.1%	44.5%
80+	47.8%	47.2%	45.4%	17.8%	24.2%	31.7%
5-19	19.2%	22.5%	27.9%	5.8%	7.3%	8.7%
20+	47.6%	48.0%	46.0%	24.2%	29.9%	37.1%
FEMALES						
5-9	19.9%	23.9%	27.1%	7.1%	7.8%	9.5%
10-14	18.7%	22.2%	23.2%	5.8%	6.8%	8.2%
15-19	17.4%	21.3%	22.9%	5.7%	7.2%	7.3%
20-24	21.0%	29.4%	33.2%	13.0%	15.3%	20.3%
25-29	25.9%	33.8%	39.0%	15.2%	18.4%	22.8%
30-34	32.7%	35.0%	36.1%	18.4%	25.3%	30.4%
35-39	32.5%	34.6%	39.0%	20.6%	25.5%	30.0%
40-44	39.3%	38.4%	42.1%	20.9%	29.0%	36.1%
45-49	34.8%	39.5%	39.2%	29.2%	33.3%	39.7%
50-54	39.1%	41.1%	39.2%	31.1%	39.5%	47.8%
55-59	42.8%	40.9%	34.1%	35.6%	42.0%	54.6%
60-64	44.1%	41.4%	39.4%	33.9%	40.7%	48.8%
65-69	37.5%	37.9%	35.0%	34.3%	39.8%	49.1%
70-74	38.9%	39.8%	36.0%	34.8%	39.7%	49.4%
75-79	45.7%	47.6%	44.1%	27.1%	33.2%	41.3%
80+	44.0%	43.9%	40.2%	24.0%	31.6%	38.5%
5-19	18.7%	22.5%	24.4%	6.2%	7.3%	8.3%
20+	34.8%	37.4%	38.0%	24.3%	29.8%	36.7%

*BMI of 25 to less than 30

Table B3. Predicted future number of people overweight and obese - Australia

Age group (years)	Overweight but not obese*			Obese		
	2005	2015	2025	2005	2015	2025
MALES						
5-9	94,774	125,081	175,446	39,178	48,787	59,814
10-14	155,077	170,296	199,356	31,085	39,780	48,820
15-19	155,641	177,440	221,754	51,393	64,523	76,763
20-24	215,113	292,941	343,215	105,629	119,653	127,679
25-29	309,534	374,339	368,769	112,051	156,330	225,551
30-34	387,807	406,765	422,459	154,731	206,332	272,331
35-39	352,943	384,334	386,922	174,760	226,656	323,621
40-44	403,569	395,112	406,644	172,180	256,012	325,998
45-49	370,028	376,621	342,812	214,202	270,558	356,372
50-54	330,207	364,108	336,689	231,790	321,632	400,321
55-59	328,248	367,733	369,398	183,649	243,449	301,057
60-64	231,178	293,083	316,837	165,159	261,777	362,883
65-69	201,461	290,668	299,571	105,670	205,588	294,638
70-74	148,221	205,054	254,716	90,050	153,272	269,488
75-79	131,729	145,969	228,028	65,726	116,091	223,279
80+	125,150	183,849	261,569	46,513	94,100	182,799
5-19	405,493	472,817	596,557	121,656	153,091	185,398
20+	3,535,187	4,080,577	4,337,629	1,822,109	2,631,451	3,666,018
FEMALES						
5-9	128,486	154,587	179,360	45,754	50,724	63,045
10-14	126,881	146,728	157,185	39,077	44,586	55,183
15-19	117,209	146,487	158,432	38,175	49,918	50,555
20-24	144,430	213,943	235,272	89,424	111,218	144,065
25-29	174,669	249,656	294,853	102,662	135,851	172,536
30-34	248,704	269,345	292,672	140,270	195,092	246,276
35-39	241,384	258,344	316,331	152,653	190,065	243,386
40-44	303,943	310,141	344,262	161,633	234,444	295,207
45-49	255,709	303,553	302,703	214,922	255,690	306,935
50-54	263,266	320,097	319,306	209,126	307,441	389,167
55-59	265,909	298,084	260,703	220,917	305,888	416,869
60-64	206,531	274,203	302,940	158,695	269,013	374,635
65-69	146,090	228,422	249,224	133,732	240,170	349,970
70-74	127,440	176,559	227,846	114,273	175,924	312,119
75-79	138,002	166,002	242,424	81,842	115,846	227,243
80+	197,916	255,335	310,747	107,969	184,046	297,552
5-19	372,575	447,803	494,978	123,007	145,228	168,783
20+	2,713,992	3,323,683	3,699,282	1,888,118	2,720,689	3,775,960
Total persons	**7,027,247**	**8,324,879**	**9,128,446**	**3,954,890**	**5,650,458**	**7,796,158**

*BMI of 25 to less than 30

Table B4. Predicted future number of people overweight and obese - Victoria

Age group (years)	Overweight but not obese*			Obese		
	2005	2015	2025	2005	2015	2025
MALES						
5-9	22,821	28,184	39,478	9,434	10,993	13,459
10-14	37,298	40,110	44,368	7,476	9,369	10,865
15-19	37,586	42,946	50,444	12,411	15,617	17,462
20-24	53,161	71,298	81,881	26,104	29,122	30,460
25-29	77,727	91,742	90,336	28,137	38,313	55,252
30-34	96,716	100,948	103,704	38,589	51,206	66,851
35-39	89,276	95,818	94,904	44,205	56,508	79,377
40-44	98,753	98,369	100,606	42,132	63,738	80,654
45-49	90,370	94,419	84,681	52,313	67,829	88,030
50-54	79,856	88,622	83,090	56,055	78,284	98,793
55-59	78,736	89,456	91,933	44,051	59,222	74,925
60-64	55,665	70,416	76,491	39,769	62,894	87,607
65-69	49,445	69,264	72,347	25,935	48,990	71,156
70-74	37,192	49,175	61,042	22,595	36,757	64,582
75-79	33,435	35,700	54,434	16,683	28,393	53,300
80+	32,203	47,334	65,686	11,969	24,227	45,905
5-19	97,704	111,241	134,290	29,321	35,979	41,786
20+	872,536	1,002,562	1,061,133	448,537	645,483	896,893
FEMALES						
5-9	30,883	34,844	40,381	10,998	11,433	14,194
10-14	30,625	34,618	34,911	9,432	10,519	12,256
15-19	28,654	35,473	36,106	9,333	12,088	11,521
20-24	37,085	53,691	57,780	22,961	27,911	35,381
25-29	44,663	64,114	74,967	26,251	34,888	43,868
30-34	63,490	70,018	74,849	35,809	50,715	62,983
35-39	62,045	65,611	80,935	39,238	48,271	62,272
40-44	75,255	78,348	88,377	40,020	59,226	75,784
45-49	63,033	76,807	75,704	52,979	64,697	76,762
50-54	64,776	78,677	79,774	51,455	75,567	97,228
55-59	65,521	73,236	65,467	54,435	75,154	104,683
60-64	50,741	67,278	74,135	38,989	66,005	91,680
65-69	36,836	56,177	61,108	33,720	59,066	85,811
70-74	32,673	43,372	55,927	29,297	43,216	76,613
75-79	35,768	41,708	59,611	21,212	29,106	55,879
80+	51,703	67,164	79,601	28,205	48,412	76,221
5-19	90,162	104,935	111,398	29,762	34,041	37,971
20+	683,589	836,201	928,236	474,570	682,232	945,164
Total persons	**1,743,992**	**2,054,940**	**2,235,058**	**982,191**	**1,397,735**	**1,921,814**

*BMI of 25 to less than 30

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