In: Focus on Nutrition Research
Editor:Tony P. Starks, pp.
ISBN 1-59454-768-8

Chapter

Food and Weight-Related Behaviours: Do Beliefs Matter More than Nutrition Knowledge?

Madeleine Nowak[1], Petra G Buettner[1], David Woodward[2], and Anna Hawkes,[3]

[1]School of Public Health and Tropical Medicine, within the North Queensland Centre for Cancer Research, James Cook University, Townsville, Australia, [2]School of Medicine, University of Tasmania, Hobart, Australia and [3]currently, National Heart Foundation of Australia - Queensland Division, Fortitude Valley, Australia

Abstract

Western societies are faced with two diametrically opposed weight-related problems. Firstly, the average weight of their populations is rising, together with the health, social and economic problems associated with overweight and obesity. The rise in weight is probably due to a combination of: time constraints; readily available inexpensive prepared foods, beverages and snack foods; and lower activity levels due to energy saving devices and more sedentary leisure activities. Secondly, the slim image, prevalent in these societies, results in weight loss measures even among those who are not overweight. This unnecessary and unrealistic 'striving for slimness' may result in poor eating habits, inadequate dietary intake, needless psychological pressure, and eating disorders. Preoccupation with a slim body image and restrictive eating practices is not solely an issue among adult populations, but is also alarmingly prevalent in adolescents.

In order to better understand some of these issues, we have examined the food, nutrition, weight and shape-related beliefs and behaviours of a group of adolescents in Northern Australia. In this chapter we: report on a study showing that beliefs of adolescents predict their weight loss behaviour; review information from the same population showing that beliefs are a better predictor of food choice than nutrition knowledge; and propose a model for food and weight

related behaviour, which incorporates the individual's beliefs into the well established Transtheoretical Model of Change.

Introduction

Western societies are faced with two diametrically opposed weight-related problems. Firstly, the average weight of their populations is rising [1-5] together with the health, social and economic problems associated with overweight and obesity [6,7]. Secondly, the slim image, prevalent in these societies, results in weight loss measures even among those who are not overweight [8,9]. This unnecessary and unrealistic "striving for slimness" may result in poor eating habits, inadequate dietary intake, needless psychological pressure, and eating disorders. Preoccupation with a slim image and restrictive eating practices are not solely an issue among adults, but are alarmingly prevalent among adolescents [10-12].

In previous studies of food and weight-related behaviour of adolescents from northern Australia we found that the majority of students in Year 8 were dissatisfied with their bodies, with approximately 40% reporting being "happy with the way my body looks" [13]. So many of the girls (52%) wanted to lose weight, including some who did not consider themselves overweight, that we suspected that wanting to lose weight among females may have become a fashion. In contrast, equal numbers of boys wanted to lose or gain weight, with 54% reporting they did not want to change their weight.

There were significant changes in the level of body satisfaction across school years with males becoming increasingly more satisfied while females became increasingly less satisfied [14]. Both males and females were concerned about their body shape and their weight, however there were major gender differences across school years. More males in higher school years than lower years thought their calves, thighs, chests and lower arms were too thin and consequently wanted to "bulk up". In contrast, more females in higher than lower years thought their hips, stomachs, thighs and buttocks were too fat and hence they reported wanting to lose weight.

More females (66%) than males (24%) had attempted weight loss, and older females were more likely to attempt weight loss than younger ones, but there was little change in the proportion of males attempting weight loss across school years. Among those who wanted to lose weight, the females were more likely to manipulate their food intake while the males were more likely to exercise. However, among those who attempted weight loss, hazardous methods of weight loss were used equally by males and females (10%). While there were no significant changes in the frequency of hazardous weight loss methods used by males across school years, more females in higher than lower years used diuretics and laxatives to manipulate their weight.

These adolescents reported a poor intake of core foods, with only one in four eating fruit, vegetables, a dairy product and a core cereal food daily [15]. They also reported a high intake of fatty and sugary foods. Thus foods high in fat and sugar appeared to be replacing these core foods in the diets of these adolescents. The fruit intake was particularly low, with only 41% of females and 35% of males eating fruit daily. Furthermore, 19% of students did not consume dairy products daily. Adolescents who ate three main meals per day were more likely than others to eat all four core foods daily.

There were significant gender differences in food intake and food related behaviour amongst these adolescents. The females ate fruit and vegetables more often and high fat savoury foods and high sugar foods less often than the males. However, the females also ate core cereal foods less often than the males, possibly because they considered these foods to be fattening.

Although the females were more concerned about their health than the males and reported trying to eat well, they tended to reduce their intake of bread, milk and meat when attempting weight loss. Furthermore, the lower intake of bread and milk persisted beyond the weight loss attempt as did the tendency to eat breakfast and lunch less often [15].

The major changes in food intake and exercise behaviour across school years were that females in the higher school years tended to exercise less often and were less likely to consume bread and milk every day than females in lower school years. The females in higher school years also ate between meal snacks less often, which correlated with their lower intake of some high fat and high sugar snack foods: potato crisps and high fat extruded snacks, ice cream, muesli bars, candies and chocolates, and soft drinks. In contrast, the males in higher school years consumed between meal snacks more often than those in lower school years [15].

The majority of these adolescents reported an association between eating and negative food-related emotions [15]. Overall, 70% of the males and 94% of the females reporting at least one of the following behaviours: eating more when depressed; eating from boredom; or associating guilt with eating. There were no significant changes across school years in the proportion of students reporting at least one of these behaviours. This type of emotional eating was reported more frequently by both males and females who had tried to lose weight than by students who had not tried to lose weight.

Most of these adolescents were aware of the relationship between their current food intake and the risk of future ill-health, however, future health was not particularly important to them [16]. When asked about a series of issues relating to looks, health and well being, they ranked issues of current looks and energy more highly than issues relating to future ill health, with looks and energy being even more important in higher school years. This ranking, was not gender specific, although more females assigned the highest rank to their weight whereas more males assigned the highest rank to their fitness.

In this chapter we: explore the relationship between beliefs and behaviours relating to weight loss attempts; review information from the same population showing that beliefs are a better predictor of food choice than nutrition knowledge; and propose a model which can be used to both understand and change food and weight related behaviour.

Predictors of Weight Loss Attempts Among Adolescents

The objective of the present study was to explore the relationships between weight and shape related beliefs and behaviours among these Australian adolescents, and to identify predictors of attempting weight loss. In addition to exploring these data with the more traditional multiple logistic regression analysis, we used Classification and Regression Tree (CART)- analysis [17-20] to provide more insight into the relationship between the variables and to identify specific risk groups.

CART- analysis is an explorative method of data analysis that was developed in the 1960s and 1970s [17-20]. The general aim of a CART-analysis is to define most homogeneous subgroups of a

data set with respect to an outcome variable. This is achieved by a step-wise procedure. In the first step, the entire data set is analysed by bivariate analysis of all potentially important predictors against the outcome variable. The strongest predictor is identified and the data set is divided into subgroups according to this predictor. In all subsequent steps of the analysis, the first step is repeated using the newly defined subgroups as the entire data set. CART-analysis is free from some of the restrictive assumptions inherent in many classical multivariate models and has been shown in other epidemiological research to provide important insights into the structure of data [21-23]. In particular, CART-analysis: provides a graphical display of the data with respect to the target variable; identifies interactions between variables; and defines prognostic groups or risk groups. CART-analysis has been rarely used previously in nutrition literature although Woodward used a similar technique to explore predictors of intakes of energy, nutrients and food-categories [24,25].

In this study, data were collected using a questionnaire (Appendix 2), administered by teachers during a single school period and answered anonymously. The participants were 902 high school students attending Grades 8, 10, 11, and 12 (age range 12-20 years) at four of the six non government schools in Townsville, which is an Australian tropical coastal city with a population of approximately 145,000. Students in Grade 9 were not included in the sample because some of them had participated in a similar survey the previous year. The questions used for this component of the study included demographic information, questions relating to weight behaviour, weight-related beliefs and attitudes, perceptions of body weight and shape, and personal ranking of the importance of issues of weight, shape and health (Appendix 2). Data analyses included both stepwise multiple logistic regression analysis (backward) and CART-analysis (Appendix 1).

Predictors of Attempting Weight Loss

A total of 902 students (54% males) with a mean age of 15 years (SD ± 1.6 years) participated in the study. Of these students 43.3% (23.8% boys; 65.8% girls) had attempted weight loss during the previous year. The mean body mass index (BMI) of all students was 20.3 kg/m^2 (SD ± 3.0 kg/m^2) with no significant gender difference ($p = 0.298$). Analysis of predictors of attempted weight loss was stratified by gender, as gender was identified as the strongest predictor of weight loss attempts, and because the authors hypothesised that predictors of attempts of weight loss are different for males and females.

For both sexes, weight loss attempts were strongly and significantly ($p<0.0001$; bivariate analyses) related to: BMI; a number of measures of personal body image; ranking of the importance of weight; and the negative emotions "I eat more when I feel depressed" (boys only), and "I often eat too much and feel guilty" (Table 1, Table 2). However, weight loss attempts were not related to a range of other general beliefs about body image or the frequency of undertaking exercise (Table 1, Table 2). Further descriptive information about the way these students ranked a number of issues relating to health, looks, and energy have been previously reported [16].

Table 1:Description and bivariate results of potential predictors of weight loss attempts during previous year for boys

Predictor	Weight loss attempts No (n=364)	Yes (n=114)	p-value
Demographics			
Mean age (± SD) in years	15.0 (±1.5)	15.0 (± 1.6)	p=0.7570
Boarder	4.7%	4.5%	p=0.9188
Mother at work	67.9%	74.6%	p=0.1771
Father at work	93.0%	90.9%	p=0.4576
Body image			
Body mass index (± SD) in kg/m^2	20.0 (±2.6)	22.3 (±3.3)	p<0.0001
Median number of body parts regarded too fat	0; IQR=0-0*	2; IQR=1-4	p<0.0001
"I see myself as being overweight"	12.7%	57.5%	p<0.0001
"I am happy with the way I look"	59.6%	35.1%	p<0.0001
"I would like to lose weight"	8.1%	67.3%	p<0.0001
"Others think I am too fat"	4.7%	28.8%	p<0.0001
Beliefs about body image			
Median rank of importance of weight	5; IQR=3-8	3; IQR=2-5	p<0.0001
"Slim people have more friends"	15.6%	23.2%	p=0.0635
"Slim people are most attractive"	55.9%	51.8%	p=0.4488
"Being thin is more important for a women"	56.7%	62.2%	p=0.3087
"Overweight women are not attractive for men"	54.9%	48.6%	p=0.2505
"To be fashionable a women must be thin"	46.1%	38.4%	p=0.1510
"Overweight people should blame themselves"	33.4%	37.3%	p=0.4573
"Fat people are lazy"	39.7%	36.0%	p=0.4861
"Overweight people are not healthy"	40.5%	42.9%	p=0.6585
Negative emotions			
"I eat more when I feel depressed"	20.0%	42.1%	p<0.0001
"Sometimes I eat because I am bored"	55.6%	72.8%	p=0.0011
"I often eat too much and feel guilty"	12.5%	41.2%	p<0.0001
Exercise			
Median number of days exercised last week	6; IQR=3-7	6; IQR=3-7	p=0.8751

*IQR = Inter-quartile range

Table 2:Description and bivariate results of potential predictors of weight loss attempts during previous year for girls

Predictor	Weight loss attempts No (n=142)	Yes (n=273)	p-value
Demographics			

Mean age (± SD) in years	14.7 (±1.7)	15.2 (± 1.6)	p=0.0030
Boarder	20.6%	24.3%	p=0.3972
Mother at work	67.9%	70.2%	p=0.6219
Father at work	89.7%	88.6%	p=0.7461
Body image			
Body mass index (± SD) in kg/m^2	18.4 (±2.2)	21.2 (±3.1)	p<0.0001
Median number of body parts regarded too fat	1; IQR=0-3*	5; IQR=3-6	p<0.0001
"I see myself as being overweight"	14.5%	70.8%	p<0.0001
"I am happy with the way I look"	50.0%	15.5%	p<0.0001
"I would like to lose weight"	27.0%	91.2%	p<0.0001
"Others think I am too fat"	1.4%	28.0%	p<0.0001
Beliefs about body image			
Median rank of importance of weight	5; IQR=3-6	2; IQR=1-5	p<0.0001
"Slim people have more friends"	8.6%	11.1%	p=0.4213
"Slim people are most attractive"	27.9%	38.6%	p=0.0303
"Being thin is more important for a women"	51.4%	61.0%	p=0.0600
"Overweight women are not attractive for men"	16.9%	25.3%	p=0.0523
"To be fashionable a women must be thin"	13.4%	30.4%	p=0.0001
"Overweight people should blame themselves"	18.6%	20.2%	p=0.6899
"Fat people are lazy"	16.9%	16.9%	p=0.9979
"Overweight people are not healthy"	30.7%	31.3%	p=0.9114
Negative emotions			
"I eat more when I feel depressed"	45.1%	57.4%	p=0.0174
"Sometimes I eat because I am bored"	73.2%	83.2%	p=0.0171
"I often eat too much and feel guilty"	32.6%	70.0%	p<0.0001
Exercise			
Median number of days exercised last week	3; IQR=1-7	4; IQR=2-6	p=0.6410

*IQR = Inter-quartile range

Logistic Regression Analyses:

For both boys and girls, the independent predictors of weight loss attempts included: the number of body parts regarded as too fat; considering themselves overweight; and their ranking of the importance of weight. For boys the strongest predictor was the number of body parts they believed were too fat, with a significantly increased odds ratio of 10.2 (95%-CI = [3.5, 30.4]; $p < 0.0001$) for more than three body parts compared to none. The final logistic model for boys also included "I eat more when I feel depressed" ($p = 0.0082$), and the number of days of exercise during the previous week ($p = 0.0045$; Table 3). For female students, the strongest predictor of trying to lose weight was believing that others thought they were too fat (POR = 9.8; 95%-CI = [2.2, 44.1]; $p = 0.0030$). The additional predictor for girls was another negative emotion "I often eat too much and feel guilty" ($p = 0.0037$; Table 4). There were no significant interactions in either model.

Table 3:Result of multiple logistic regression identifying predictors of attempted weight loss during the previous year, among boys (n = 456)

Predictor	Weight loss attempts No (n=348)	Yes (n=108)	POR [95%-CI]*	p-value
How do you see yourself?				
Underweight/Okay/Don't think about it	307	45	1	
Overweight	41	63	3.0 [1.5, 6.0]	=0.0024
Number of body parts regarded too fat*				
No body parts too fat	254	22	1	
1-3 body parts too fat	55	37	4.8 [2.3, 9.8]	<0.0001
4-12 body parts too fat	10	33	10.2 [3.5, 30.4]	<0.0001
Rank importance of weight*				
Lower ranking (4-10)	226	45	1	
Higher ranking (1-3)	80	51	2.4 [1.3, 4.3]	=0.0046
"I eat more when I feel depressed"				
Disagree/not sure	276	62	1	
Agree	72	46	2.3 [1.2, 4.2]	=0.0082
Number of days exercised last week				
less than 6 days				
6 or 7 days	170	50	1	
	178	58	2.4 [1.3, 4.3]	=0.0045

* POR [95%-CI] = Prevalence odds-ratio and 95%-confidence interval.

** This model was adjusted for missing data in the answers to numbers of body parts regarded as too fat (45 missings) and ranking of importance of weight (54 missings).

This model was also adjusted for the confounding effects of body mass index, the negative emotion "I often eat too much and feel guilty", and the body image issue "Others think I am too fat". The model correctly predicts 83.3% of the cases.

Table 4: Result of multiple logistic regression identifying predictors of attempted weight loss during the previous year, among girls (n = 385)

Predictor	Weight loss attempts No (n=129)	Yes (n=256)	POR [95%-CI]*	p-value
How do you see yourself?				
Underweight/Okay/ don't think about it	111	75	1	

Overweight	18	181	5.8 [2.9, 11.9]	<0.0001
Number of body parts regarded too fat				
None or 1 body part too fat	76	29	1	
2 or more body parts too fat	53	227	2.8 [1.4, 5.5]	=0.0027
Rank importance of weight*				
Lower ranking (4-10)	79	78	1	
Higher ranking (1-3)	39	152	2.8 [1.6, 5.1]	=0.0007
"Other people think I am too fat"				
Disagree/not sure	127	183	1	
Agree	2	73	9.8 [2.2, 44.1]	=0.0030
"I often eat too much and feel guilty"				
Disagree/not sure	88	78	1	
Agree	41	178	2.4 [1.3, 4.2]	=0.0037

* POR [95%-CI] = Prevalence odds-ratio and 95%-confidence interval.

** This model was adjusted for missing data in the answer to ranking of importance of weight (40 missings).This model was also adjusted for the confounding effect of the belief "Slim people have more friends". The model correctly predicts 82.6% of the cases

CART-Analysis For Male Students

The end point of the CART was a tree-like structure of subgroups which are represented by boxes. The upper most box represents the entire data set, which consisted of 419 boys of whom 23.4% had tried to lose weight. The area of this box represents the sample size (n = 419), and the placement of the middle of this box relates to the scale of "percentage of boys who tried to lose weight".

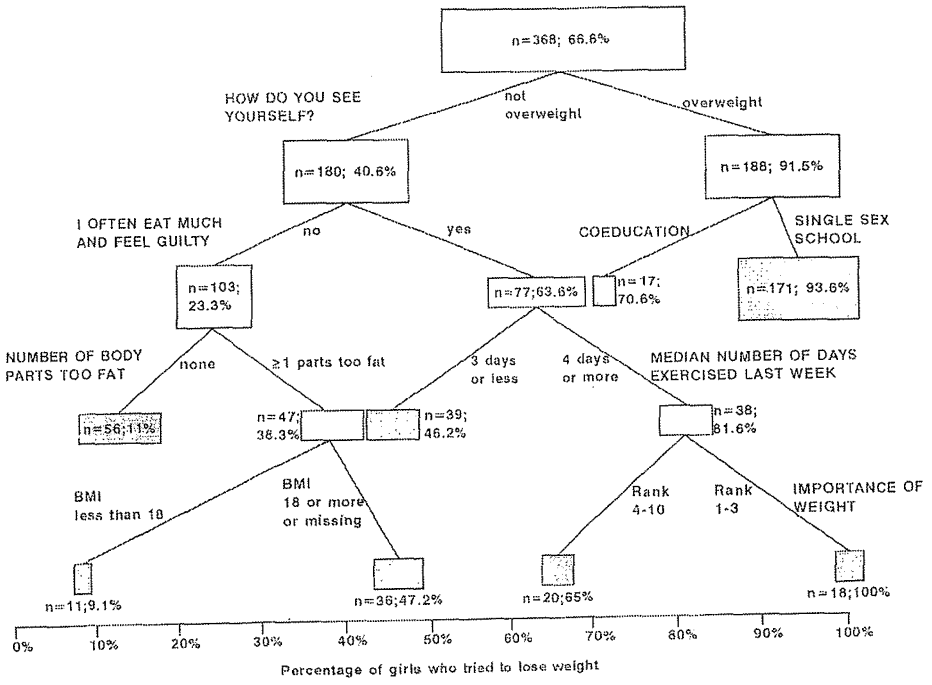

Figure 1: The CART-analysis for male students (n = 419) resulted in 9 homogenous subgroups for weight loss attempts. For each subgroup, the sample size and the percentage of boys who tried to lose weight are given. The area of a box refers to the sample size of the subgroup and the boxes are placed along the scale of percentage of boys attempting weight loss. Filled boxes mark end groups.

Table 5: Result of Classification and Regression Tree (CART)- analysis identifying predictors, among boys (n = 456), of attempted weight loss during the previous year

	1. Split n = 419	2. Split n = 322	3. Split n = 97	4. Split n = 246	5. Split n = 76	6. Split n = 61	7. Split n = 57	8. Split n = 44
	whole sample	**I'm no t over weight**	**I'm over weight**	**I'm not over weight; no body part too fat**	**I'm not overwei ght; 1+ body parts too fat**	**I'm over weight, don't eat more if sad**	**I'm not overwt; no body part too fat; weight is importa nt**	**I'm overwt, don't eat more if sad; don't think overwt = unhealthy**
Demographic variables								
Class (8 vs ≥10)	ns	ns	ns	ns	ns	ns	p=0.020 8	ns
Age (≤13 yr vs > 13 yr)	ns	ns	ns	ns	ns	ns	p=0.020 8	ns
Body size and exercise								
BMI (<18 kg/m^2 vs ≥18 kg/m^2)	p=0.01 26	ns	ns	ns	ns	/	ns	/
BMI (<20 kg/m^2 vs ≥20 kg/m^2)	p=0.00 03	ns	ns	ns	ns	ns	ns	ns
BMI (<22 kg/m^2 vs ≥22 kg/m^2)	p<0.00 01	p=0.04 13	ns	ns	ns	ns	p=0.047 8	ns
Days exercising last week (0-5 vs more)	ns	ns	ns	ns	ns	ns	ns	**p=0.0457**
Attitudes to own eating								
Sometimes I eat because I am bored (agree vs disagree/unsure)	p=0.00 85	ns	ns	ns	ns	ns	ns	ns
I eat more when I feel depressed (agree vs disagree/unsure)	p<0.00 01	p=0.02 67	**p=0.01 26**	ns	ns	ns	ns	ns
I often eat too much and feel guilty (agree vs disagree/unsure)	p<0.00 01	p=0.00 02	ns	ns	ns	ns	ns	ns
Attitudes to body size in general								
People who are	ns	ns	p=0.02	ns	ns	ns	ns	ns

overweight have only got themselves to blame (agree vs disagree/unsure)			96					
Overwt people are not healthy (agree vs disagree/unsure)	ns	ns	p=0.0181	ns	ns	p=0.0376	ns	ns
Attitudes to own body size								
I see myself as overweight (yes vs no)	p<0.0001	/	/	/	/	/	/	/
I see myself as underweight (yes vs no)	p<0.0001	p=0.0003	/	p=0.0133	p=0.0264	/	p=0.0071	/
I feel happy with the way my body looks (agree vs disagree/unsure)	p<0.0001	ns	ns	ns	ns	ns	ns	ns
Other people think that I am too fat (agree vs disagree/unsure)	p<0.0001	ns	p=0.0300	ns	ns	ns	/	ns
Ranking of importance of weight (rank 1-3 vs rank 4-10)	p<0.0001	p=0.0016	ns	p=0.0090	ns	ns	/	ns
No. of body parts described as too fat								
(0 vs more)	p<0.0001	p<0.0001	ns	/	/	ns	/	ns
(0,1 vs more)	p<0.0001	p<0.0001	ns	/	ns	ns	/	ns
(0-2 vs more)	p<0.0001	p<0.0001	ns	/	ns	ns	/	ns
(0-3 vs more)	p<0.0001	p<0.0001	ns	/	ns	ns	/	ns
(0-4 vs more)	p<0.0001	p=0.0008	ns	/	ns	ns	/	ns
(0-5 vs more)	p<0.0001	p=0.0171	ns	/	ns	ns	/	ns
(0-6 vs more)	p=0.0116	p=0.0171	ns	/	ns	ns	/	ns
(0-7 vs more)	p=0.0128	p=0.0171	ns	/	ns	ns	/	ns
(0-8 vs more)	p=0.0128	p=0.0171	ns	/	ns	ns	/	ns
(0 –9 vs more)	p=0.0128	p=0.0171	ns	/	ns	ns	/	ns
(0 –10 vs more)	ns	p=0.0171	/	/	ns	ns	/	ns
(0 –11 vs 12)	ns	p=0.0171	/	/	ns	ns	/	ns

The following explanation is intended to help the reader understand the analysis using Figure 1 and Table 5. As shown in Table 5 ("split 1"), boys who reported trying to lose weight differed in several characteristics from those who did not. They had a higher BMI, and were more likely to have unfavourable attitudes to their body. For example, they were more likely to see themselves as overweight; and less likely to see themselves as underweight; they were less likely to be happy with their body's appearance, and more likely to see multiple parts of their body as too fat; they gave a higher importance rating to body weight, and were more likely to report that other people consider them too fat. They were also more likely to have unfavourable eating behaviours: eating associated with boredom, depression or guilt. Statistically, the strongest association of attempted weight loss was with perceiving oneself as overweight, and for the next stage of the CART- analysis we analysed the "I'm overweight" and the "I'm not overweight" groups separately.

The "I'm not overweight" sub-group comprised 322 boys, of whom 13% had attempted weight loss; the "I'm overweight" comprised 97 boys, of whom 59% had attempted weight loss. In these two sub-groups analysed separately, we no longer find in either group a significant impact for a number of the predictors noted in the previous paragraph (eg, two of the BMI dummy variables, link of eating with boredom, dissatisfaction with body), suggesting that these predictors form a tight cluster with self-perceived overweight. (Table 5, splits 2 and 3). Awareness of such a cluster could allow more holistic intervention strategies.

Among Those Who Did Not Consider Themselves Overweight:

Some of the predictors mentioned above were significant in the whole sample, but not in the "I'm overweight" group – suggesting that their impact in one of the two sub-groups was strong enough to prevent it being "diluted out" by the other sub-group in the whole sample of boys. In the "I'm not overweight" sub-group, those who had attempted weight loss had a higher BMI, were less likely to see themselves as underweight, more likely to see multiple parts of their body as too fat, and consider body weight more important; and they were also more likely to report associating eating with depression or guilt. Regarding at least one body part as too fat had the strongest impact: 30% had attempted weight loss, compared to 13% of those who did not consider any body part too fat. However, the factors mentioned in this paragraph may be considered a cluster, to be collectively targeted in interventions specifically aimed at boys who do not consider themselves overweight.

Among Those Who Considered Themselves Overweight:

In the "I'm overweight" sub-group, those who had attempted weight loss were more likely to report eating associated with depression and that other people considered them too fat, and were more likely to display negative attitudes to overweight people ("only have themselves to blame", "not healthy"). Once again, the factors mentioned in this paragraph may be regarded as a cluster to be addressed collectively in interventions specifically aimed at boys who consider themselves overweight.

The End-Product of the CART- Analysis for Boys:

The remaining steps of the CART-analysis are outlined in Table 5 and Figure 1 above. The final result of the CART- analysis (Fig 1) is the identification of nine homogeneous risk groups among boys for attempting weight loss. The key characteristics are: whether they thought they were overweight; whether they thought their body parts were too fat; whether weight was an important issue for them; whether they reported eating more when depressed; the number of days they had exercised during the previous week; and their attitudes to overweight people ("overweight people are not healthy"). At one end of the spectrum, boys who did not think they were overweight or that any of their body parts were too fat, and who gave a low rating to the importance of weight (n=189), were least likely to have attempted weight loss in the previous year (4.8%, 95%-CI = [1.8%, 7.8%]). Interestingly, even among the group of 33 boys who considered themselves to be about the right weight and did not feel that even one of their body parts was too fat, but for whom weight was an important issue, 27.3% (95%-CI = [13.3, 45.5]) had tried to lose weight. At the other extreme, 75% (95%-CI = [57.8, 87.9]) of the 36 boys who thought they were overweight and who reported eating more when depressed, had tried to lose weight in the previous year.

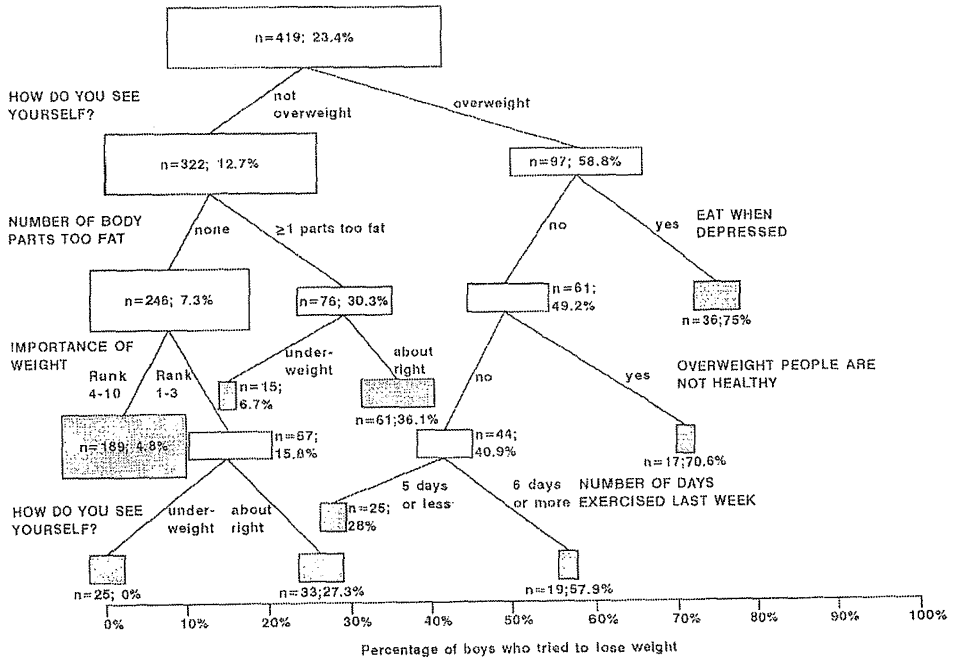

Figure 2: The CART-analysis for female students (n = 368) resulted in 8 homogenous subgroups for weight loss attempts. For each subgroup, the sample size and the percentage of girls who tried to lose weight are given. The area of a box refers to the sample size of the subgroup and the boxes are placed along the scale of percentage of girls attempting weight loss. Filled boxes mark end groups.

Table 6: Result of Classification and Regression Tree (CART)- analysis identifying predictors, among girls (n = 368), of attempted weight loss during the previous year

	1. Split n = 368	2. Split n = 180	3. Split n = 188	4. Split n = 103	5. Split n = 77	6. Split n = 47	7. Split n = 38
	whole sample	I'm not over weight	I'm over weig ht	I'm not overwt, not guilty about over-eating	I'm not overwt, am guilty about over-eating	I'm not overwt, not guilty about over -eating, 1+ body parts too fat	I'm not overwt, feel guilty about over -eating, exercise 4+ d/w
Demographics							
Type of school (single sex vs co-education)	p=0.0002	ns	p=0. 002	ns	ns	ns	ns
Class (8 vs ≥10)	p=0.0008	ns	ns	ns	ns	ns	ns
Class (8 or 10 vs 11 or 12)	p=0.0156	p=0.048 1	ns	ns	ns	ns	ns
Class (8, 10, 11 vs 12)	p=0.0083	ns	ns	ns	ns	ns	ns
Age (≤13 years vs > 13 years)	p=0.0011	ns	ns	ns	ns	ns	ns
Age (≤15 years vs > 15 years)	p=0.0209	p=0.035 3	ns	ns	ns	ns	ns
Age (≤16 years vs > 16 years)	p=0.0407	ns	ns	ns	ns	ns	ns
Body size							
BMI (<18 kg/m^2 vs ≥18 kg/m^2)	ns	ns	ns	ns	ns	p=0.0324	ns
BMI (<20 kg/m^2 vs ≥20 kg/m^2)	p=0.0117	ns	ns	ns	ns	ns	ns
BMI (<22 kg/m^2 vs ≥22 kg/m^2)	p<0.0001	ns	ns	ns	ns	ns	ns
Days exercising last week							
(0, 1 vs more)	ns	ns	ns	ns	p=0.041 0	ns	/
(0-2 vs more)	ns	ns	ns	ns	p=0.002 1	ns	/
(0-3 vs more)	ns	ns	ns	ns	p=0.000 6	ns	/
(0-4 vs more)	ns	ns	ns	ns	p=0.010 0	ns	ns
(0-5 vs more)	ns	ns	ns	ns	p=0.020 0	ns	ns
(0-6 days vs more)	ns	ns	ns	ns	p=0.044 7	ns	ns
Attitudes to own eating							
Sometimes I eat because I am bored (agree vs disagree/unsure)	p=0.0171	ns	ns	ns	ns	ns	ns
I eat more when I feel	p=0.0174	ns	ns	ns	ns	ns	ns

depressed (agree vs disagree/unsure)							
I often eat too much and feel guilty (agree vs disagree/unsure)	p<0.0001	p<0.0001		/	/	/	/
Attitudes to body size in general							
Slim people are most attractive (agree vs disagree/unsure)	p=0.0303	ns	ns	ns	ns	ns	ns
Overweight women are not attractive to men (agree vs disagree/unsure)	ns	ns	p=0.0248	ns	ns	ns	ns
To be fashionable and look nice a woman must be thin (agree vs disagree/unsure)	p=0.0001	ns	ns	ns	ns	ns	ns
Attitudes to own body size							
I see myself as overweight (yes vs no)	p<0.0001	/	/	/	/	/	/
I see myself as underweight (yes vs no)	p<0.0001	p=0.0126	/	ns	ns	ns	ns
I feel happy with the way my body looks (agree vs disagree/unsure)	p<0.0001	p=0.0091	ns	ns	ns	ns	ns
Other people think that I am too fat (agree vs disagree/unsure)	p<0.0001	p=0.0002	p=0.0245	ns	p=0.0237	ns	ns
Ranking of importance of weight (rank 1-3 vs rank 4-10)	p<0.0001	p=0.0002	ns	ns	p=0.0090	ns	p=0.0096
No. body parts considered too fat							
(0 vs more)	p<0.0001	p<0.0001	/	p=0.0018	ns	/	ns
(0,1 vs more)	p<0.0001	p<0.0001	ns	p=0.0023	ns	ns	ns
(0-2 vs more)	p<0.0001	p<0.0001	ns	ns	ns	ns	ns
(0-3 vs more)	p<0.0001	p=0.0003	ns	ns	p=0.0337	ns	ns
(0-4 vs more)	p<0.0001	p=0.0007	ns	ns	p=0.0222	ns	ns
(0-5 vs more)	p<0.0001	p=0.0395	ns	ns	ns	ns	ns
(0-6 vs more)	p<0.0001	ns	ns	/	ns	/	ns
(0-7 vs more)	p=0.0002	ns	ns	/	ns	/	ns
(0-8 vs more)	p=0.0054	ns	ns	/	ns	/	ns
(0 –9 vs more)	p=0.0034	ns	ns	/	ns	/	ns
(0 –10 vs more)	p=0.0315	/	ns	/	/	/	/

Footnote 1 to Table 6:

P-values (approximate or exact; ns = not significant) for potential predictors (coded as dummy variables) refer to their relation to "trying to lose weight". The "splits" refer to the branches of the CART presented in Figure 1 (from left to right and from top to bottom).

Footnote 2 to Table 6

The following dummy variables were also tested, but were not significant in the whole sample or any of the sub-groups shown (or, for some sub-groups, were not applicable):

Demographic variables: Boarder (yes vs no); Mother is working (yes vs no); Father is working (yes vs no);

Body size and exercise: BMI missing (yes vs no); Days exercising last week (none vs some days);

Attitudes to body size in general: Slim people have more friends (agree vs disagree/unsure); Being thin is more important for a woman than a man (agree vs disagree/unsure); People who are overweight have only themselves to blame (agree vs disagree/unsure); Most people who are fat are lazy; (agree vs disagree/unsure); Overweight people are not healthy; (agree vs disagree/unsure);

Attitudes to own body size: Ranking of importance of weight (missing vs valid value)

No. of body parts described as too fat Number of body parts described as too fat; (0 –11 vs 12); Number of body parts described as too fat (missing vs valid value);

Footnote 3 to Table 6:

Within a column, more than one dummy variable may achieve a $p<0.0001$. The DV chosen for the split was the one with the highest chi-square statistic value, and is denoted in each column by the use of bold type. (The chi-square values themselves have been omitted to save space.)

CART- Analysis for Female Students

As shown in Table 6 ("split 1"), girls who reported trying to lose weight differed in several characteristics from those who did not. The strongest association with attempted weight loss was self-perceived overweight: only 41% of the girls who saw themselves as not being overweight had attempted weight loss, compared to 92% of those who saw themselves as being overweight. Further analysis, therefore, focussed on the sub-groups 'I'm overweight" and "I'm not overweight".

Several other characteristics (higher BMI, eating because of boredom or depression, believing that slimness is linked to being attractive and fashionable) were also associated with attempted weight loss among girls as a whole, but were not significant in the two sub-groups. These would appear to form a cluster with self-perceived overweight, and intervention strategies aimed at girls as a whole might sensibly focus on these collectively.

Among Those Who Did Not Consider Themselves Overweight:

A number of characteristics significant in the whole sample of girls retained significance only among those who did not consider themselves overweight (higher year at school, older, being guilty about eating, not seeing herself as underweight, not being happy with her body, placing greater importance on weight, seeing several body parts as too fat). Their impact in the whole sample may therefore be regarded as an artefactual side-effect of their impact in the "I'm not overweight" sub-group. The factor with greatest impact in this sub-group was guilt: 64% of those who felt guilty about over-eating had attempted weight loss, compared with 23% of those who didn't. Several other factors mentioned in the previous paragraph - higher year at school, older, not seeing herself as underweight, not being happy with her body – did not reach significance in either the "guilty" or the "not guilty" sub-group; these would appear to form a cluster with guilt about over-eating, and

intervention strategies aimed at girls who did not consider themselves overweight might sensibly focus on these collectively.

Among Those Who Considered Themselves Overweight

One characteristic, which was significant in the whole sample of girls retained significance only among those who considered themselves overweight: 94% of those at single-sex schools had attempted weight loss, compared to 71% of those at coeducational schools. This finding suggests that intervention strategies focussed on those who consider themselves overweight are particularly relevant to single-sex schools.

The End-Product of the CART- Analysis For Girls

Once again, it would be tedious to continue this description step by step. But the final result of the CART- analysis (Fig 2) is the identification of eight homogeneous risk groups for attempting weight loss. The key characteristics are: whether they thought they were overweight; whether they reported feeling guilty about over-eating; whether they attended a single-sex or coeducational school; whether they thought their body parts were too fat; their BMI; the number of days they had exercised during the previous week; and whether weight was an important issue for them. At one end of the spectrum, weight loss had been attempted by only 9% of those girls who did not think they were overweight or feel guilty about over-eating, had at least one body part they considered too fat but had a BMI less than 18 (9.1%; 95%-CI = [0.2, 41.3]). At the other extreme, weight loss had been attempted by 100% of those who did not think they were over-weight but felt guilty about over-eating, exercised more than four days per week and regarded weight as important (100%; 95%-CI = [81.5, 100.0]).

Logistic Regression and CART- Analysis are Complementary

For both male and female students, the predictors identified using logistic regression analysis were also evident in CART-analysis. For male students, CART-analysis provided additional information about: (1) "eating when depressed" which was particularly important for boys who believed they were overweight; (2) the number of days of exercise which was only important for a small group of boys who thought they were overweight but did not have negative emotions relating to food or negative attitudes to overweight people; and (3) the most extreme groups were identified by an association between food and negative emotions and the belief that "overweight people are not healthy". A relationship between eating and negative emotions was also of importance for girls who did not think they were overweight. Unlike the boys, believing that "overweight people are not healthy" did not affect weight loss attempts among girls.

As logistic regression and CART-analyses were conducted on the same data sets, one would expect both approaches to identify the same major predictors. However, CART-analysis creates subgroups where variables, which are less important in the whole sample can become influential and

vice versa. Examples of both can be found in the CART-analysis for females. For example, believing that others thought them "too fat" did not constitute a risk factor within the CART-analysis, although it had the strongest impact on attempting weight loss in regression analysis.

In general, regression models and CART-analyses have different but complementary roles. Regression models identify risk factors and assess their impacts, whereas CART-analyses provide risk groups. In the present study, results of logistic regression analyses for boys and girls were relatively simple with only five predictors in each model. Nevertheless, these models would initially define 48 different groups of male and 32 groups of female students and, to the authors' knowledge, there is no simple solution for combining these groups into meaningful risk groups. CART-analyses directly provide such risk groups, and furthermore, can easily identify "outlier groups". For example, overall only 23.4% of the male students had attempted weight loss, however, the CART-analysis identified three relatively small groups in which more than 70% of the boys had attempted weight loss. Multiple logistic regression also enables the identification of extreme groups by using multiplication of effects. For example, the boys who: saw themselves as overweight; felt that four to 12 body parts were too fat; considered weight an important issue; reported eating more when depressed; and had exercised for at least six days in the previous week, would have a prevalence odds-ratio of 405.4 for trying to lose weight, compared with boys in the baseline categories for those predictors. In the present data set, this extreme group consisted of three boys. However, in many multiple logistic regression models, these groups are a mere theoretical concept and, consequently, estimates based on them must be considered weak. In contrast, groups identified by CART-analysis are always obvious in the CART diagrams of the data set.

Weight Loss Behaviours are Linked to Student Beliefs

Beliefs about their own weight and shape and the importance that they placed on weight were identified in our multiple logistic regression analyses as the major predictors of attempting weight loss for both male and female students. For both boys and girls these were essentially personal beliefs, however, girls were also more likely to attempt weight loss if they believed that others considered them too fat.

In boys, extreme groups from CART-analysis were associated with negative emotions surrounding eating behaviour and the belief that "overweight people are not healthy", while a substantial number of girls who did not consider themselves overweight, but associated eating with feelings of guilt were also likely to attempt weight loss. An association between eating and depression or negative emotions is recognised in the clinical literature in obese individuals [26], especially binge eaters [27,28], and those with eating disorders [29]. The results of this study suggest that such an association also occurs in the wider adolescent population. While adolescents have greater mood fluctuations than adults and may describe emotions as "depression", "boredom", "anxiety", or "guilt" when those a little older would merely report mild mental discomfort, adolescents do nevertheless report eating more in association with these feelings.

As stress and anxiety levels rise [30] in affluent societies with ready access to food, it may become increasingly difficult to moderate the food intake in a population, which turns to food for comfort and nurturing. Awareness of the variety of issues which are important to young people attempting weight loss may be helpful when designing population based interventions to moderate

weight loss behaviour among adolescents. In the present study the beliefs that these students held about their own weight and shape were identified as the major predictors of weight loss behaviour. Therefore, interventions, which either promote weight loss or attempt to prevent unnecessary weight loss among adolescents, should address their beliefs and concerns about body weight and shape. On the other hand, adolescence may be a time when dealing with negative emotions is a more appropriate method of weight control than emphasising food restriction. However, negative emotions and believing there is a link between ill health and being overweight were only important in some subgroups. Thus, more tailor-made approaches seem warranted when tackling weight related behaviour in adolescents.

Food and Weight Beliefs and Behaviours of Adolescents

A study in the same population found strong associations between concerns about constituents of food and the consumption of those foods [31]. Males who expressed concern about the fat in food ate fried and takeaway foods less often than those who did not have this concern ($p<0.0022$). This relationship did not hold for the females who generally ate these foods less often than the males. In addition, students who were concerned about the fat in food ate high fat savoury foods less often than other students ($p=0.0001$). Furthermore those reporting concern about the sugar in foods ate high sugar foods less often than other students, while those concerned about the salt in food added salt to their food less often than students who did not hold this belief ($p=0.0001$). However, no relationship was found between concerns about the vitamin content of food and the frequency of intake of vitamin supplements, possibly because it is likely to be parents who purchase vitamin supplements and encourage their use.

Relationships between beliefs about food and the consumption of those foods were also highly significant. Students who reported that "eating fried food is bad for your health" were less likely to eat fried foods ($p=0.0014$), while those who believed that "most takeaway foods contain a lot of fat" ate fried and takeaway less often than students who did not hold that belief. Moreover, those who reported that "you should not eat the fat on meat" reported eating the fat on meat less often than other students ($p=0.0001$). However, there was no significant difference in the frequency of consumption of red meat between students who did or did not believe that "red meat is bad for you ($p=0.0779$).

The adolescents who reported trying "to eat foods I know are good for me" ate fruit more often ($p=0.0001$) and were more likely to eat fruit daily ($p=0.0005$) than other students. In addition, those who reported that "everyone needs to add salt to their food" added salt to their meals more often than those that did not hold this belief ($p=0.0001$). Furthermore, those who believed that "most people need to take vitamin and mineral supplements" were more likely to do so ($p=0.0001$).

Similarly, there was a strong relationship between beliefs about weight or weight reduction and the related behaviour. More students who agreed with the statement "I think I am overweight" also reported having tried to lose weight ($p=0.0005$). Among students who had tried to lose weight, those who believed that "exercise is important for weight loss" were more likely to have exercised for

weight loss than those who did not hold this belief (p=0.002). Furthermore, among those who had attempted weight loss during the previous year, girls (but not boys) who believed that "skipping meals is a good way to lose weight" were more likely to also report having skipped meals as a weight loss measure (girls p=0.0005; boys p=0.1090).

However, among the adolescents who reported trying to lose weight at the time of the survey, the only significant association (of 16 options) between knowledge of foods to reduce when attempting weight loss and consumption of those foods, was that those who knew that high fat takeaway foods should be reduced ate those foods less often than students without that knowledge (p=0.0120).

It was concluded that beliefs about food and weight may be more important than knowledge in determining food related behaviour.

Development of a Food and Weight Behaviour Model

The Importance of Beliefs

Beliefs about weight and shape and the importance that these adolescents placed on their weight in relation to other issues of health and well-being were the strongest predictors of whether they would try to lose weight. Furthermore, there were significant relationships between their beliefs about the effectiveness of specific weight loss behaviours and their use of that behaviour. For example, those who believed that "skipping meals is a good way to lose weight" were more likely to miss meals when attempting weight loss than those who did not hold this belief. Therefore, any attempt to reduce the level of unnecessary weight loss attempts among adolescents should address issues of beliefs. Although beliefs were the major predictors of weight loss attempts, other issues were important in some subgroups, suggesting that it may be valuable to add specifically targeted interventions when designing weight loss programs.

There were also strong relationships between concerns about specific food components and the consumption of the relevant foods (such as sugar, fat and salt). Similarly, there were significant relationships between beliefs about foods and the consumption of those foods. However, there were few relationships between the knowledge of foods to eat for weight loss and the consumption of those foods by adolescents attempting weight loss. Hence, changing beliefs about foods to eat when attempting weight loss may have more impact on changing food related behaviour, than providing knowledge alone.

The consistent relationship between beliefs and behaviours for food intake and weight manipulation suggests that beliefs have a major role in explaining and changing such behaviour, at least in this adolescent population. While beliefs were the major predictors of weight loss behaviour, emotional eating and negative attitudes to overweight people were also important in some subgroups. The multifaceted nature of such behaviour must be acknowledged when designing population based programs.

The importance of beliefs in determining health behaviour has been previously incorporated into models of health behaviour such as the Health Belief Model [32,33], the Theory of Reasoned Action [34] and the Social Learning Theory [35]. These models recognise the importance of a number of personal, environmental and psychosocial factors in determining health behaviour. These factors are

also considered to play an important role in determining food choices [36,37] and their relative importance is known to vary with age, population and between population subgroups [38,39].

Models of Health Behaviour

Eating and exercise behaviours are multifactorial and require a multidisciplinary approach which is grounded in a conceptual framework based on behavioural theory. Several behavioural models have been used to explain such behaviour and to guide interventions to promote behaviour change. Models of health behaviour have been used to explain behaviours as diverse as addictive behaviour and attendance at health clinics [40]. They have also been used to explore eating behaviour [41-47].

The cognitive behavioural models most commonly used to explain eating and weight loss are the Health Belief Model [32] and the Theory of Reasoned Action [34]. The original Health Belief Model suggests that the important issues which explain health behaviour are perceived susceptibility to disease and perceived severity of the disease [32]. This model was later modified to include perceived control and self-efficacy [33]. The key issue in the Theory of Reasoned Action is behavioural intention, which is then modified by the person's attitude to the action and their beliefs about how others will respond to that action [34]. The Theory of Reasoned Action was then further modified into the Theory of Planned Behavior which incorporated "perceived behavioral control" [48]. Social Learning Theory has also been used as a framework for understanding the influences of knowledge, beliefs, and psychosocial and environmental factors on food selection [35,49] and more recently Turrell and colleagues developed a conceptual framework to identify determinants of socioeconomic health inequalities [50].

The model most frequently used to describe dietary change is the Transtheoretical Model of Change (TMC) or Stages of Change Model [51,52]. This model can identify the readiness for change of an individual or group, and correctly locate different population sub-groups within the stage of change cycle, enabling a more targeted intervention. This model was initially developed in the clinical context for use with addictive behaviours [53], but it has also been used as a model of behaviour change for many health related behaviours in both the clinical and community setting, including weight control [54], eating [53-57], and exercise behaviour [54, 58, 59].

There are, however, important differences between addictive behaviour and eating behaviour [53, 60-62]. Dealing with addictive behaviour usually requires cessation of a single behaviour, which although addictive, is not necessary to sustain life (e.g. smoking). However, changing eating behaviour involves changing many behaviours whether targeting foods (e.g. increasing fruit; decreasing takeaway foods) or nutrients (e.g. increasing dietary calcium; decreasing fat intake). Moreover, unlike addictive behaviours, it is not possible to stop eating. Even the intake of fruit and vegetables which is usually assessed as a unit is more complex, as Trudeau and colleagues [63] found that intrinsic motivators (such as feeling well, controlling weight, staying healthy or preventing serious illness) were more strongly associated with fruit intake than vegetable intake.

Eating behaviour is far more complex than addictive behaviour, resulting in some limitations to the use of the TMC. For example, in its original form there were time frames for each stage, which may not be relevant to eating behaviour. Furthermore, it may be more difficult for an individual to know whether they are eating a high fibre diet or a low fat diet [53], although a single eating habit

such as eating two pieces of fruit per day, is as easy to identify as not smoking cigarettes. Nevertheless the model has been used widely for eating and exercise behaviour.

The Proposed Model of Food and Weight Behaviour

A new model is proposed which can be used to both understand and change food and weight related behaviour. This model builds on the TMC and is based on: the data presented here; 15 years of clinical dietetic experience; extensive observation of food habits and lifestyle in other cultures [64]; anthropological data, which suggests that people confuse their own experience with reliable nutrition knowledge [65]; and the recognised role of cognitive dissonance (i.e. the discomfort associated with a lack of concordance between beliefs and behaviours) in aligning behaviours with beliefs [66].

There are national examples of the linkages between culture, beliefs, environment, body shape, weight, and eating habits that can serve as prototypes for interventions. These national examples indicate some potential directions for change.

The eating and activity culture of the United States of America and Australia result in high (and rising) levels of overweight and obesity [67-70], and thus provide an undesirable cultural model. The eating and activity culture of many non Anglo-Saxon countries result in lower levels of overweight and obesity, although these are also increasing [71-74]. French food culture is one of the strongest in Europe and yet the incidence of overweight and obesity of adults in France is among the lowest in Europe [74]. The levels of 32% for French women and 47% for men in France [75] compares favourably with Australian data of 52% for women and 68% for men [76] and the reported levels of overweight and obesity in the United States of America (66%) [70]. The differences in the level of obesity in these countries is even more marked: France <10% [75], Australia 19% for man and 22% for women [76] and 31% in the United States of America [70].

French culture is strongly based on food [77] and the consumption of a variety of healthful foods [78]. For example the average meal includes 3 to 5 small courses and usually contains bread, a meat (or alternative protein) dish, a vegetable or salad, a dairy product and dessert (which is often fruit). There are traditional rules relating to what a meal should contain and when it should be eaten [79]. For example, it is difficult to buy ready to eat food between meals in many regions of France, because people simply do not eat between meals. Physical activity is built into daily life more by accident than design, because of the infrastructure of European cities. However, walking for relaxation at weekends is common and the legendary extended French Sunday lunch is usually followed by a long walk, preferably in a park or the countryside.

We suggest that the important role of culture in determining eating and exercise behaviour cannot be ignored when explaining these behaviours. The proposed model builds on current models, by incorporating belief constructs and cultural concepts into the TMC [51,52]. It acknowledges that while environmental, psychosocial, physiological, personal factors and knowledge are all important in determining eating, exercise and weight loss behaviour, the relative importance of these may vary among individuals, groups, subgroups and cultures. Different issues are likely to dominate in different cultures, just as different standards of beauty are evident in different cultures [80]. A robust model, which can accommodate variety is essential in a multicultural society, such as Australia.

Furthermore, we suggest that beliefs may be the driving force in determining eating and exercise behaviour in most Anglo-Saxon cultures. The environment, however, may be a more important influence in other cultures such as those with strong religious cultures (e.g. Buddhists, Orthodox Jews or Seventh Day Adventists) or cultures based around the table with an emphasis on fine food (e.g French, Italian or Chinese). In addition, eating behaviour is so complex that single behaviours may need to be identified before using any model to explain or change behaviour. For example, fruit and vegetables are often considered together, yet regular vegetable consumption was more common than regular fruit consumption among these adolescents.

In the suggested model (Figure 3), the classic TMC is used as a framework and to initially identify the stage of change of the individual or group, as different intervention techniques are appropriate for people at different stages of change. The model considers that when beliefs are the dominant determinants of behaviour, the personal, environmental and psychosocial factors, together with knowledge will determine the beliefs, and changing these beliefs can change behaviour. However, in strong cultures, it may be the culture, itself, which determines behaviour. The dominant features of culture in this context are the environment and psychosocial factors. Among other subgroups, knowledge, environment or personal characteristics may guide eating, exercise and weight-related behaviours.

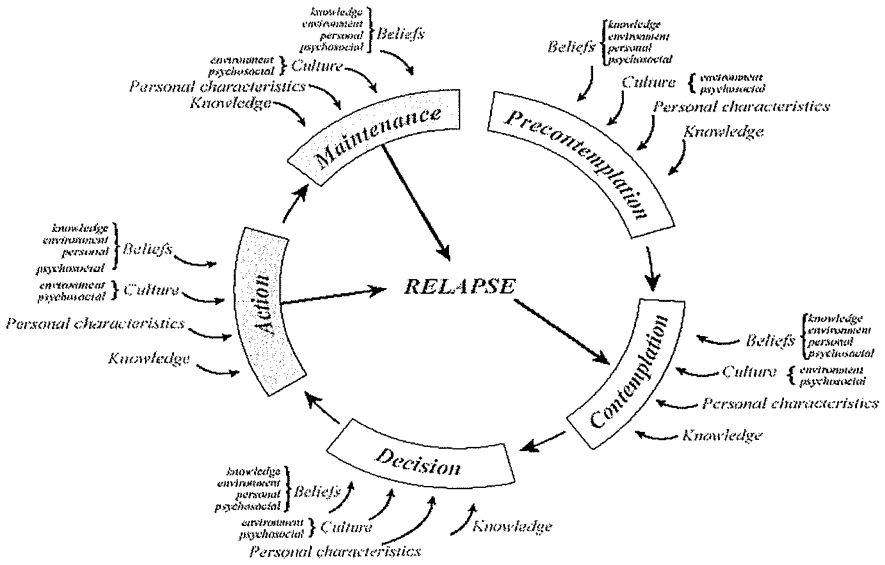

Figure 3: Model proposed for understanding and changing food and weight related behaviour. In this model the concept of relapse is based on action rather than cognition.Γ cognitive phase of the model;Ī active phase of the model

The stages of the proposed model are those of the classic TMC: precontemplation; contemplation; decision; action and maintenance, which can be divided into two components: the cognitive component (precontemplation, contemplation and decision stages); and the active component (action and maintenance stages). In the proposed model we consider that relapse is based

on action, so that at each stage of the model an individual can remain in that stage or move on to the next. In addition, in the active phase, action or maintenance, there is the potential for relapse. The route out of relapse is through the contemplation stage.

It is suggested that beliefs are the major determinants of behaviour (especially in multicultural societies such as ours, which do not have strictly defined eating or exercise patterns). Beliefs are modified by food knowledge (whether accurate or not), personal characteristics, environmental factors and psychosocial factors. Personal characteristics which have the potential to modify beliefs include: appeal of food (appearance, smell, taste, texture, familiarity, food temperature, quality, variety); demographics (age, sex, locality, education, socioeconomic level); health priorities, health status; performance (academic, fitness, sport); and physiological issues (mood, hunger, food cravings, weight).

Psychosocial factors which may modify beliefs include: advertising; body image beliefs and weight concerns; convenience; cost; fashion; family members; habit; media; mood; peers; social norms; social support; and time. Environmental issues which can affect beliefs include: accessibility; advertising; availability; culture and religion; infrastructure; media; policy (economic, health, housing, taxation, transport, welfare); role models; social norms; and weather/season. These potential influences on beliefs can also be considered as either internal or external factors.

According to this model, beliefs, culture, personal characteristics, and environment can have an impact at each stage in the change cycle. It is also possible that the issues which have an effect, may change between stages. For example: a taste preference for fatty food may decrease when dietary fat intake has been reduced for some months; beliefs about self efficacy in relation to cooking low fat meals may change with experience; and the enjoyment gained from exercise may increase with fitness.

If the hypothesis that in Anglo-Saxon societies personal beliefs are important in determining eating and exercise behaviour is correct, then a change in these behaviours is dependent, at least in part, on changing beliefs. Thus, methodology (or the manner in which information is presented) becomes extremely important. Changing beliefs is the "core business" of psychologists (and is also regularly used by advertising companies). In communities (or individuals) where beliefs determine behaviour, involvement of health psychologists in interventions to change eating, exercise and weight-related behaviour may be vital [81].

Careful attention should be paid to how dietary knowledge is presented. If it is presented in a way that is relevant to the target audience, matches their readiness to change, and has the potential to change their beliefs, it may result in change. Otherwise, no matter how good or well prepared the information might be, it will fall on deaf ears. Health professionals trying to improve the eating and exercise habits of the community will be much more effective if they employ strategies to modify the beliefs of their target audience.

Conclusion

While changing behaviour is difficult, it is more likely to be successful if interventions are designed around the perceived needs of the target group, and acknowledge the importance of beliefs, knowledge, environment and psychosocial factors which can affect behaviour and readiness to

change. The model presented here may help to achieve these aims by providing a theoretical framework for interventions to alter the eating and exercise patterns of adolescents.

Appendix 1 – Methods From Section on Predictors of Weight Loss Attempts Participants

In 1993 a questionnaire survey was conducted amongst high school students attending Grades 8, 10, 11, and 12 at four of the six non government schools in Townsville, which is an Australian tropical coastal community (latitude 19.16□S; population approximately 145,000). A total of 902 students participated with no refusals from students who were in class on the day of the study. Students in Grade 9 were not included in the sample because some of them had participated in a similar survey the previous year. Both co-educational and single sex schools, and Catholic and non-Catholic schools were included in the sample. Further details about the sample have been published previously [16]. Ethics approval was obtained from James Cook University Ethics Committee and clearance was received from Education Queensland.

Questionnaire

The standardised questionnaires (Appendix 2) were administered by teachers during a single school period and were answered anonymously. There were eight demographic questions, 15 questions relating to weight behaviour, 15 on perception of weight and body shape, and 18 on weight-related beliefs and attitudes. Demographic data included school, grade, sex, and date of birth. Information on education level of parents or socio-economic status was sought by asking the students about their parents' occupations, however, the answers received were considered too vague to be useful. Answers to questions about weight-related beliefs, attitudes, concerns and some of the body image questions were presented as a five point Likert scale with categories ranging from strongly disagree to strongly agree. Self-reports of weight and height were obtained. Height was missing for 25.4% of the students and weight was missing for 23.4%. Consequently, body mass index (BMI) could not be calculated for 35.6% of all participants. BMI was categorized into quartiles (< 18.0 kg/m^2, 18.0 - 19.9 kg/m^2, 20.0 - 21.9 kg/m^2, ≥ 22 kg/m^2,) and a further category containing the missing values.

Statistical Analysis

The outcome variable "tried to lose weight during the previous year" was constructed as a dichotomous variable in categories "no" or "yes". The following potentially relevant predictors of weight loss behaviour were considered: school grade; type of school (co-educational/single sex); "are you a boarder? (no/yes); "does your mother work?" (no/yes); "does your father work?" (no/yes); BMI (categories as above); the number of their body parts the students considered too fat

(range: 0-12); "how do you see yourself?"(underweight/about right or don't care/overweight); "would you like to gain weight, stay the same or lose weight?" (gain weight/stay the same/lose weight); the ranking students placed on their weight among a number of issues of health and well-being (rank 1 = most important to 10 = least important); "last week how many days did you exercise or play sport continuously for 30 minutes or more?" (range: 0-7 days); and the following beliefs and behaviours: "I am happy with the way my body looks"; "other people think I am too fat"; "slim people have more friends"; "slim people are the most attractive"; "being thin is more important for a woman than a man"; "overweight women are not attractive to men"; "to be fashionable and look nice a woman must be thin"; "people who are overweight have only themselves to blame"; "most people who are fat are lazy"; "overweight people are not healthy"; "I eat more when I feel depressed"; "sometimes I eat because I am bored"; "I often eat too much and feel guilty", which were all categorised as agree and disagree or not sure.

Numerical variables were presented as mean values with standard deviations (SD) when the data were approximately normally distributed or median values with inter-quartile ranges (IQR) when they were not. Chi-square tests, t-tests, and non-parametric Wilcoxon tests were used to assess bivariate relationships between potential predictors and the outcome variable.

In preparation for CART- and logistic regression analyses, dichotomous dummy variables were created for all of the potentially influencing variables. For each potential predictor the category with the smallest probability of having "tried to lose weight during the previous year" was chosen as the baseline category of the dummy variables. Missing value categories were constructed for the following variables: BMI (n = 321; 35.6%); the number of body parts considered too fat (n = 74; 8.2%); and the ranking of the importance of weight (n = 106; 11.8%). These missing categories were included in the analyses.

CART-Analysis:

For CART-analysis, associations between potential predictors and the outcome variable were assessed using bivariate chi-square test statistics. The dummy variable providing the largest statistically significant chi-square statistic was used to define the first two subgroups. This procedure was repeated within each subgroup to subdivide the data set into a tree-shaped structure. By convention a CART-analysis is considered completed when the subgroup is too small (less than the square root of the sample size) or none of the influencing variables provide a statistically significant association with the outcome variable [20]. The subgroups defined by CART-analysis were described as the proportion of students who tried to lose weight and 95%-confidence intervals (95%-CI).

Logistic Regression:

Stepwise multiple logistic regression analysis (forward and backward) was used to identify independent significant predictors of weight loss attempts. Results of logistic regression analyses are presented as prevalence odds-ratios (POR) together with 95%-CI. These logistic regression models were multiplicative. Potential confounders were identified and the logistic regression models were

adjusted for their effects. All possible two- and three-way interactions were investigated. Separate CART- and logistic regression analyses were performed for boys and girls, because previous analysis of the data had identified gender as the most powerful confounder [16]. Statistical analyses were performed using SPSS for Windows (release 6.1.3). Throughout the analysis p-values less than 0.05 were regarded as statistically significant.

Appendix 2 – Questionnaire

Anton Breinl Centre
Schools Nutrition Project

This is a question about the foods you eat and your opinion about food.

There are no right or wrong answers.

The questionnaire is anonymous so choose a nickname for yourself and write it down for question 1.

Q1. Write the nickname you have chosen for yourself here

Q2. How old are you in years? . . . . . years

Q3. What is your date of birth? . . . . . .day . . . . . month . . . . . year

Q4. Which suburb do you live in?

Please Tick a Box to Answer the Following Questions

Q5. What sex are you? ☐ MALE ☐ FEMALE

Q6(a) Are you a boarder? ☐ NO ☐ YES

(b) Which grade are you in?

(c) In which grades did you do Home Economics?

Grade 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ none ☐

(d) In which grades did you do Health and PE?

Grade 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ none ☐