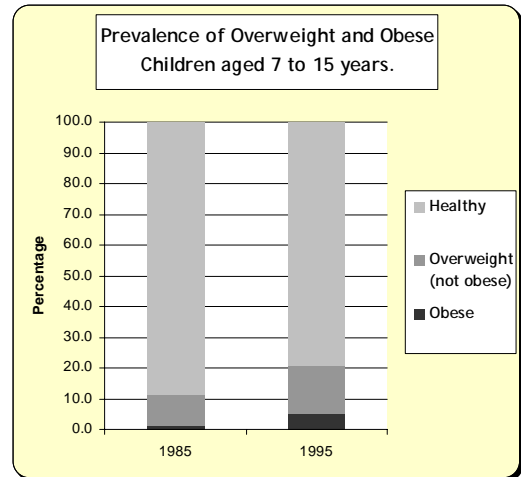


Obesity – a global epidemic

- An application involving the refinement of an algebraic model -

Introduction

Obesity and the health problems that it causesⁱ, are widely acknowledged as an epidemic of global proportionsⁱⁱ. As part of this epidemic, Australia is currently experiencing significant increases in overweight and obesity levels. The percentage of Australians over 25 who are overweight has more than doubled in 15 years, from 12.1% in 1988 to 26.7% in 2003. In the same time period the percentage of Australians over 25 who are obese has increased by more than 360%, from 1.7% to 7.9%ⁱⁱⁱ.



Obesity in the young - tomorrow's health crisis today -

Perhaps of greatest concern, some of the most dramatic increases in obesity are seen amongst the young. In Australians aged 7 to 15 years, obesity tripled between 1985 and 1995, affecting 5.1% of children; with a further 15.7% overweight.

This trend has continued and accelerated, with recent studies suggesting that obesity levels amongst children have now reached nearly 8%. Even more worryingly, obesity is starting to occur earlier in life, with around 5% of preschoolers now considered obese.

Measuring Obesity.

Gathering data like the information presented above requires an accepted definition of who is overweight and obese. The accepted definition involves an individual's Body Mass Index (BMI). Persons over 18 having a BMI of,

- greater than 25 are considered overweight.
- greater than 30 are considered obese.

There are similar cut-offs for children.

What is the BMI?

The Body Mass Index is an approximation for an individual's *percentage body fat*. An individual's BMI can be found by dividing their weight (in kilogram's) by the square of their height (in metres) i.e.

$$\text{BMI} = \frac{\text{weight}}{(\text{height})^2}$$

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Activity 1: Working with the BMI.

1. I am 180 cm tall and weigh 80 kg. What is my BMI? Am I overweight?
2. A healthy BMI range is considered to be between 20 and 25.
If my partner is 170 cm tall, what is her *healthy weight range*?
3. *Optional* Calculate your own BMI.

Checkpoint



As mentioned previously, BMI is used to classify obesity because it approximates an individual's percentage body fat. The question is, how well can such a simple formula approximate a complex quantity like an individual's percentage body fat?

Activity 2: Evaluating the BMI model for percentage body fat.

To evaluate how well BMI approximates percentage body fat requires the calculation of BMI's for individuals with known percentage body fat, measured using a different, more accurate method^{iv}. Fortunately such data was the subject of a study by Roger W. Johnson, published in the Journal of Statistics Education and at <http://www.amstat.org/publications/jse/v4n1/datasets.johnson.html>

In this study the percentage body fat of 252 men was measured, along with their height, weight and 10 other body measurements. To see how well the BMI approximates percentage body fat we are going to study a random selection of 30 of these men, whose data appears below.


Age	Weight (kg)	Height (m)	BMI	% Body Fat
22	69.9	1.68		25.0
23	89.9	1.87		11.9
32	81.9	1.77		20.7
28	68.6	1.72		14.1
41	112.2	1.87		31.7
46	68.3	1.73		28.0
48	98.4	1.78		31.0
62	98.0	1.86		25.8
72	71.6	1.71		15.0
46	80.3	1.78		20.4
48	80.4	1.85		20.0
42	80.5	1.75		26.8
47	89.4	1.86		23.4
49	96.5	1.91		20.3
40	80.2	1.80		24.6
23	85.3	1.97		10.6
26	69.1	1.75		9.7
27	90.8	1.87		20.8
33	88.9	1.85		14.7
35	98.4	1.87		19.1
35	103.5	1.77		34.5
35	80.4	1.80		20.4
37	109.4	1.82		29.4
41	105.6	1.89		23.3
42	110.8	1.93		37.3
42	101.9	1.90		24.4
50	78.4	1.85		19.4
51	67.7	1.77		13.7
54	69.5	1.79		12.6
68	70.5	1.76		15.3

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Activity 2 (continued): Evaluating the BMI model for percentage body fat.



A. Enter these weights and heights into a CASIO *ClassPad 300*.

B. Calculate the BMI of these men in  mode in the following way,

- Tap on the heading row of List 3 and name it as BMI.
- Tap on the Cal row of this column and enter the BMI formula as $\text{weight} \div \text{height}^2$
- You may wish to copy these BMI values into the previous table.

	weight	height	BMI
1	69.9	1.68	
2	89.9	1.87	
3	81.9	1.77	
4	68.6	1.72	
5	112.2	1.87	
6	68.3	1.73	
7	98.4	1.78	
8	98	1.86	
9	71.6	1.71	
10	88.3	1.78	
11	88.4	1.85	
12	88.5	1.75	
13	89.4	1.86	
14	96.5	1.91	
15	86.5	1.8	
16	85.3	1.97	

Cal= $\text{weight}/\text{height}^2$



C. Enter the percentage body fat data into List 4.

1. Examine the BMI and % body fat data. Describe what you notice.
2. If there were a perfect correspondence between BMI and percentage body fat, what would a scatter plot of BMI against percentage body fat look like?
3. What do you think the scatter plot of our data will look like?
4. Draw a scatter plot of our data.
5. Hence comment on the relationship between BMI and percentage body fat for the data in our sample.
6. Discuss how well BMI predicts percentage body fat across the range of BMI's observed in the data set.

Checkpoint



Activity 3: Doing better than *percentage body fat = BMI*

Given the limited validity of the algebraic model $\% \text{ body fat} = \text{BMI}$,

1. Develop a better algebraic model for percentage body fat in terms of BMI.
2. Comment on the degree to which this new model can be used to predict an individual's body fat based on their BMI.

Checkpoint



ⁱ These consequences include heart disease, type 2 diabetes and cancer.

ⁱⁱ World Health Organisation; Global Strategy on Diet, Physical Activity and Health.

ⁱⁱⁱ All Australian data was obtained from the Australian Government's Australian Institute of Health and Welfare

^{iv} Percentage body fat is most accurately determined using an underwater weighing method. It can also be calculated based on skin fold measurements.