"Games Galore"

A feasibility study to investigate the effect of a physical activity and nutrition education programme for 10-14 year old New Zealand overweight and obese children

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Players of the Auckland Blockbuster Basketball team and some of the participants' of the "Games Galore" feasibility study in action.

Abstract

It is widely acknowledged that obesity has emerged as an epidemic in developed countries during the last quarter of the 20th century [1]. It is an issue of great concern, affecting adults and children of both wealthy and middle-income people in both middle-income countries as well as residents of countries previously considered to be poor [2]. The World Health Organisation has stated that the prevalence of obesity and overweight is increasing in both adult and childhood populations throughout the world, and has acknowledged management of obesity as a priority area of public health action [1].

This feasibility study "Games Galore" investigated the effect of a physical activity and nutrition education intervention for the development of ongoing self-motivated participation in physical activity and of healthy eating habits of both male and female 10-14 year old New Zealand overweight or obese children.

Twenty-two students of an intermediate and a full primary school enrolled in the "Games Galore" feasibility study. The participants were all residents of West Auckland, New Zealand and participated twice weekly in a games programme and once every fortnight in a nutrition education programme. Anthropometric data was collected at baseline, 4 months, 6 months (end of the intervention), 10 months (4 months post intervention), and 16 months (10 months post intervention). A qualitative dietary habit questionnaire, a diet and activity questionnaire, a food frequency questionnaire, a 3 day diet and physical activity diary, and a three 24-hour recalls were administered to assess nutrient intake and physical activity.

There was no significant change seen in any of the assessed anthropometric indicators from baseline to 16 months post intervention. Some positive change was seen for outdoor play during weekdays ($p=0.02$). However, there was no significant change in any of the other measurements for physical activity, indicating no increase in self-motivated participation in physical activity. There was also no change in dietary intake during and post intervention, indicating no change in eating habits.

During this 16 months "Games Galore" feasibility study (6 month intervention, 10 month follow-up) there was no significant change in the participants' participation of physical activity and the participants' eating habits. This is most likely due to the implementation of too few predictors of childhood overweight and lack of parental support. The latter limits the results due to lack of stimulation and motivation for the participants to participate at the nutrition education sessions and incorporate a "healthy" lifestyle

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List of Abbreviations Used

Abbreviation	Full word(s)	Abbreviation	Full word(s)
BIOSIS	biological abstracts	BMI	body mass index
BMR	basal metabolic rate	CI	confidence interval
CINAHL	cumulative index to nursing and allied health literature	CHD	coronary heart disease
CHO	carbohydrate	cm	centimeter
CT	computed tomography	CVD	cardiovascular disease
DEXA	dual energy x-ray absorptiometry	DLW	double-labelled water
DRV	dietary reference values	E exp	energy expenditure
E int	energy intake	EMBASE	biomedical and pharmacological abstracts
FFQ	food frequency questionnaire	g	grams
HR	heart rate	IOTF	international obesity taskforce
Kcal	kilo calories	kg	kilograms
kg/m^2	kilograms per square meter	kJ	kilojoules
m	meter	MANOVA	multiple analysis of variance
MEDLINE	medical literature, analysis, and retrieval system online	MJ	megajoules
MRI	magnetic resonance imaging	n	number
NIDDM	non insulin dependent diabetes mellitus	NHANES	national health and nutrition examination survey
NZ	New Zealand	p	power
RDA	recommended dietary allowance	RDI	recommended dietary intake
RMR	resting metabolic rate	SD	standard deviation
TEF	thermic effect of food	TV	television
USA	United States of America	VO2max	maximum value of oxygen
WHO	World Health Organisation	WHR	waist to hip ratio
%	percent	$	dollar

1 Introduction

Throughout most of human history, weight gain and fat storage have been viewed as signs of health and prosperity. In times of hard labour and frequent food shortages, securing an adequate energy intake to meet requirements has been the major nutritional concern. Today, however, as standards of living continue to rise, weight gain and obesity are posing a growing threat to health in countries all over the world [2]. It is widely acknowledged that obesity has emerged as an epidemic in developed countries during the last quarter of the 20th century [1]. It is an issue of great concern, and affecting adults and children of both wealthy and middle-income people in both middle-income countries as well as residents of countries previously considered to be poor [2]. The World Health Organisation (WHO) has stated that the prevalence of obesity and overweight is increasing in both adult and childhood populations throughout the world, and has acknowledged management of obesity as a priority area of public health action [1].

1.1 Prevalence of paediatric obesity

Measurement definition inconsistencies make it difficult to give an overview of the global prevalence of overweight and obesity in children. Developing consistent approaches to the measurement of childhood obesity is a priority issue in this field and recent international standardised cut-points have been proposed [3].

In New Zealand adult obesity increased from 11% in 1989 [4] to 17% in 1997 [5]. Maori (28%) and Pacific people (37%) are more likely to be classified as obese than New Zealand Europeans and others (15%). Also, the 1997 National Nutrition Survey [5] highlighted that 35% of the population are classified as overweight. A study from Tyrrell *et al.* [6] over 2273 Auckland children aged 5 to 10 years found that one in seven of the participants were classed as obese. This study indicates that obesity rates varied with ethnicity and were higher in Pacific people (24%) and Maori (16%) than in New Zealand European children (9%). At present, the Child Nutrition Survey is investigating the prevalence of overweight and obesity in New Zealand children nation-wide.

1.2 Causes and consequences

Childhood obesity is a complex and seriously debilitating disorder that has an impact on both physical and psychosocial health [7]. It is generally accepted that obesity develops from an imbalance between energy ingested and expended. Some studies suggest that the Body Mass Index (BMI) and other measures of fatness are under strong genetic control [8-10]. However, the rapid increase in obesity rates in recent years has occurred in too short a time for there to have been any significant genetic changes within the population. This suggests that the primary cause of this increase must be sought in the environmental and societal changes now affecting a large proportion of the world's population.

1.3 Interventions to treat childhood obesity

Innovative strategies have been evaluated to address each of these concerns. However, to date, no intervention by itself, has produced large long-term reductions in the prevalence of overweight and obesity in children. Like adolescent smoking, teen pregnancy, and youth violence, childhood overweight is prevalent because it arises from deeply rooted behaviours and social practices that are not merely confined to children. However, given the profound consequences of childhood inactivity, poor nutrition, and overweight throughout the life span, urgency is warranted in developing an effective treatment for overweight and obesity.

1.4 "Games Galore"

Successful weight management programmes require life-long commitment to healthy lifestyle behaviours emphasising eating practices and daily physical activity that are sustainable and enjoyable [11]. However, interventions that combine healthy eating practices and physical activity to treat overweight and obesity in New Zealand children are limited and to date none have been reported.

The feasibility study "Games Galore" is a community-based intervention that aims to develop and implement a physical activity and nutrition programme for 10-14 year old overweight and obese children. To determine whether this feasibility study is effective

and/or feasible for the treatment of overweight or obese children of this age, this thesis aims to review the "Games Galore" feasibility study, and looks at:

- The effect of the physical activity intervention on the development of an ongoing self motivated participation in physical activity.
- The effect of the nutrition education intervention on the development of healthy eating habits.
- The effect of the feasibility study on anthropometric indicators.

2 Literature Review

2.1 Purpose of the review

To assess the currently available literature on the effect of nutrition education and physical activity interventions to treat childhood overweight and obesity on:

- the development of an ongoing self motivated participation in physical activity
- the development of healthy eating habits

2.2 Search strategy

The following electronic medical databases were searched: Cochrane Central Register of Controlled Trials (Cochrane Library Issue 4, 2002), MEDLINE (1966 to October 2002), EMBASE (1980 to October 2002), Biological Abstracts (BIOSIS) (1980 to September 2002) and CINAHL (1982 to October 2002).

2.3 Definitions

The amount of fat in the body may be expressed either as total fat mass (in kg) or as a fraction (percentage of total body weight). Body weight is reasonably well correlated with body fat but is also highly correlated with height, which is weakly correlated with body fat. Therefore weight adjusted for height is a useful index with which to assess whether overweight and is a reasonable indicator of fatness. Weight adjusted for height squared (BMI; in kg/m^2) is used to measure overweight and obesity [12].

In agreement with the classification recommended by The WHO the "normal range" is classified as a BMI between 18.50 and 24.99, while overweight is classified as a BMI greater than 25.00. This classification includes additional subdivisions for pre-obese (BMI between 25.00 and 29.99), obese class I (BMI between 30.00 and 34.99), obese class II (BMI between 35.00 and 39.99), and obese class III (BMI greater than 40.00) [1].

2.4 Causes of paediatric overweight and obesity

Research has identified that body weight is a complex phenotype that is regulated by a series of physiological processes that have the capacity to maintain weight with a

relatively narrow range (stable weight) [13]. However, powerful societal and environmental forces influence energy intake and expenditure, and may overwhelm the above-mentioned physiological processes. The susceptibility of individuals to these forces is affected by genetic and other biological factors over which they have little or no control [14]. Dietary factors and physical activity patterns are considered to be the modifiable intermediate factors through which the forces that promote weight gain act [2].

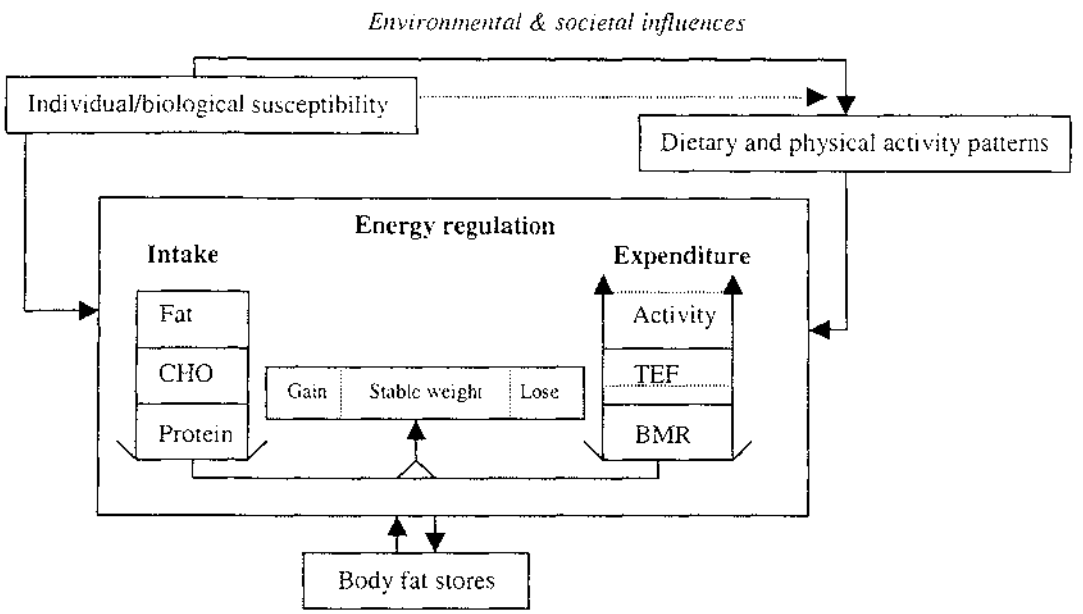
2.4.1 Energy balance and the physiological regulation of body weight

Stated simply, obesity is the result of a positive energy balance or an increased energy intake relative to expenditure (Energy Stored = Energy Intake – Energy Expenditure). Energy intake refers to all energy consumed as food and drink that can be metabolised inside the body. For example: fat, alcohol, protein and carbohydrate.

Energy expenditure has the following three main components (1) the basal metabolic rate (BMR) (2) the Thermic Effect of Food (TEF) and (3) physical activity. The proportion that each component contributes to the total energy expenditure varies according to the regularity and intensity of physical activity. In addition to the three major components of energy expenditure children require additional energy for growth [15].

It is often stated, or assumed, that obesity is simply the result of overeating, lack of physical activity, or a reduced metabolic rate. The cause of obesity, however, is not as simple as this, many complex and interrelated factors are likely to contribute to the development of obesity; it is extremely unlikely that any one factor causes obesity. Cultural, behavioural, and biologic factors drive energy intake and energy expenditure and contribute to the homeostatic regulation of body-energy stores. In addition, many of these factors are influenced by individual susceptibility, which may be driven by genetic, cultural, and hormonal factors. Figure 1 shows that many complex and diverse factors can give rise to a positive energy balance [1]

Figure 1 Influences on energy balance and weight gain (Source ref. 1)



A positive energy balance occurs when energy intake is greater than energy expenditure; it promotes an increase in energy stores and body weight. Conversely, a negative energy balance occurs when intake is less than expenditure, promoting a decrease in energy stores and body weight. Thus high levels of body fat (i.e. energy) are accumulated as the result of energy intake being unusually high or energy expenditure being unusually low, or a combination of these two options [1].

Body weight is remarkably constant in many people over long periods of time. The body has some capacity to adjust energy intake and/or expenditure to maintain its current state of energy balance. Multiple physiological mechanisms act within each individual to equate overall energy intake with overall energy expenditure and keep body weight stable in the long term [16]. It is only when there has been a positive energy balance for a considerable period that obesity is likely to develop.

Despite the extensive physiological regulation of body weight outlined above, a positive energy balance can lead to weight gain if it persists in the long term. The initiation of a chronic positive energy balance is due to an increase in energy intake relative to requirements, either as a result of an increase in total energy intake, a decrease in total

energy expenditure, or a combination of the two. Currently there is little information about the fluctuations in energy balance that lead to weight gain and obesity. Large deviations from energy balance at regular intervals may contribute to weight gain, but also a small consistent deviation over a long period is capable of producing large increases in body weight.

The process of gaining weight can be divided into the following three phases:[1]

1. The pre-obese static phase, when the individual is in a long-term energy balance and weight remains constant.
2. The dynamic phase, during which the individual gains weight as a result of energy intake exceeding energy expenditure over a prolonged period.
3. The obese static phase, when energy balance is regained but weight is now higher than during the pre-obese static phase.

The difference between energy intake and energy expenditure progressively diminishes in the dynamic phase. This is due to an increase in BMR as a result of the larger fat-free mass (including that in the expanded adipose tissue) as well as an additional energy cost of activity imposed by the extra weight [17]. There may also be an increase in resting metabolic rate (RMR) with overfeeding [18].

Once the obese static phase is established, the new weight appears to be defended. This can best be shown by the response of obese individuals to underfeeding; they show a fall in metabolic rate as the body recognises the loss of energy [19] and unconscious physiologically driven increase in energy intake [20].

The exact physiological mechanisms responsible for body weight regulation are currently not completely understood. There is increasing evidence of a range of signalling mechanisms within the intestine, the adipose tissue and the brain, and perhaps within other tissues, that sense the inflow of dietary nutrients, their distribution and metabolism and/or storage [21]. Those mechanisms are co-ordinated within the brain and lead to changes in eating, in physical activity and in body metabolism so that body energy stores

are maintained. The recent discovery of the hormone leptin, which is secreted by adipocytes in proportion to their triglyceride stores and binds with receptors in the hypothalamus, provides interesting insights into possible regulatory signal systems that act to maintain the energy balance [22].

2.4.2 Environmental and behavioural factors influencing obesity

Although there have been advances in the human genetics of obesity, researchers can not blame genetics for the dramatic 20% increase in obesity that has occurred over the past decade [23]. Clearly, the increasing prevalence of obesity is not under genetic control but rather, related to two major lifestyle factors mentioned before: the energy content of the diet and an increasingly sedentary lifestyle. Environmental and behavioural factors, through their effects on food intake and physical activity patterns, are thought to be the primary cause of the increase in obesity.

2.4.2.1 Environmental factors

One way in which the current environment promotes obesity is by providing more frequent opportunities for the consumption of large quantities of food [24-26]. A variety of highly palatable, inexpensive foods is available nearly everywhere. This problem is compounded by a growing trend towards larger portions. Larger portions give the consumer an impression of "better value" for money, and marketing strategies such as "super sizing" and "eat all you can for X dollars" represent an encouragement to eat beyond natural biological limits. Furthermore, these foods and outlets are backed by substantial advertising campaigns that, in stark contrast to public health or nutrition campaigns, are extremely persuasive and successful [27].

Other ways in which the environment promotes obesity is by providing more labour-saving devices both at home and in the workplace that require little energy expenditure and decrease involuntary exercise. Also, increased use of motorised transport, automated work and sedentary leisure pursuits increases the average body weight and fatness of the population.

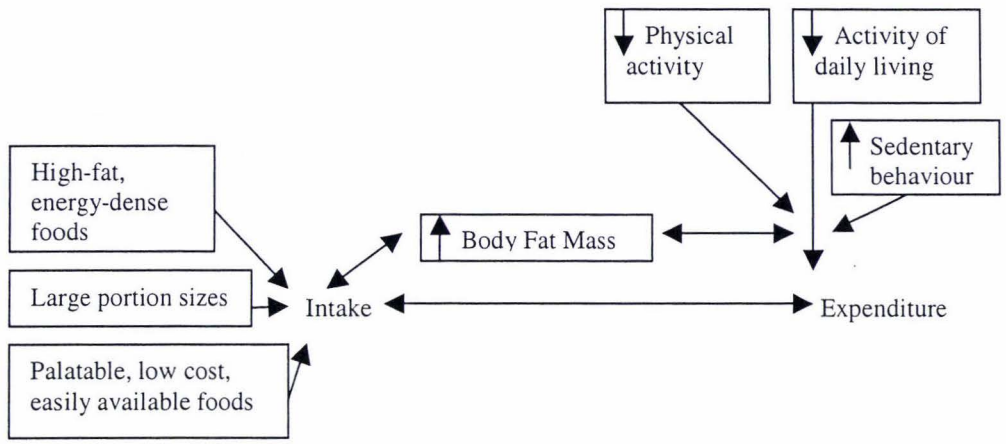
2.4.2.2 Behavioural factors

Behavioural factors can also modulate the effect of dietary fat on the development of obesity. There is evidence that people who select full-fat foods have, on average, a higher energy intake and gain more weight. Whereas people selecting reduced-fat foods do not increase energy intake or change body weight [28]. Nevertheless, there is some disagreement over the association between the intake of dietary fat and the development of obesity [29].

Also, changes in physical behaviour over the past few decades may have influenced the levels of daily exercise. For example, the decrease in physical activity (children are dropped off at school by car and the time allocated for physical activity programs is reduced) and decrease in leisure time physical activity. According to NHANES III, 24% of American adults are completely sedentary and 54% spend inadequate time in physical activity [30]. Currently about one-third of New Zealand adults are insufficiently physically active to benefit health [31]. To date, there is no data about physical activity patterns of New Zealand children. But it is more than likely that this trend is related with the adiposity seen in children.

Also, the daily eating pattern is an important behavioural factor related to overweight and obesity. Regular (high fat) snacking has been associated with increased overall dietary intake in affluent societies. However, this relationship with obesity remains controversial [32]. Other evidence from affluent societies suggest that dietary restraint and slimming leads to skipping breakfast and that this may result in over-consumption later in the day [33]. Some people exhibit additional eating during the night, possibly as part of a night-eating syndrome that is associated with obesity [34]. Other people suffer from other eating disorders including binge eating disorder. Figure 2 [16] shows the environmental and behavioural factors that influence the energy balance.

Figure 2 The effect of environmental and behavioural factors on energy balance



The figure shows that dietary and physical activity patterns are strongly influenced by behaviour and environment. They influence the energy balance equation and can be considered to be the major modifiable factors through which many of the external forces promote weight gain (Figure 1). In particular, high-fat, energy-dense diets and sedentary lifestyles are the two characteristics most strongly associated with the increased prevalence of obesity world-wide.

2.4.2.3 Dietary factors

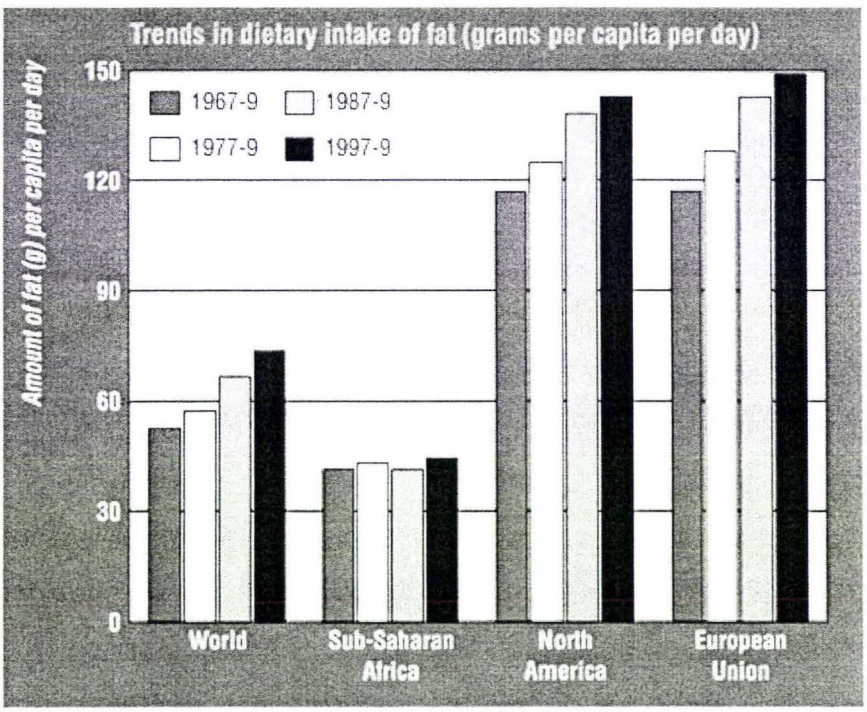
An important dietary factor is the macronutrient density of the food. The energy density of the different macronutrients is shown in Table 1. In population studies that pay careful attention to the determinants of obesity, a positive association is observed between dietary factors and obesity identical with those found in animal models and human clinical studies [35]

Table 1 Energy content of macronutrients

Macronutrient	Energy contribution (kJ/g)
Fat	37
Alcohol	29
Protein	17
Carbohydrate	16

As shown in table 1, dietary fat has a higher energy density than other macronutrients. This higher energy density is thought to be largely responsible for the overeating effect experienced by many people exposed to high-fat foods [36]. Figure 3 shows the trends in dietary intake of fat (grams per capita per day) world-wide [37]. The stimulatory effect of fatty foods on energy intake may be due to the pleasant mouth-feel of fat when consumed [38]. In addition, several studies indicate that the consumption of high-glycemic-index carbohydrates is related to obesity [39-41]. Fibre, by contrast, limits energy intake by lowering a food's density and allowing time for appetite-control signals to occur before large amounts of energy have been consumed [36].

Figure 3 Trends in dietary intake of fat (Source ref. 37)



The second dietary factor to consider is the macronutrient composition of the diet. Macronutrient composition influences the extent to which excess energy is stored, depending on the storage capacity within the body (see Table 2) [42].

Table 2 Storage capacity of macronutrients within the body

Macronutrient	Storage capacity	
Alcohol	No	Oxidised immediately. The response dominates oxidative pathways and reduces the rates at which other fuels are oxidised.
Protein	Limited	Storage is accessible only through loss of lean body mass. Metabolism is tightly regulated to ensure the oxidation of any excess.
Carbohydrate	Small	Small capacity for storage as glycogen. Intake and oxidation of carbohydrate are very tightly "autoregulated", rapid and substantial changes in carbohydrate oxidation taking place in response to alterations in carbohydrate intake.
Fat	Unlimited	Excess does not markedly increase fat oxidation. Fat is readily stored in adipose tissue depots.

The macronutrients with a low storage capacity within the body are preferentially oxidised when intakes exceed requirements. Thus, carbohydrate and protein balances, but not fat balance are well regulated. Weight changes following changes of energy intake are due primarily to disruptions in fat balance, as these account for most of the imbalance produced in total energy [43].

The third dietary factor is the food palatability and pleasure. The palatability of food has an important influence on behaviour [36]. Food palatability tends to promote consumption and is one of the most powerful influences in inducing a positive energy balance. It increases both the rate of eating and the sense of hunger during and between meals. Sweetness is one of the most powerful, easily recognised and pleasurable tastes. Also, the presence of fat in food is particularly enjoyable, and is associated with a pleasurable mouth-feel [44].

2.4.2.4 Physical activity patterns

Figure 2 shows that physical activity is the other characteristic strongly associated with overweight and obesity. Physical activity patterns have an important influence on the physiological regulation of body weight. They effect the total energy expenditure, fat balance and food intakes.

Research [45] shows an inverse relationship between BMI and physical activity. For example, prospective data of Dietz and Gortmaker [46] have shown that the amount of television watching by young children is predictive of BMI some years later. Children

spend a substantial part of their lives in front of the television. Recent parent-report and self-report data from a nationally representative sample of 3155 children indicate that 8 to 18 year old children spend an average of about 4.5 hours per day watching television and video tapes and playing video games [47]. In 2002, New Zealand 5 to 14 year old children watched approximately 2 hours of television per day. Furthermore, children from families with lower socio-economic status, those demographic groups at highest risk for obesity, tend to watch even more television [47].

Increased energy expenditure is an intrinsic feature of physical activity and exercise. Energy requirements increase from basal levels immediately after the initiation of physical activity, and the increase persists for the duration of the activity. The total amount of energy expended depends on the characteristics of the physical activity (mode, intensity, duration and frequency) of the individual performing the exercise (body size, level of habituation and fitness) [48]. Research suggests that overweight children expend 50% more energy moving their bodies than non-obese subjects [49].

If exercise is vigorous, oxygen consumption remains elevated above resting levels for some time after exercise ceases [50]. This metabolic response (the excess post-exercise oxygen consumption) is due to the need to restore energy reserves, especially glycogen levels in liver and muscles.

The second effect of physical activity is its effect on fat and substrate balance. One of the most important adaptations to regular exercise is the increased capacity to use fat rather than carbohydrate during moderate physical activity. These differences become considerable when the exercise is maintained over a longer period; physically trained individuals metabolise more fat at given levels of energy expenditure than the untrained [51]. It is thought that people who sustain moderate or high levels of physical activity throughout life can tolerate diets with a high fat content (e.g. 35-40% of energy) whereas lower fat intakes (20-25% of energy) may be needed to minimise energy imbalance and weight gain in sedentary individuals and societies [1].

Also, the metabolic responses to low- and high-intensity physical activity are different. The extent to which fat and carbohydrate contribute to energy metabolism depends on the intensity level of the activity; fat is preferentially oxidised during low-intensity activity (between 50-60% of VO_{max}) whereas carbohydrate is the dominant fuel at high intensity (above 60% of VO_{max}) [52]. An important point to remember is that the amount of fat oxidised during activity increases with the intensity and the duration of the activity, despite the fact that the proportion of fat in the mixture of fuel oxidised for muscular contraction may decrease at higher intensities. Also, fat is oxidised not only during the activity but also during the recovery period.

The third factor is the impact of physical activity on food intake and preference. At present, the common perception that exercise stimulates appetite can not be supported by research. If a compensatory rise in intake does occur, this tends to be accurately matched to expenditure in lean subjects so that energy balance is re-established in the long term [53]. However, Woo *et al.* [54] showed that obese women did not compensate for the higher energy expenditure induced by exercise by increased intake, and thereby obtained a significant negative energy balance on exercise. This suggests that those who have stored an excess amount of energy may particularly benefit from exercise.

In the short term hunger can be suppressed by intense exercise and possibly by low-intensity exercise of long duration [52]. The effect is short-lived, however, so that the temporal aspects of exercise-induced anorexia may best be measured by the delay in eating rather than the amount of food consumed [55].

More research is needed in order to assess the value of a higher intake of carbohydrate-rich foods in the general population in whom changes in the level of physical activity are relatively small [56].

2.4.3 Genetic and non-genetic factors

Obesity is commonly seen as a complex multi-factorial disease: it is a condition resulting from a lifestyle that promotes a positive energy balance, but also one that becomes manifest more readily in people who have an inherited susceptibility to be in positive energy balance.

2.4.3.1 Genetic factors

The role of genetic factors in weight gain is currently the subject of much research. It is thought that genes may protect some individuals from becoming obese and contribute to differences in the extent to which obesity occurs. With the recent discovery of both leptin and the GATA-2 and GATA-3 genes [57] interest is renewed in the genetic and metabolic influences in the development of obesity. Although, it is possible that single or multiple gene effects may cause overweight and obesity directly, and indeed do so in some individuals, this does not appear to be the case in the majority of people. Instead, it is currently considered that genes involved in weight gain increase the risk or susceptibility of an individual to the development of obesity when exposed to an adverse environment [58].

A large number of adoption [10], family and twin studies [8, 9] have suggested that human obesity can have a significant genetic component, with the heritability of body fatness varying between 25% and 90%, depending on the study [59]. However, familial obesity appears to be the single strongest predisposing factor, probably mediated by genetic predisposition and promoted by a shared environment. Depending on whether none, one or both parents are obese, it could be shown that obese parents more frequently also have obese children. If both parents are obese, there is an 80% probability that their children will be obese too. The probability declines to 40% if there is one obese parent [60].

The responsiveness to energy intake and dietary composition is partly dependent on specific genetic factors [61]. Most of those genetic factors have yet to be clearly identified. It is known that many genes are involved in causing the susceptibility to

obesity. Currently there is statistical proof or experimental support for the role of circa 70 genes, loci or markers [62]. However, many more years of research will be needed before the important genes and critical mutations are finally identified for both excess body fat content and upper body and abdominal fat accumulation. Table 3 [62] shows a selected list of candidate genes for human obesity and body composition, this list is not intended to be comprehensive.

Table 3 Selected list of candidate genes for human obesity, identified on the basis of animal models, physiology, and prior human research

Gene	Phenotype	Chromosomal location		References
		Mouse	Human	
ASI	Obesity	2-88.8	20q11.2-q12	Michaud *et al.*, 1997
CPE	Obesity	8-32	4q28	Hall *et al.*, 1993
LEP	Obesity	6-10.5	7-q32	Geffroy *et al.*, 1995
LEPR	Obesity	4-46.7	1-p31	L'artaglia *et al.*, 1995
TUB	Obesity	7-51.45	11p15.4-p15.5	Klyen *et al.*, 1996
UCP1	Energy balance	8-37	4q31	Cassard *et al.*, 1990
UCP2	Energy balance	7-50	11q13	Fleury *et al.*, 1997
UCP3	Energy balance	7-50	11q13	Solanes *et al.*, 1997
MC3R	Feeding behavior	2-100	20q13	Magenis *et al.*, 1994
CM4R	Feeding behavior	1 or 18	18q21.3-q22	Huszar *et al.*, 1997;
POMC	Obesity (leptin levels)	12-4	2p23.2	Boston *et al.*, 1997; Mountjoy and Wong, 1997
NPYR5	Appetite regulation	8-33	4q31-q32	Nakamura *et al.*, 1997
MSTN	Skeletal muscle growth	1 or 2	2q32.1	McPherron and Lee, 1997
CCKAR	Satiety	5-34.0	4p15.1	Huppi *et al.*, 1995
TNFA	Obesity	17-19.1	6p21.3	Norman *et al.*, 1995
PPAR-γ	Adipocyte differentiation	6-53.0	3p25	Chawla *et al.*, 1994
ADRB3	Adipocyte differentiation	8-10	8p11.1-p12	Mitchell *et al.*, 1998

Abbreviations: ASIP agauti signalling protein; CPE carboxypeptidase E; LEP leptin, LEPR leptin receptor; TUB tubby; UCP uncoupling protein; MCR melanocortin receptor; POMC pro-opiomelanocortin; NPYR neuropeptide y receptor; MSTN myostatin (also called growth differentiation factor 8); CCKAR cholecystokinin A receptor; TNFA tumor necrosis factor α; PPAR γ peroxisome proliferator activated receptor-γ; ADRBB beta-3-adrenergic receptor.

2.4.3.2 Non-genetic factors

In addition to the genetic influences, a number of other non-genetic factors have been shown to influence an individual's susceptibility to weight gain and the development of obesity.

The most important influence is ethnicity. Ethnic groups in many industrialised countries appear to be especially susceptible to the development of obesity and its complications. Evidence suggests that this may be due to a genetic predisposition to obesity that only becomes apparent when such groups are exposed to a more affluent lifestyle. This is demonstrated graphically by the following:

- *Pima Indians of Arizona*: high incidence of obesity [63]
- *Australian Aboriginals*: high incidence of central adiposity, hypertension and NIDDM [64]
- *South Asians overseas*: high incidence of central adiposity, NIDDM and mortality from CHD [65]

It appears that a number of ethnic groups are more prone to the risks of obesity when exposed to the lifestyle common in industrialised countries. When those ethnic groups revert to a more traditional lifestyle, the risks for obesity and related diseases are reduced or eliminated within a very short period [66]. For the majority, this problem seems to result from a combination of genetic predisposition and a change from the traditional to a more affluent and sedentary lifestyle and its accompanying diet.

The other important non-genetic influence is the period for weight gain. Although a general rise in body weight and a modest increase in percentage body fat over the life span can be expected, recent studies have shown the importance of nutrition during certain critical periods. There is a widespread popular belief that adult fatness begins in childhood. Some studies have shown that children with weight for height at the top of the normal range are more likely to become obese adults [67]. The critical periods for the development of obesity before adulthood are shown in Table 4.

Table 4 Critical periods for the development of obesity before adulthood

Critical period	Reason for increased risk
Prenatal	Nutrition during fetal life may contribute directly to the development of the size, shape and composition of the body, and to the metabolic competence to handle macronutrients. Close relationships exist between patterns of intrauterine growth and the risk of abdominal fatness, obesity and their co-morbidities in later life.
Adiposity rebound (5-7 years)	BMI begins to increase rapidly after a period of reduced adiposity during the pre-school years. This period coincides with increased autonomy and socialisation and so may represent a stage when the child is particularly vulnerable to the adoption of behaviours that both influence and predispose to the development of obesity. It is uncertain whether early adiposity rebound is associated with an increased risk of persistent obesity in later life.
Adolescence	A period of increased autonomy often associated with irregular meals, changed food habits, and periods of inactivity during leisure combined with physiological changes that promote increased fat deposition.

As early as the prenatal period there is a relationship between nutrition and obesity. Barker *et al.* provided evidence for the "fetal origins" hypothesis [68]. The hypothesis suggest that under-nutrition at a critical period in fetal life may "programme" a permanent change in the structure or function of an individual, altering the distribution of cell types or gene expression, or both. This manifests in adult life as a high prevalence of NIDDM, which is a risk factor for cardiovascular disease. Also, the Dutch famine study [69] showed that prenatal exposure to famine is associated with a decreased glucose tolerance.

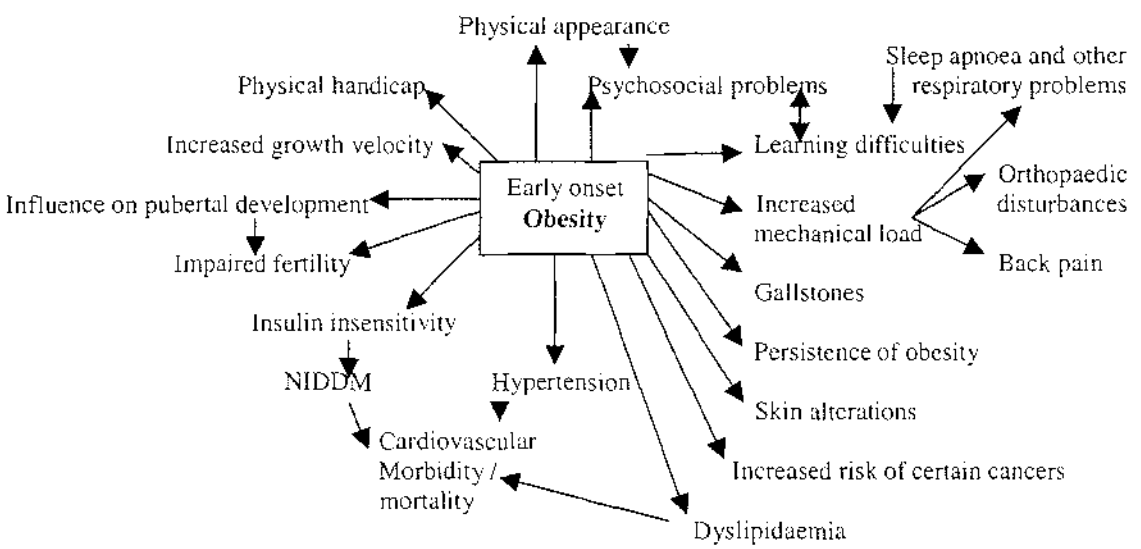
The second critical period is the adiposity rebound (5-7 years). Both Unger and co-workers [70] and the Bogalusa Heart Study [71] found that most of the children who were obese had become overweight by the age of 4 and obese at 5 years of age. Also, Rolland-Cachera *et al.* [72] demonstrated that the "early adiposity rebound" between the 2^{nd} and 5^{th} year was associated with the development of obesity.

The third critical period is adolescence. This is a time of newly discovered independence and freedom of choice. Adolescents are susceptible to external influences, particularly from the media, school and their peers. Also, they experience periods of rapid growth associated with hormonal, cognitive and emotional changes. These are often confounded by lifestyle changes, such as leaving home, changing schools or starting work. Adolescents often live in an environment that relies on snacking and irregular meal patterns [73].

2.5 Consequences of paediatric overweight and obesity

The health consequences of paediatric obesity are many and varied, ranging from an increased risk of premature death to several non-fatal but debilitating complaints that have an adverse effect on quality of life. Most of the health consequences of early onset obesity are summarised in Figure 4 [74].

Figure 4 Health consequences of early onset obesity



Dietz *et al.* [7] conducted an extensive review of the literature on different co-morbidities of childhood obesity and underlying patho-physiological mechanisms and their influence on later health outcome. They concluded that obese children are much more likely to face both health and psychological challenges related to their obesity during childhood and adolescence than their leaner counterparts.

Although childhood obesity is not the only indicator, there is still enough evidence to indicate that obesity-related disease can begin in childhood and that risk factors for disease increase, or remain at a similar level, with advancing age, growth, and development [7].

The most important long-term consequence of childhood obesity is its persistence into adulthood, with all the associated health risks. Obesity in childhood is known to be an independent risk factor for adult obesity [75]. Children who were obese at thirteen years of age are twice as likely to go on to become obese adults. It is to be noted that overweight in adolescence is a more powerful predictor of mortality risk than overweight in adulthood [76]. Obese children have about a one and a half fold increase in risk for all-cause mortality and an approximate two-fold increase in risk for coronary heart disease mortality [77]. Furthermore, among overweight children and adolescents, 60% had at least one heart disease risk factor.[78]

Obesity is more likely to persist when its onset is in late childhood or adolescence and when the obesity is severe. Overweight in adolescence has also shown to be significantly associated with long-term mortality and morbidity [79].

2.5.1 Psychosocial and medical effects of childhood obesity

The adverse effects of obesity seem to be closely associated with the metabolic disturbances induced by this overweight and obesity. Obesity-related symptoms in children and adolescents include psychosocial problems, increased cardiovascular risk factors, abnormal glucose metabolism, hepatic-gastrointestinal disturbances, sleep apnoea and orthopaedic complications. The psychosocial and medical effects of childhood obesity are discussed here.

2.5.1.1 Psychosocial effects

The most common consequence of obesity in children in industrialised countries is poor psychosocial functioning. Studies indicate that overweight and obesity in childhood have a significant impact on psychosocial health. Overweight children are known to become targets of early and systematic discrimination [7]. Children as young as six years of age described the silhouette of an obese child as "lazy", "dirty", "stupid", "ugly", "lies and cheats" more often than they did for other body shaped children [80].

Pre-adolescent children associate the shape (or silhouette) of an overweight body with poor social functioning, reduced fitness and health,[81] character defects and impaired academic success. Also, obese children may have lower self-esteem than their normal-weight counterparts, although this may vary by age, race/ethnicity and socio-economic status [82].

Among teenagers, however, cross-sectional studies [82] consistently show an inverse relationship between body weight and both overall self-esteem and body image. A marked self-awareness of body shape and physical appearance develops during adolescence so that it is perhaps not surprising that the pervasive, negative social messages associated with obesity in many communities have a major impact at this stage. Overweight in adolescence may also be associated with this stage. A longitudinal study suggested that women who had been overweight as adolescents completed fewer years of schooling, had lower household incomes and had higher rates of household poverty compared with women who were not overweight adolescents [83].

2.5.1.2 Cardiovascular risk factors

Many of the cardiovascular consequences that characterise adult onset obesity are preceded by abnormalities that begin in childhood [84]. Hyperlipidemia, hypertension and abnormal glucose tolerance occur with increased frequency in obese children and adolescents [84]. Carpio *et al.* [85] suggest that insulin resistance in children may also be associated with abdominal obesity.

NIDDM used to be very rare in children and adolescents, however the prevalence is increasing [86]. A study from the USA [87] demonstrated that NIDDM amongst adolescents increased 10-fold from 1982 to 1994, and virtually all diagnosed cases of NIDDM occurred in obese individuals. In addition, obesity in children is commonly associated with fasting hyperinsulinaemia [88]. Elevated serum lipid and lipoprotein levels, blood pressure and plasma insulin during childhood are all carried over into young adulthood, obesity status in childhood at baseline being a significant predictor of adult values [89].

2.5.1.3 Hepatic and gastric complications

Hepatic complications in obese children have been reported, particularly hepatic steatosis characterised by raised serum transaminase levels [90]. Abnormal liver enzymes may be associated with cholethiasis, but this condition is rare in children and adolescents.

Gastro-oesophageal reflux and gastric emptying disturbances, which affect a minority of obese children, may be a consequence of raised intra-abdominal pressure due to increased abdominal fat.

2.5.1.4 Orthopaedic complications

It is well documented that obese children can suffer from orthopaedic complications [91]. The more serious of these include slipped capital femoral epiphysis [92] and Blount Disease [93] (a bone deformity resulting from overgrowth of the tibia), while more minor abnormalities include knock knee (genu valgum) and increased susceptibility to ankle sprains.

2.5.1.5 Other complications of childhood obesity

Childhood obesity is associated with a range of other medical conditions. These include poor pulmonary function, advanced growth and early maturity, and a wide range of less common pathologic conditions such as polycystic ovary disease, sleep apnoea, and pseudotumor cerebri [7]. Obstructive sleep apnoea can cause hypoventilation and even sudden death in severe cases [94]. Pseudomotor cerebri is a rare condition linked to raised intracranial pressure; it requires immediate medical attention.

2.5.2 Economic burden of childhood obesity

The economic costs of overweight and obesity are important issues for health care providers and policy-makers. However, to date, Wang and Dietz [95] have only examined the impacts of paediatric overweight and obesity on health care costs. There have been no other attempts to quantify the economic burden of childhood obesity-related morbidity and mortality.

Wang and Dietz [95] concluded that the hospital costs associated with obesity may have risen to more than US$127 million per year (in 2001 constant dollars) in recent years. This figure is excluding costs for physician visits, medication, and indirect costs such as the effect of obesity on future earnings.

The increasing frequency of hospital discharges of obesity-associated diagnoses suggests a rising disease burden associated with obesity among children and adolescents. If the prevalence of obesity continues to grow, the disease burden will surely increase further. As overweight children become overweight adults,[79] the diseases associated with obesity and health care costs are likely to increase even more. Because disproportionate weight gains have occurred among heavier children,[96] the rate of obesity-associated diseases will rise even faster if the expanding prevalence of obesity continues.

2.6 Defining and classifying paediatric overweight and obesity

To date, there are no agreed definitions and classifications of paediatric overweight and obesity [97] There has been confusion both in terms of a globally applicable reference population and of the selection of appropriate cut-off points for designating a child as obese.

Important indicators of development and nutritional adequacy in childhood are weight, height, and head circumference [98] These measurements are used to assess whether the development and feeding of children is adequate and to detect the presence of overweight and obesity. However, defining standardised cut-off points for paediatric overweight and obesity remains difficult. For example, age, growth factors, and sex differences affect the cut-off points, resulting in complex relations that may also show local variations [99]. It is also difficult to standardise cut-off points for different ethnic groups. Therefore, the Agencies for Nutrition Action recognise ethnicity variables in the BMI classifications for European, Maori, Pacific, Asian and Indian people within New Zealand [100]. Another factor to consider is physical maturity, this may vary by ethnicity, and may confound analysis of cut-off points in adolescents of different cultures [101].

2.6.1 Why classify overweight and obesity?

It is useful to define and classify paediatric overweight and obesity because it can provide valuable information to: [102]

1. Identify individuals and groups at increased risk of morbidity and mortality
2. Identify criteria for intervention at individual and community levels
3. Measure changes and trends in individuals and across populations
4. Provide a basis for evaluation of public health strategies.

2.6.2 Use of BMI to classify obesity

BMI can be considered to provide the most useful, albeit crude, nonintrusive, cost-effective population-level measure of obesity. BMI can be used to estimate the prevalence of obesity within a population and the risks associated with it. However, it does not account for the wide variation in the nature of obesity between different individuals and populations [103]. The use of BMI alone is a poor indicator for assessing the true degree of adiposity (% fat) of an individual child. Age-gender- and ethnic-specific BMI rank orderings may provide a general description of the adiposity characteristics for a paediatric population.

It can generally be assumed that individuals with a BMI of 30 or above have an excess fat mass in their body. This cut-off point could in theory be identified as the point where the health risk of obesity starts to rise steeply. Unfortunately such a point cannot be identified with any precision because BMI does not distinguish between weight associated with muscle and weight associated with fat. As a result, the relationship between BMI and body fat content varies according to body build and proportion, and it has been shown repeatedly that a given BMI may not correspond to the same degree of fatness across populations. Polynesians, for example tend to have a lower fat percentage than Caucasians at an identical BMI [104]. Also, fatness is higher in women than in men of equivalent BMI [105]. Differences in body proportions and in the relationship between BMI and body fat content can effect the BMI range considered to be healthy [106].

2.6.3 Waist circumference and waist to hip ratio (WHR)

Waist circumference or WHR are often used as markers of intra-abdominal adipose tissue [107]. Waist circumferences (cm) are measured at the minimum circumference between the iliac crest and the rib cage. Hip circumference is measured at the maximum protuberance of the buttocks, and the WHR is calculated. The conicity index is calculated as waist circumference (0.109 X square root of weight/height) [108].

Abdominal fat mass can vary dramatically within a narrow range of total body fat or BMI. Over the last 10 years, a high WHR is seen as an indication of abdominal fat accumulation [109]. However, recent evidence suggest that waist circumference alone may provide a more practical correlate of abdominal fat distribution and associated ill health. A study of Taylor *et al.* [110] involving 580 New Zealand European children showed that waist circumference performs well as an index of central adiposity for both sexes over a wide range. Their results showed the superiority of waist circumference as an anthropometric indicator of regional fat distribution. Although, when classifying cut-off points age, gender, ethnicity and differences in skeletal structure have to be taken into account. Also, populations differ in the level of risk associated with a particular waist circumference [111]. Table 5 [110] shows the by Taylor *et al.* suggested cut-off points for identifying high trunk fat mass and waist circumference in growing children.

Table 5 Suggested cut-off points for identifying high trunk fat mass and waist circumference

Age	Girls Waist circumference [cm]	Boys waist circumference [cm]
10	69.6	70.1
11	71.8	72.4
12	73.8	74.7
13	75.6	76.9
14	77.0	79.0

The WHR or waist circumference used alone, prove most useful as a screening tool for large population studies. But a combination of the measures, such as the BMI with the waist circumference, may be needed for individual measurements in clinical settings [107].

2.6.4 Additional tools for the assessment of obesity

As mentioned before, measuring the body mass is challenging, because no direct method exists other than in vivo neutron activation analysis (very limited availability) and chemical analysis of the cadaver (useful for animal studies only). The lack of direct methods has led to development of various models and indirect methods for estimation of fat and fat-free mass. All of these methods are imperfect and require a number of assumptions, many of which require age-specific considerations, because the usual assumptions in multi-compartmental models (e.g. hydration of fat-free mass, density of fat-free mass) are known to be influenced by age and state of maturity [112].

Table 6 Summary of Body Composition Techniques in Children

Method	Advantages	Limitations
Densitometry	Direct measure of total body density	Two-compartment model of fat and fat-free mass; underwater weight may not be practical; expensive equipment (US$ 30,000); research based
DEXA	Quick and simple; separates bone tissue; data on fat distribution accuracy versus known standards has been established	Different machines and software for different subjects; expensive equipment (US$ 70,000); research based
Skinfolds and anthropometry	Quick and simple; inexpensive useful for large studies; information on fat pattern	Need different equations to transform data to body composition
Bioelectrical resistance	Quick and simple; inexpensive; useful for large studies	Estimates body water, so need to have information on hydration of fat-free mass
CT/MRI scanning	Measures tissue area in specific anatomic locations	CT involves radiation; expensive and limited availability; research based

Practical aspects limit the availability of techniques for use in younger children. Research-based techniques that could be used are: total body water, dual energy x-ray absorptiometry (DEXA), total body electrical conductivity, total body potassium, and other more convenient and widely available techniques such as bioelectrical resistance, skinfolds, and other clinical anthropometric evaluations (e.g. weight for height, ideal body weight, BMI) [113]. Table 6 shows briefly some of the more frequently used body composition techniques for children [114].

2.6.5 Use of growth charts

To date, many countries have published BMI-for-age charts for their populations, and some have also defined cut-off points on these charts to define overweight and obesity. The cut-off points vary from country to country and the rationale for the choice of cut-off points is rarely provided. As a result, different BMI-for-age values define overweight and obesity in different populations [115].

International BMI-for-age charts would be useful for making comparisons between countries and monitoring the global epidemic of obesity. The WHO recommends using the sex-age specific BMI 85th centiles derived from data from NHANES collected from 1971-1974 to define adolescent overweight for international use [116].

However, for wider international use this definition raises two questions. Firstly, why base it on data from the United States? And, secondly why use the 85th or 95th centile? Other countries are unlikely to base a cut-off point solely on American data, and the 85th or 95th centile is intrinsically no more valid than the 90th, 91st or 98th centile. Regardless of centile or reference population, the cut-off point can still be criticised as arbitrary.

It is recognised that BMI in childhood changes substantially with age [117]. At birth the median is as low as 13 kg/m^2, increases to 17 kg/m^2 at age 1, decreases to 15.5 kg/m^2 at age 6, then increases to 21 kg/m^2 at age 20. A cut-off point related to age is needed to define child obesity, based on the same principle at different ages.

Recent attempts to standardise cut-off points for children and adolescents have been carried out by Cole *et al.* [3] They use data on BMI of large nation-wide surveys from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and United States. Each survey had over 10,000 subjects, with ages ranging from 6-18 years and quality control measures to minimise measurement error [3].

This method addresses the two main problems of defining internationally acceptable cut-off points for BMI for overweight and obesity in children. The reference population was

obtained by averaging across a heterogeneous mix of surveys from different countries, with widely differing prevalence rates for obesity. Whereas the appropriate cut-off point was defined in BMI units in young adulthood and extrapolated to childhood, conserving the corresponding centile in each data set.

Cole *et al.* recognises that the reference population reflects Western populations adequately but lacks representation from other parts of the world. The authors state that data sets from Africa and Asia would be helpful. This questions the validity of the international cut-off points in a multi-cultural society like New Zealand.

There are also difficulties associated with the interpretation of BMI in childhood, which depends not only on height but also on sex and pubertal status [118]. Furthermore, a recent report comparing BMI cut off values with percentage body fat in prepubertal children found that although high cut-off points had high specificity, the sensitivity was poor and depended on gender [119].

Charts of BMI, standardised at an agreed level, are undoubtedly useful for monitoring population trends. It is questionable, however if the index in itself can provide a standard definition for overweight and obesity in children that would be useful in clinical practice. Table 7 shows the international cut-off points of Cole *et al.* [3] for BMI for overweight and obesity for children and adolescents.

Table 7 International cut-off points by BMI defined by Cole *et al.*

Age (years)	BMI 25 Males	kg/m^2 Females	BMI 30 Males	kg/m^2 Females
10	19.8	19.9	24.0	24.1
10.5	20.2	20.3	24.6	24.8
11	20.6	20.7	25.1	25.4
11.5	20.9	21.2	25.6	26.1
12	21.2	21.7	26.0	26.7
12.5	21.6	22.1	26.4	27.2
13	21.9	22.6	26.8	27.8
13.5	22.3	23.0	27.2	28.2
14	22.6	23.3	27.6	28.6
14.5	23.0	23.7	28.0	28.9

Taylor *et al.* [120] recently developed cut-off points for overweight and obesity in children and adolescents aged 3-18 year (Table 8). Their study involved a large sample of 661 New Zealand European participants and the use of DEXA, a validated measure to determine percentage body fat in children.

Table 8 Cut-off points by BMI defined by Taylor *et al.*

Age (years)	BMI 25 • Males	kg/m^2 Females	BMI 30* Males	kg/m^2 Females
10	21 (20, 22)	28 (27, 29)	35 (32, 37)	41 (39, 43)
11	22 (21, 23)	30 (29, 31)	36 (33, 38)	43 (42, 46)
12	22 (21, 23)	32 (31, 33)	35 (33, 38)	46 (44, 48)
13	23 (21, 23)	33 (32, 34)	35 (32, 37)	46 (45, 49)
14	23 (21, 23)	34 (33, 35)	34 (31, 36)	46 (45, 49)

• = The BMI at each age that is equivalent to a BMI of 25 in an 18 year old as calculated according to Cole *et al.* [3] * = The BMI at each age that is equivalent to a BMI of 30 in an 18 year old as calculated according to Cole *et al.* [3]

In conclusion, there is no single method of defining paediatric cut-off points that is clearly the best in all situations and for all purposes. It is likely that a number of methods work similarly well and produce fairly similar results. Estimates of overweight and obesity may be sensitive to the methods chosen.

2.7 Assessment of food intake

Measurement of habitual food intake remains one of the most challenging aspects of human obesity research. Dietary surveys of individuals are usually carried out for one of three reasons: to compare the average nutrient intakes of different groups, to rank individuals within a group, and to assess and individual's usual intake [121].
There are some difficulties measuring the food intake of children. Dietary intake techniques for this group tend to suffer from the general limitation that they involve an interview approach and, thus, they often rely on the child, the child's parents or teacher to recollect daily intake accurately. An additional limitation of studies examining children's intake is the possibility of recall bias, and the child's capacity to complete the questionnaire is affected by memory failure, level of nutrition knowledge, and motivation to complete the form accurately [122].

When assessing food intake, investigators have typically employed 24-hour recalls, prospective food diaries, or food frequency questionnaires (FFQ), often using multiple methods. Each assessment approach has advantages and disadvantages that must be weighed in selecting the method (or methods) which best meets the needs of a particular evaluation. The advantages of 24-hour recalls include precision and, when multiple days are assessed, validity [123]. Disadvantages include cost and administration time; the need to obtain multiple recalls to reliably estimate usual intake; participant burden; and literacy demands in the estimation of portion size [124]. The advantages of diaries are similar to those of recalls, with the added disadvantage of increased literacy demands and respondent burden. Advantages of FFQ include relatively lower administrative costs and time and the ability to assess usual and longer term intake; disadvantages include inaccuracy of absolute nutrient values, fluctuation of nutrient values depending on instrument length and structure,[125] lack of detail regarding specific foods, and general imprecision [126]. Table 9 summarizes the advantages and limitations of some food assessment methods used in children extracted from the literature.

Table 9 Summary of methods for assessment of food intake in children

Method	Advantages	Limitations
24-hour recall	Can use alternative interview approaches to maximise the accuracy of subject recall; has been validated for group mean energy intake	Multiple recalls are required to overcome daily variability
Food frequency questionnaire	Mail-in forms can be used for large population studies	Questionnaires lack information on portion sizes for children; data are more qualitative in nature
Food records	More thorough recording of information; has been validated for group mean energy intake	Invasive technique that may change habitual behaviour; demanding for research subjects

2.7.1 Food diaries

Multiple-day food records, sometimes with weighed quantities instead of estimated portion sizes provide estimates of actual food intake. This method requires a high degree of subject co-operation. Subjects are instructed to weigh or measure individual food and - beverage items, to provide detailed information on portion sizes and accurately record this information.

Until recently diet records were used as a reference instrument. However, recent research suggests that diet records are not as reliable as first indicated [127]. Studies involving biomarkers, such as doubly labeled water for measuring energy intake and urinary nitrogen for measuring protein intake, [128] suggest that reports using food records or recalls are biased (on average, towards underreporting) and that individuals may systematically differ in their reporting accuracy. This could mean that all dietary report instruments involve bias at the individual level, although direct evidence for individual macronutrients other than protein is not yet available. Part of the bias may depend on true intake (which manifests itself in what we call group-specific bias), therefore violating the first assumption for a reference instrument. However, in 7- and 9- year-old children, there was good agreement between energy intake estimated from a weighed 7-day diet record and total energy expenditure from double-labelled water [114]. However, a systematic negative bias was evident in adolescents. Other investigators confirmed this finding in a cohort of 28 non-obese and 33 obese 12- to 18-year-old adolescents by using 2-week diet records in which reported energy intake was underestimated by 19% in non-obese adolescents and by 41% in obese adolescents [121].

2.7.2 Food frequency questionnaires

FFQ assesses the type and amount of food consumption in a qualitative, quantitative or semi-quantitative manner. Respondents are presented with a preprinted list of foods with options to indicate how often each food is eaten (qualitative FFQ). An element to quantify portions may be included (quantitative FFQ). Many of the questionnaires frequently used do not take into account the smaller portions consumed by children and thus may overestimate intake. To date, the FFQ has been the dietary assessment method used most frequently in large-scale studies, primarily because it is easy to administer, is less expensive than other dietary assessment methods, and provides a rapid estimate of usual intake. The FFQ was originally developed for use in epidemiological research to classify individuals on a continuum of nutrient-intake distributions [126].

The accuracy of FFQ has repeatedly been challenged. A FFQ include a list of foods, a rough indication off portion size, and a set of frequency options. Inaccuracies result from:

1. incomplete listing of possible foods,
2. errors in estimating portion size;
3. from errors in estimating the usual frequency of food consumption

Errors in estimating portion size address the fact that one of the original designs of the FFQ was a measure of semi-quantitative food intake (i.e., relative macronutrient intake), which incorporated typical serving sizes for adults, thereby allowing for quantification of total energy intake. The reliability of the FFQ in adults is good [e.g., reliability coefficient for total energy intake 0.63 and 0.65], but weaker in children [e.g., reliability coefficient for total energy intake 0.46; 0.28 in boys and 0.48 in girls] [129].
Flegal and Larkin [130] found that errors in classification were primarily attributable to errors in frequency estimation instead of to errors in serving size estimates. Therefore, modification of serving sizes would not necessarily affect the quality of information obtained. On the other hand, Block and co-workers [131] found that correlation's between the modified food frequency questionnaire and 16 days of dietary record were improved significantly with the addition of age-specific portion sizes. The role of modifying serving sizes to improve the accuracy of estimating energy intake in children with the food frequency questionnaire warrants additional investigation.

Errors in estimating the usual frequency of food consumption refer to memory errors. They may play a major role in the disparity between estimated intake and actual intake [132]. Sources of memory error consist of memory failure and elaboration or confusion with current diet. Additionally, the inability of the child to correctly appraise serving sizes, the degree of the perceived value of the food items to be recalled, and the fact that children tend to better remember preferred foods as larger portions than non-preferred foods augments the amount of error [129]. However, some researchers state that the FFQ critically depend on the participants' long term knowledge of their own dietary patterns and are intended to measure intakes averaged over at least a year [133]. That viewpoint tacitly acknowledges that FFQ have less to do with memory for what was consumed than

with subjective inferences about the nature of the habitual diet. FFQ, much like food preferences or body image, appear to be a measure of attitude. Such an image may include food likes and dislikes and is likely to be influenced by age, sex, and concerns about dieting and health. As such, the reported frequency of food use is more a measure of attitude than actual dietary behaviour [134].

Most food intake methods underestimate actual intake, and this bias is more pronounced in women and in obese individuals. However, previous studies have shown that the FFQ overestimates total energy intake by [approximate] 50%, [129] whereas repeated 24-hour recalls and food records provide reasonably accurate group mean values for intake, and although the values are not accurate on an individual basis [135]. Also, a FFQ significantly underestimated percent of energy from fat for people on a high-fat diet and overestimated fat for people on a low-fat diet, demonstrating a tendency toward the mean [136]. Because of this "blurring" of intakes, the FFQ is described as inadequate and unreliable in assessing both absolute and relative macronutrient intakes [130].

However, the few studies that have been conducted in children suggest that food frequency questionnaires overestimate energy intake. A portion of the overestimation of energy intake by the FFQ is explained by the inability of the FFQ to account for variation in the actual portions consumed by children. Block *et al.* [131] found that the validity of the food-frequency questionnaire had improved with the addition of age-specific portion sizes.

It has to be considered that the FFQ was not designed to reflect accurately and precisely true energy intake, the techniques still may permit classification of subjects into categories of intake for epidemiologic research, but are clearly not very useful for determining individual differences in energy requirements [130].

There are numerous problems relating to memory, conceptualisation skills, and validity, questionnaires, properly validated, may be appropriate for assessing intakes for nutrients that are highly concentrated in relatively few foods that can be quantified using models or

household measures. Copper, retinol, carotene, and vitamin B-12 lend themselves to such an approach [136].

2.7.3 24-hour recall method

The 24-hour recall method has been widely used in children, and reported energy intake with this technique compares well with total energy expenditure in young children when the multiple-pass interview technique is used. The multiple-pass approach was developed to overcome the dilemma of underreporting that is known to exist with interview techniques [137]. The multiple-pass approach involves three distinct stages of an interview:

1) quick listing of food consumed,
2) more detailed description of the specific items, and
3) review of the information.

Food portion sizes are determined by using two-dimensional food models. When applied in triplicate in 24 young boys and girls,[137] total reported mean intake was not significantly different than total daily energy expenditure averaged over 14 days by double-labeled water. Thus on a group basis, the 24-hour reported intake reflected energy intake accurately. However, the correlation between individual expenditure and reported intake was not significant, indicating that the recall technique is not precise enough to estimate actual energy intake on an individual basis. The degree of misreporting of energy intake is not influenced significantly by gender, age, or body-fat content in children [137].

One of the limitations of the 24-hour recall is that several recalls are needed to overcome daily fluctuations in intake pattern. Taking into account inter- and intra-individual variation in young children, Nelson *et al.* [121] estimated that 10 days of recall would be required to achieve an r value of 0.9 between measured and actual average intake. Collection of numerous recalls and multiple dietary analysis would be cumbersome and

time-consuming. Although, during the face to face interview, true eating and drinking habits are most likely to be reported.

2.8 Assessment of physical activity and energy expenditure

Fitness and physical activity levels of children and adolescents are commonly addressed but data on scientific investigations are both equivocal and methodologically diverse. The intensity and type of physical activity that benefit health and development during childhood are not known. Measurement of activity in children is problematic since there is no valid method of assessing activity [138].

Currently, physical activity is a broadly used term, and its heterogeneous nature makes it extremely difficult to characterise and quantify. However, physical activity can be defined as any physical movement that is a result of skeletal muscle contraction. Physical activity is often measured in terms of energy cost. But this may not be appropriate when one considers the benefits and health effect of physical activities using a high-energy expenditure (e.g. running at a certain intensity) versus a low-energy expenditure (e.g. strength training). Thus, quantification and description of physical activity should probably consider all aspects, including the following:[114]

1) type and purpose of physical activity (e.g. recreational or obligatory, aerobic or anaerobic, occupational)
2) intensity (strenuousness)
3) efficiency
4) duration (i.e. time)
5) frequency (i.e. times per week)
6) specific energy cost of the activity performed

It is also important to consider that physical activity and exercise may not be synonymous. Exercise typically refers to structured activities that are performed for the purpose of improving physical fitness and well being. This distinction is of particular relevance in children [139].

An additional difficulty with the development of rigorous techniques for measuring physical activity is the lack of an ideal standard with which to validate the data, thus making it difficult to truly validate any given technique [114]. Various methods are available for assessing physical activity in children, including questionnaires, accelerometry or pedometry, double-labelled water (DLW) for assessment of free-living physical activity-related energy expenditure, and heart-rate (HR) monitoring. Table 10 summarises the methods for assessment of physical activity in children extracted from the literature.

Table 10 Summary of methods for assessment of physical activity in children

Technique	Advantages	Limitations
Double-labelled water	Free-living; unobtrusive; incl. All non resting energy expenditure; long-term (14 days)	No information on activity pattern or acute periods of activity; expensive; limited to measurement of energy expenditure; researched based
Questionnaires	Cheap; useful for large-scale studies	Behavioural bias; relies on memory and recall; conversion to energy use
Heart rate	Small and inexpensive; assesses patterns; validated against double-labelled water	Factors other than activity affect heart rate; invasive and obtrusive; potential for subjects to tamper with a mechanical device; not useful for very large studies; potential for behavioural bias
Accelerometry	Small and cheap; assesses patterns; triaxial accelerometry measures movement in three planes	Invasive and obtrusive potential for subjects to tamper with a mechanical device; not useful for very large studies; behavioural bias

The most commonly used methods for assessing physical activity and/or energy expenditure are observation, diaries, activity recalls, motion sensors, indirect calorimetry, HR monitoring, DLW-method [140].

Observational procedures are suitable for small sample sizes when information on specific types and duration of activity is the primary focus of concern. The disadvantage of those methods is that they are time consuming, labour intensive and interfere with spontaneous activity patterns [141].

Self-report questionnaires or diaries have been used most frequently in large-scale studies of habitual physical activity of adolescents and adults. Diaries and recalls rely on memory, are subject to misrepresentation and do not have documented reliability and validity. Due to cognitive limitations their use in young children is problematic [140]. Motion sensors, such as pedometers, actometers and accelerometers, have been developed to provide more objective information on body movement. Since acceleration in the vertical plane is measured, accelerometers will reflect walking and running very well but are relatively insensitive to other common children's activities such as cycling. Thus new, three-dimensional accelerometers have been developed. These units compare well with energy expenditure during specified laboratory test and free-living energy expenditure [142].

Minute-by-minute HR recording is able to measure both energy expenditure and physical activity in children. However, at low levels of physical activity the interpretation of HR data is confounded by the fact that HR responses reflect not only physical activity but also metabolic status, posture, temperature and emotional status [143]. The relationship between HR and physical activity is more secure at higher levels of physical activity and it is possible to identify and quantify bouts of exercise from individually derived HR versus oxygen uptake regression equations. For moderate- to high-intensity activity, HR monitoring provides a good general index of physical activity [144].

Currently the most acceptable and powerful technique for the measurement of total energy expenditure is the DLW-method [138]. As the technique is non-invasive and since measurements are performed over a more extensive period than with other techniques it is more likely to obtain a more representative estimate of total energy expenditure. However, cost and technical complexity limit its application in large-scale studies. Also, in epidemiological studies it may not be the most appropriate method to apply since it provides no data on the patterns of physical activity, which are important functional indicators off children's health status.

Each of these methods has its advantages and limitations and there is a need to improve methodology particularly among children. Also, each of the above mentioned methods is deficient in at least one aspect, a combination of techniques should be considered.

2.9 Obesity programmes for children

There has been a lot of interest in developing effective treatments for overweight and obesity, with the overwhelming majority of this research focused on treating adults. The objectives of weight-management strategies for children differ from those for adults because consideration needs to be given to the physical and intellectual development of the child [145]. Whereas adult treatment may target weight loss, paediatric treatment targets the prevention of weight gain. Lean body mass increases as children age, so that reducing fat mass or keeping it constant will result in a normalisation of body weight [145].

Recent recommendations [146] for the treatment of childhood obesity suggest that the type of intervention should be based on the degree of obesity and the existence or likelihood of obesity-related complications. For example, morbidly obese children with or without co-morbid conditions may require aggressive weight loss treatments such as reduced energy diets, pharmaceutical treatments or even surgical procedure. However, treatment of uncomplicated childhood obesity should reinforce healthy eating and physical activity behaviours to achieve weight loss without adverse effects on growth or lean tissue [147].

2.9.1 Treatment of paediatric overweight and obese children

Treatment of obesity aims at long-term weight maintenance and normalisation of body weight and body fat and therefore they have to modify eating and exercise behaviour of the obese child. However, obesity is not a disease that develops quickly; a typical pattern is gradual weight gain over a period of several years. Weight loss should occur, if it occurs, also slowly over a long period of time. Preferably children need to grow into a healthy weight [148].

Given the risks factors there is an urge to become more knowledgeable about preventing and treating obesity in children and adolescents. However, the wrong intervention could be as dangerous as the consequences of excess weight. Restrictive diets for children can cause a lot of physical and psychological problems. Consideration of the following issues important when developing interventions aimed at preventing or treating obesity in young children.

- Risk of malnutrition and deficiency of certain nutrients. As adequate nutrition is essential for promoting healthy growth, only small reductions in overall energy intake are recommended where such an approach is advised [149].
- Risk of eating disorders. It is important that interventions do not encourage the type of dietary restraint that has been linked to the development of eating disorders and other psychological problems [150].
- Risk of isolation. It is important that overweight children are not ostracised and made to feel any more different from their peers than is necessary, either at home or at school [79].

2.9.1.1 Behaviour change

The establishment of new, healthier behaviour and lifestyle is necessary to reduce and maintain normal body weight. Behavioural changes need time to be established and confirmed, they need reinforcement and positive feedback [151]. To date many programmes try to influence behaviour, however compliance with programmes to modify eating and exercise behaviour programmes is often poor [152]. Many factors influence compliance, including knowledge, attitudes, beliefs, habits, intention, and the environment [153]. Traditionally interventions mainly provide nutrition information for participants. However, this approach fails to take into account many other factors that may limit change. Many models of behaviour change that incorporate these factors have been developed and then applied to the area of health, e.g. the health belief model. Also, Prochaska and DiClimente's Transtheoretical Model of Behaviour Change ("Stages of Change") [154-156] was developed as a means of integrating the stages and processes of behaviour change used by several distinct therapies in the discipline of psychology.

The model proposes that there are five distinct stages in behaviour change: (1) precontemplation – not intending to make behaviour changes in the foreseeable future; (2) contemplation – considering a behaviour change but not yet making a firm commitment to change; (3) preparation – commitment to changing behaviour (those in preparation may also have made an unsuccessful attempt to change their behaviour over the past year and may have begun making small behavioural changes; (4) action – successfully changing behaviour; and (5) maintenance – behaviour change sustained over six months. Relapse is an event that terminates the action or maintenance stage, which prompts a cyclical movement back to the initial stages. Table 11 summarises the different phases of the stages of change model.

Table 11. Stages of change

Stage of change	Persons in this stage are:
Pre-contemplation stage	Not considering the possibility of change, either because they are unaware of the of the need for change or unwilling to confront the problem
Contemplation stage	Aware of the existence of a problem. Seriously considering the possibility of change but feel ambivalent. They see the benefits but feel distressed about the sacrifices involved.
Preparation	Decided on their commitment to change and will make a change in the near future (within 3 months). Still some ambivalence.
Action	Actually starting to make a change in their behaviour. Might be confident in their ability to sustain change at the start.
Maintenance	Attempting to sustain the progress achieved during action. Are likely to be constantly struggling with thoughts about relapsing. Last between six months and a lifetime.
Termination	Free from temptation to return to old habits. The new behaviour is more habitual than the old.
Relapse	Not strictly a change of change, but a possible outcome of action or maintenance. Unsuccessful in their attempt to change. Likely to go back into contemplation and seriously intend to make another attend at change in the near future.

Note that the model of change looks like a linear process, however this is not the case. People can get stuck in different stages, move backwards or forwards, or spiral onwards. The stages are not as compartmentalised as the model suggests, however, as there is considerable overlap between the neighbouring stages. People might move around the stages of change several times, making unsuccessful attempts at change over a period of weeks, months or years.

2.9.1.2 Reducing energy intake and improving dietary quality

Research indicates that only small reductions in energy intake should be made in the diet of the overweight child. Children require an adequate intake of both energy and nutrients to ensure that normal growth and development are not compromised [157].

Motivation to eat a healthy diet is known to be a problem amongst children because of their perceived lack of urgency associated with health issues [158] and their conceptualization of healthy food as 'adult', contextually separated from 'child' food and generally 'boring, dull, tasteless, expensive and inaccessible' [159]. There are several ways to promote the consumption of 'healthy' foods and reduce the intake of energy. Firstly, limit portion sizes of energy-dense foods. This can be achieved by preparing and serving smaller quantities of such foods or by encouraging free consumption of fruits and vegetables so that energy density is reduced without imposing dietary restrictions [160]. Secondly, limit take-away and ready-prepared foods. Those foods tend to be high in fat and are energy-dense. Take-away foods are making increasingly large contributions to the energy intake of children and adolescents around the world. Children should also be encouraged to eat fewer high-fat snacks, and to avoid obtaining a large proportion of total energy from sweetened beverages or even to choose unsweetened drinks or water [161]. And thirdly, promote the consumption of food high in complex carbohydrates, low in fat and low in energy density is likely to be important in preventing excessive energy consumption in children [161].

2.9.1.3 Increasing physical activity

There are a limited number of studies that test the effect of exercise in treating childhood obesity. Much remains to be elucidated, particularly in relation to be long-term benefits of physical activity in the control of weight through childhood and adolescence. Available evidence suggest that exercise alone is not sufficient for the effective management of childhood obesity, and that a combination of diet and exercise is more effective for long-term control [162].

Children should be encouraged to be as active as possible. However, it is unclear what types, amounts, and intensities of exercise may be used safely and effectively to treat childhood obesity. Specific guidelines for intensity (how hard or fast), duration (how long), frequency (how often), and mode (type of activity) of exercise are unclear [49, 163]. Some investigators support the use of weight-bearing activities, such as walking and jogging, in obese children [164]. Others indicate that weight-bearing activities may not be appropriate because of disabilities caused by carrying excess weight loads [49, 163, 165]. Although, researchers agree that energy expenditure can be safely and more effectively increased through general activity and play rather than competitive sport and structured exercise [162].

Some of the methods that have been used to improve adherence to exercise programs in adults may be equally useful for children. These include making the activity enjoyable by increasing the choice of type and level of activities, as well as by providing positive reinforcement of their achievements during exercise rather than only after the successful completion of the exercise session [162]. Increasing physical activity in children is associated with benefits other than raising energy expenditure [166]. For example, being active may compete with snacking and thereby make adherence to a diet easier.

2.9.1.4 Reducing time spend in sedentary behavior

More research is indicating that the amount of time spent in sedentary behavior or inactivity may play an even more important role than low levels of physical activity in the genesis of children's weight problems [46]. The rapid rise in childhood overweight and obesity is accompanied by an explosion of non-active leisure pursuits for children such as computer and video games. Television is the principal cause of inactivity for most children and adolescents in developed countries and has been linked to the prevalence of obesity [167]. Television viewing is also associated with increased intake of high-energy snacks [168].

2.9.1.5 Behaviour modification

Behaviours related to eating and physical activity are some of the mechanisms that influence body weight. Currently, most behavioural treatments for paediatric obesity have focused on three components: (1) diet, (2) physical activity, and (3) behaviour change [169]. The behaviour change components are what make the treatments unique. Many people know what they should be doing, but knowledge often is insufficient to change behaviour. Therefore, techniques for changing behaviour based on the learning theory and neuroscience are implemented [169]. However, there are a limited number of investigators sufficiently knowledgeable about basic and applied research to translate basic behavioural science findings into clinical research. For this reason, the newest developments in basic behaviour theory may not be translated into behavioural interventions. More funding and research is necessary to develop a better understanding of behaviour change.

2.9.2 Previous interventions

Many studies have been undertaken in the area of paediatric overweight and obesity prevention and treatment. Children and their parents[170], peers [171] and teachers/schools [172] have all been the targets of interventions aimed at influencing children's food choice. However, despite the use of such apparently influential intermediaries and the incorporation of theories of modelling change, such as social learning theory or social cognitive theory, the success of those programmes has been limited. Interventions have been confined to local populations and many focus solely on increasing consumption of fruit and vegetables through intense strategies [173, 174]. This thesis focuses on treatment intervention studies in which obese children and adolescents were placed on nutrition and exercise programs for the purpose of weight loss. Studies included had to meet two criteria:

1. Children or adolescents were defined as obese using objective criteria for obesity
2. Obese children or adolescents were provided with a nutrition intervention plus any type of exercise intervention

It is generally recognised that nutrition intervention is ineffective as a solitary treatment for paediatric obesity [175]. As mentioned above weight loss occurs by attacking both energy input and energy output. Thus interventions that deal with the prevention of obesity through the combined effect of dietary education and physical activity should be more effective. The low-cost non-pharmacological nature of this intervention enhances their therapeutic appeal.

There are several different approaches to improve food choice and reduce energy intake in children. For example: energy restricted diets, providing individualised dietary interventions, structured eating plans that increase the nutrient density of the diet and the protein-sparing modified fast [145]. Also, there are no comparative studies in which other aspects of treatment are held constant as the types of dietary recommendations are varied. The effect of diet depends on the context in which it is presented in the treatment; dietary recommendations are complemented by strong components of behaviour change to enhance weight control [176].

There are also several different approaches to increase energy expenditure in children [162]. For example aerobic exercise and lifestyle exercise. However, research is a bit more conclusive in this area, several data suggest that less structured, more flexible lifestyle exercise may be superior to more structured and higher intensity aerobic exercise for weight control.

2.9.3 Different obesity-management programmes

Table 12 lists a variety of different obesity-management programmes offered for obese and overweight children and adolescents extracted from the literature.

Table 12 Variety of obesity-management programs offered for obese children and adolescents

Treatment program	Description
School-based programs	Encourage an active school to open school sport and recreational facilities for the use of pupils families and surrounding populations, safe walking and cycling to school and also to enable teachers to receive training in nutrition and physical activity
Family-based therapy	Interventions modify diet and exercise habits within the family unit. Since the family environment may be conductive to overeating or a sedentary lifestyle
Outpatient treatment	Offer different therapeutic approaches for different age groups. E.g. individual treatment or group treatment, some of the programs incl. Family, others offer specific family orientated programs
Dietary camps	Pre-camp: recruiting, diet, exercise counselling, self-monitoring and goal setting. Camp: in daily regular sessions behavioural program is thought, diet, exercise programs are performed. Follow up treatment is included
Group therapy	Behaviour modification programs done in groups
Individual therapy	Behaviour modification programs done on individual basis
Surgical treatment	E.g. techniques that reduce food intake by reducing gastric volume and creating a small pouch where only a limited amount of food can be ingested. Should only be considered in selected cases
Pharmacological treatment	The use for paediatric obesity is controversial and belongs to experimental therapeutic approaches

2.9.3.1 School-based programs

During the eighties and nineties, programmes dealing with weight control were popular at many schools [177-179]. However, many of those studies focus on primary school students instead of adolescents [180-182]. School-based programmes seem ideal because much of children's eating and exercise patterns take place in this setting. There is also a general understanding that schools can assist in identifying children who may be at risk of obesity through educational programs and visits to the school doctor at key developmental stages [177]. Furthermore, the start of schooling corresponds to a period of increased risk for excessive weight gain as children begin to become independent and vary their diet and activity patterns in line with their new circumstances [183]. Also, increasing physical activity through integrating regular exercise programs into school curricula is a strategy that has often been suggested as an effective means of improving the weight and health status of children [184].

2.9.4 Family-based programmes

The family environment is one of the strongest influences on a child's risk of obesity [185]. A logical setting for childhood obesity prevention and management would appear to be the families of susceptible children. Education on eating and lifestyles to parents has been shown to significantly reduce the prevalence of obesity in children of

participating families for periods of three months to three years when compared with families not receiving advice and support [186]. Parental attitudes, purchase and presentation of food modeling of eating and exercise habits, and support for active leisure pursuits can all affect a child's eating and exercise pattern [187].

By targeting obesity-prevention measures on the family of susceptible children there is the added advantage that all members of the family are likely to benefit. This helps to increase social support and to reduce the feelings of isolation that may develop when one child is treated separately from the rest of the family. In addition, parents are able to exert a higher degree of external control over the child's eating and activity patterns under these circumstances [150].

2.9.5 Primary-care-based programs

Frequent contact with health professionals from an early age has been identified as one of the most important strategies for the effective management of overweight and obese children [188]. Regular assessment and contact through home visits, group- and individual therapy provides an excellent opportunity for education about the potential lifestyle risk factors associated with obesity, as well as for advice, encouragement and support to help children and parents to adopt healthy household eating and exercise patterns [188].

2.9.6 Drugs and surgery

To date, limited information is available on the use of aggressive forms of treatment such as drugs and surgery for children and adolescents. Such treatment may only be indicated in children with potentially fatal complications of obesity.

2.9.6.1 Epstein *et al.*

The strongest evidence that the treatment of obesity in children can be successfully managed over the period from childhood through adolescence to adulthood is provided by Epstein *et al.* [189]. In a series of four studies, data from 158 families with children at

high risk for significant adult obesity were followed up 10 years after their initial treatment. At the time of initial treatment, the children were between 6 and 12 years of age, averaged 40-50% overweight and, with the exception of one study group, had at least one obese parent. Different treatment conditions were investigated but all involved a diet plan together with intensive group behaviour modification over and 8-12 week period, followed by monthly maintenance sessions for 6-12 months.

After 10 years of follow-up, six out of nine actively treated groups showed a net reduction in percentage overweight of between 10% and 20%. Inclusion of a parent with the child in treatment and introduction of exercise into the basic diet and behaviour change program enhanced the long-term effects. However, it may not always be feasible to provide the high level of support given in the studies mentioned above, and the children in these studies were recruited from a largely white, middle-class, two-parent families.

2.9.6.2 Other studies

A recent systematic review of Epstein [190] reports thirteen randomised controlled trials covering a range of dietary plus physical activity interventions to treat paediatric obesity The eleven studies included in table 10 describe treatment interventions for parents and children together, parental involvement in treatment, addition of controlled exercise to diet, reinforcement of behavioural diet and exercise strategies, and the promotion of lifestyle changes. However, it has to be considered that the studies have different caloric ranges for diet and are in the context of different types of exercise programs and different methods to enhance behaviour change.

The small number of controlled outcome studies in combination with the use of different dependent variables across studies limits the strength of conclusions that can be drawn.

Table 13 Characteristics and results of exercise programs (Adapted from ref. 190)

Authors	Age	N	Groups	Exercise	Diet	Results
Beque et al (1988)	12-13	11 11 14	Diet+Ex Diet Control	3Xwk.50 min supervised aerobic activity	Loss of 1-2 lb.wk	%BF, BW: Diet+Ex=Diet+Con Fitness: Diet+Ex=Diet=Con
Epstein et al (1994)	8-12	55	Diet+Ex Diet+Sed Diet+Com	Reinf for activity Reinf for less sed Comb Ex+sed	900-1200 kcal	%OW,%F:Rx:Sed>Ex %OW,%F:Fu:Sed>Ex, Com Fitness:Rx,FU:NS
Epstein et al (1985)	8-12	13 12 10	Diet+Pro Diet+LS Diet+Cal	Programmed aerobic Ex Lifestyle Ex Comb Ex+sed	900-1200 kcal	%OW,%F:FU:Sed>Ex, Com Fitness:Rx, FU:NS
Epstein et al (1985)	8-12	23	Diet+Ex Diet	3 mile walk 3Xwk	900-1200 kcal	%OW,BW:Rx:Diet+Ex>Diet %OW,BW:FU:NS Fitness:Rx:NS;Fu:Ex, Diet>Cont
Epstein et al (1984)	8-12	18 18 17	Diet+Ex Diet Control	Lifestyle Ex	900-1200 kcal	%OW,:Rx:Diet+Ex,Diet >cont %OW:FU:Diet=Diet+Ex
Epstein et al (1982)	8-12	8 10 11 8	Diet+pro Diet+LS Pro LS	Programmed aerobic Ex Lifestyle Ex Programmed aerobic Ex Lifestyle Ex	900-1200 kcal	%OW,BMI:Rx:NS %OW,BMI:FU:all Pro Fitness:Rx:Pro>LS Fitness:6mnth FU:NS
Hills & Parker (1988)	Pre-pubertal	20 20	Diet+Ex Diet	Gymn 1X.wk, 20 min home aerobic activity 3-4Xwk	Nutrition educatio	BMI:NS SF:Diet+Ex>Diet
Pena et al (1989)	10-15	20 20 20 20	HiF+Ex LoF+Ex HiF LoF	20 min jogging + cycling at 70% VO2max 5X.wk(2X.d)	1000kcal HiF = 20+ 5g.d LoF + 3-6 g.d	BW:boys HiF+Ex>LoF for BW BW:girls HiF+Ex> HiF or LoF BW:LoF+Ex>LoF for BW
Pena et al (1980)	8-14	16 21	Diet+Ex Diet	Platform stepping 5X.wk Walk for 2h 7X.wk	27 kcal.kg ideal wt.ht	BW,BF:NS %BF:Ex>Diet
Reybrouck et al (1990)	6-14	14 11	Diet+Ex Diet	Daily aerobic exercise 14-40 min at 70-75% Hrmax 3X.wk	800-1000 kcal	%BF:Ex>Diet %OW:Rx:Ex>Diet %OW:FU:Ex=Diet
Rocchini et al (1988)	9-15	23 22 18	Diet+Ex Diet Control		Loss of 1-2 lb.wk	BW,%BF;Diet or Ex.Control Fitness:Ex.Diet or Control

Abbreviations: FU=follow-up period; Ex=exercise; Con=controls; X.wk=times activity performed/week; Sed=reinforced for decreasing sedentary behaviour; Com=reinforced for decreasing sedentary and increasing active behaviour; Pro=programmed aerobic exercise; LS=lifestyle exercise; Cal=calisthenics; NS=not significant; %BF=%body fat; %BW=% body weight; OW=overweight defined by standard weight for height and age tables; SF=skinfold measurements; HiF/LoF=high fiber/Low fiber diet.

The only areas in which there are sufficient studies to make quantitative data based conclusions for body composition changes in is the comparison of diet versus diet plus exercise. These results indicate diet plus exercise improve short-term obesity treatment by almost one-half standard deviation above and beyond the contribution made by diet alone. Exercise reliably increases fitness effects whether compared with diet alone or no exercise controls. There are too few studies comparing exercise versus no exercise, or comparing different exercise programs to make firm conclusions. In addition, there are very limited data on long-term effects of exercise, and any conclusions would be premature.

Table 13 also indicates that besides from Epstein only a few other researchers have included dietary and physical activity interventions. The studies that contrasted diet versus diet and exercise varied with respect to diet and exercise methods, but all demonstrated better changes in weight and fitness for diet plus exercise that diet alone. Reybrouck *et al.* [191] found that after 4 months a group expending 250 kcal in one session of exercise per day, in addition to a low-calorie diet, showed a greater decrease in percent of overweight than the diet alone group. In another 4-month study, Hills and Parker [192] found differences in skinfold changes but not in weight in preadolescent children provided weekly supervised exercise sessions plus a three- or four-time per week home aerobic activity program versus diet alone. In a much shorter treatment period of 15 days Pena *et al.* [193] demonstrated greater changes in percent body fat for diet plus exercise than diet alone. Another study of Pena *et al.* [194] provided a one month treatment, which crossed an isocaloric high- and low-fiber diet with a no-exercise group and exercise group that jogged and cycled twice daily, five times a week. The high-fiber/exercise group showed greater decreases in weight than the low-fiber/no-exercise group.

The studies that contrasted diet versus diet and exercise versus no intervention provided a control for non-specific effect of the intervention. In contrast to the previous studies, none of these found differences between the diet and diet plus exercise groups. Rocchini and Beque [180, 195] explored the benefits of aerobic activity designed to maintain heart

rate between 60% and 80% of maximal exercise heart rate for 40 to 60 minutes in 20-week interventions. In both studies, both diet and diet plus exercise were equal for weight and body fat changes, although the diet plus exercise groups showed better improvements in other physiologic parameters. The studies indicate that changes in blood pressure and other coronary heart disease variables are possible with diet and exercise intervention.

2.10 Summary

Overweight and obesity are increasing world-wide [1]. Research [6] suggest that approximately one in seven Auckland children are obese. This study also indicate that rates of obesity varied with ethnicity and are higher among Pacific (24%) and Maori (16%) children than among New Zealand European children (9%).

Twin and adoption studies [8-10, 59] demonstrate a large genetic component to obesity. However, the increasing prevalence of obesity over the last 20 years can only be explained by environmental and behavioural factors. Paediatric overweight and obesity is related to an increased energy intake (i.e. consumption of large volumes of high energy dense food) and a reduced energy output (i.e. increased sedentary behaviour and decreased physical activity).

BMI is a quick and easy way to screen for childhood obesity. However, to date the criteria for specifying overweight and obesity in children traditionally depend on the classic criteria of specifying abnormal weights when they deviate beyond the two standard deviations of the mean values found in the reference international growth curves [116]. This arbitrary definition unfortunately does not relate to the WHO adult criteria of "healthy" BMI's [1]. Recently, Cole *et al.* [3] combined several international data sets and developed cut-off points for children depending on sex and age. Taylor *et al.* [120] also developed a data set for children with cut-off points that might be more appropriate for New Zealand children.

Currently there are no accurate assessment methods to assess nutrition intake and physical activity. It can be concluded that for studies in overweight and obese children

food records and repeated multiple-pass 24-hour recalls may provide the most accurate group mean estimates of energy. Although, systematic negative bias in the underreporting of energy intake has been noted [196].

At this stage there are limited controlled data on physical activity and nutrition education in the treatment of paediatric obesity. This highlights a paradoxical situation; at a time in which we see obesity prevention nominated as a public health priority, [1] we find a research environment that currently lacks the power to set clear directions for the treatment of paediatric overweight and obesity. However, initial research is encouraging, but more research is needed to maximise the effects of dietary and physical activity interventions on overweight and obese children.

Preliminary data suggest that less structured, more flexible lifestyle exercise (e.g. games) may be superior to more structured and higher intensity aerobic exercise for weight control. Also, data suggest that improving dietary habits by using motivational communication strategies in combination with educational strategies and behavioural change strategies to influence nutrition behaviour may be superior to the implementation of low-fat, calorie-restricted diets. In addition, from the available data we can conclude that there are better changes in weight and fitness for diet plus exercise. However, investigators need to take into account the participants characteristics, characteristics of the exercise programs, the nutrition education programmes, and the outcomes to be achieved to develop the most effective exercise and nutrition programmes. The development of an active lifestyle and healthy eating habits in overweight and obese children has the potential for a lifestyle that may increase lifelong health benefits.

3 Aims of the study

This study investigated the effect of the "Games Galore" intervention on the development of healthy eating habits and the development of an ongoing self motivated participation in physical activity in both male and female 10-14 year old children.

This age group was chosen as previous studies have shown that physical activity habits, dietary habits and food preferences which affect energy consumption and nutrient intake are generally developed during adolescence [73]. In addition, obese adolescents generally have not had the unhealthy eating or activity patterns as long as obese adults and respond with greater relative weight loss and better maintenance of weight loss [197]. Also, physical activity and nutrition interventions can take advantage of growth and increases in lean body mass as well as weight change.

The secondary aim was to determine whether the "Games Galore" feasibility study had a positive effect on anthropometric indicators.

Finally, we wanted to determine whether the "Games Galore" feasibility study was effective and/or feasible for the treatment of overweight or obese children of this age.

4 Methodology

This study concept was outlined by Ms. Christine King, lecturer Sports Nutrition, School of Sports, UNITEC Institute of Technology. The nutrition education programme was designed by the author of this thesis. The physical education programme was designed by third year students of the school of sports, UNITEC Institute of Technology, as part of their course. Ethical approval for the study was obtained by Ms. Christine King from the Research Ethics Committee UNITEC. Ms. Christine King and the author of this thesis organised and ran the "Games Galore" programme. Because of the problems encountered with the project the study supervisors, Ms. Christine King and the author of this thesis made several changes to the methodology as the project progressed (see 4.3.4)

4.1 Participants

Overweight or obese adolescents born between 1988 and 1990 who were attending a full primary or intermediate schools surrounding UNITEC Institute of Technology (Unitec) were potentially eligible to participate in the study. This age group (adolescence) was targeted for several reasons. Adolescence is a time of newly discovered independence and freedom of choice. One of the ways independence is exhibited is through eating. It is often a time for making rebellious or non-conformist statements and adopting social causes. This coupled with a lack of knowledge and experience necessary to make adequate evaluations of dietary practice, can lead to the adoption of ill-conceived diets. Targeting this age group could result in the development of life long healthy eating habits and the ongoing self motivated participation in physical activity.

4.2 Recruitment strategies

Principals of 5 full primary and intermediate schools surrounding Unitec were sent a letter (Appendix 1) to inform them about the "Games Galore" programme by the researchers. This letter explained briefly the goals of the programme and invited the school to participate in the programme. Circa one month later the researchers telephoned the principals of the schools contacted. This phone conversation explained the objectives and methodology of "Games Galore" and invited the school to participate in the project.

Only two schools expressed interest and were willing to participate: an intermediate and a full primary school. The Public Health Nurse, the principals and teachers of the participating schools recruited the participants by handing out information sheets to children that were potentially eligible. The information sheet explained the goals of the "Games Galore" programme and invited the student and his/her family to participate (Appendix 2).

Participants and their parents/caregivers could officially enrol in the "Games Galore" feasibility study by signing a contract (Appendix 3). This contract stated that the participants attended at least 75% of the organised sessions, and exercise 30 minutes or more on three of the days they did not attend the physical activity programme. In the contract the parents/caregivers agreed to exercise together with the participant and they also agreed to encourage the participant to make healthy food choices.

4.3 Methods

The intervention aimed to encourage development of life long healthy eating habits and to develop an ongoing self motivated participation in physical activity. Therefore "Games Galore" developed two interventions (1) a physical activity intervention and (2) a nutrition education intervention.

The physical activity sessions took place two times a week after school (with the exception of school holidays). These sessions were mainly based on ball games and lasted one hour. Every fortnight participants and their parents/caregivers were invited to attend nutrition education sessions. Those sessions involved information about "healthy eating" and a cooking demonstration to persuade participants that healthy foods are tasty, not too costly and easy to prepare. The "Games Galore" programme was free for all participants.

4.3.1 Activity programme

Two Unitec buses picked up the participants from their Auckland based schools: an intermediate and a full primary school. Participants were transported to the Unitec campus in Mount Albert to attend the activity programme of "Games Galore". The participants were picked up immediately after school and they were taken straight to the Unitec campus, a trip of twenty minutes. Before the activity programme the participants changed into their physical education clothes and received a cordial drink.

The activities were organised by a student of Unitec School of Sport (Martin Burke). Other students from the Unitec School of Sport assisted during the physical activity sessions. The programme included some well-known sports people (role models) who were associated with Unitec (i.e. players of Auckland Blockbuster Basketball Team, Coach of the Soccer Kingz, Players of Auckland Blues Rugby team, Players of the Warriors Rugby League team etc.)

After the games the children were provided with an after school snack (museli bar and a piece of fruit) and flavoured milk (Primo). After the snack the participants were returned to their school.

4.3.2 Nutrition education programme

The researcher organised ten nutrition education sessions during semester three and four. The sessions were organised fortnightly at the Unitec campus during the evening from 19.00 to 20.00 hours. Before every session the researcher invited both participant and their parent(s)/caregiver(s) to the nutrition education sessions. The invitation letters were sent to the participants' home addresses (Appendix 4).

The nutrition education programme focussed on the family and aimed to improve dietary habits by using consciously and systematically motivational communication strategies in combination with educational strategies and behavioural change strategies [198] to influence nutrition behaviour. The education programme recognised the various steps of

behavioural change from exposure and attention through comprehension and persuasion to action and maintenance of new purchase behaviour. For example information about "healthy nutrition" was provided to improve knowledge and skills to recognise and value nutritious products. By identifying the gaps in the participants knowledge about "healthy nutrition", goals were defined and identified. In the process of behaviour change, participants were persuaded to act on the information that they had been given. The programme aimed to improve food patterns by promoting moderation, appropriate portion size, balance and dietary adequacy as fundamental and interrelated principles.

Moderation refers to eating a wide selection of foods within the major food groups, recognising that no one major food group is more or less important than any other food group [199]. Moderation should also include appropriate portion size in order to minimise passive overeating [200].

Balance and its corollary term, proportionality, refer to eating relatively more servings from the larger food groups at the bottom of the Food Pyramid and fewer servings of the foods from the smaller food groups at the top of the pyramid.

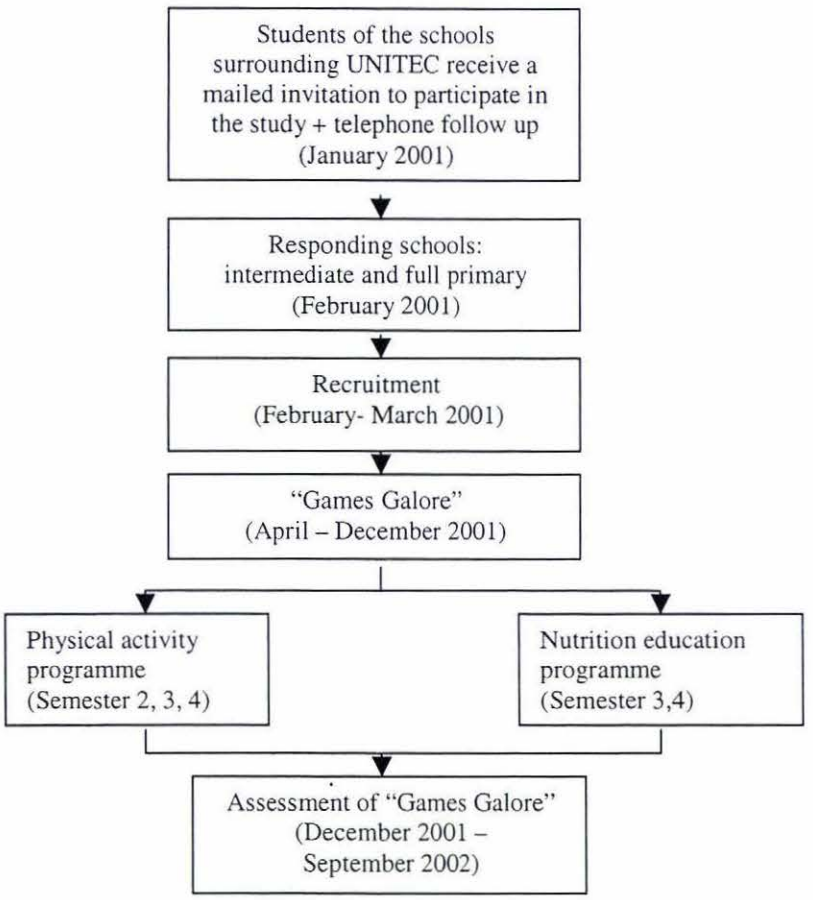
Dietary adequacy could be achieved by including a variety of nutrient-dense foods, such as grains, fruits and vegetables, within the context of the total diet. The programme aimed to be aware of the social, cultural, economic and emotional meanings that may be attached to some foods and allowed for flexibility whenever possible.

The education programme also aimed to convince participants that products, other than fast food products, were tasty and enjoyable. Therefore cooking and tasting sessions were implemented. Those sessions showed participants and their parents/caregivers how family meals could be adjusted to be tasty and nutritious. Recipes and tips were introduced to further encourage participants to consume "healthy" products.

Other motivational strategies were the anticipation of positive and negative consequences of the participant's behaviour (i.e. shifting the dietary pyramid from high-fat foods to

low-fat, high carbohydrate foods). For a description of the nutrition education sessions see Appendix 5.

Figure 5 Methodology



4.3.3 Gifts

Other motivational strategies to encourage participants to participate in the "Games Galore" programme were to offer incentives in the form of special gifts. During the intervention the participants received a T-shirt (sponsored by Unitec), lunch box (sponsored by 5+), backpack (sponsored by Xenical), several gift vouchers, free tickets to some home games of the Auckland Blockbuster Basketball Team and a A4 sized photo of the participants with the Blockbuster Basketball Team.

4.3.4 Ad hoc changes of the methodology

The participants and their parents/caregivers received numerous invitation letters to attend the nutrition education programme. Also, the participants were reminded before, during, and after the physical activity sessions of the nutrition education sessions. Most participants still failed to show during the evening sessions, only one participant attended all the nutrition education sessions. Other ways to communicate the nutrition message to the participants were sought.

During the third and fourth semester participants received the information about healthy nutrition before and after the exercise sessions. While consuming the snack and/or beverage the participants received some information about: the food pyramid, the importance of moderation, breakfast, fat content in different take-aways, and the impact of overweight and obesity on non-communicable diseases. These nutrition sessions were backed up by written information from the National Heart Foundation of New Zealand and the New Zealand Ministry of Health (Appendix 6).

The researchers acknowledge that the attendance of a parent/caregiver during the nutrition education sessions was important in the process of behaviour change. However this was not always feasible.

4.3.5 Ethical Consent

The Unitec Ethics Committee approved the protocol of the feasibility study "Games Galore" (Appendix 7). Parents/guardians had to sign a consent form (Appendix 8) to approve the participant's participation for the programme and to ensure that the participants did not have any medical condition.

4.4 Assessment methods

To assess the effect of the feasibility study "Games Galore" several assessment methods were used. The assessment methods used during this study were:

- Anthropometric indicators
- Qualitative dietary habit questionnaire
- Diet and activity questionnaire
- FFQ
- 3 Day diet and physical activity diary
- 24 Hour recall

Measurements were taken at baseline, 4 months, 6 months (end intervention), 10 months (= 4 months post intervention), and 16 months (= 10 months post intervention) by the researchers. Table 14 shows the schedule of events.

Table 14 Assessment methods

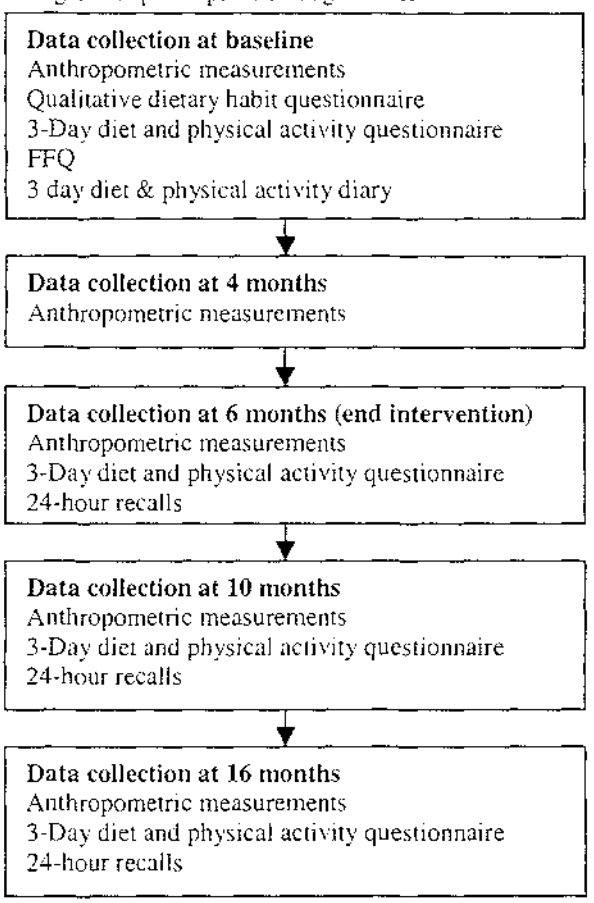
	Baseline	4 months	6 months	10 months	16 months
Anthropometric	√	√	√	√	√
Qualitative dietary habit question.	√				
Diet & activity questionnaire	√		√	√	√
FFQ	√				
3 day diet & physical activity diary	√				
24 hour recall			√	√	√

4.5 Anthropometric measurements

At baseline, during the intervention and twice post-intervention each child was weighed and measured by the researcher. Height, weight and waist and hip circumferences were taken in light clothing without shoes.

Standing height was taken by aligning the tragion and orbitale horizontally. Height was measured with a stadiometer (Massey University) to the nearest 0.5 cm. Weight measurements were taken on an electronic scale to the nearest 100 gram (Wedderburn). BMI was calculated from the conventional height and weight measurement (kg/m^2).

Figure 6 Progress of participants through the trial



Waist and hip circumferences (cm) were measured in duplicate with an anthropometric tape (Lufkin executive thinline). Waist circumference was measured at the minimum circumference between the iliac crest and the rib cage. If this measurement was not available this measurement was taken in the middle of the iliac crest and rib cage. Hip circumference was measured at the maximum protuberance of the buttocks, and the WHR was calculated.

4.6 Qualitative dietary habit questionnaire

At baseline participants were asked to complete a qualitative dietary habit questionnaire (Appendix 9). This questionnaire was designed to determine if the participants met the National Food and Nutrition Guidelines [201]. The answers were multiple choice and ranked, whereby answer "A" indicated poor nutrition (1 point), answer "B" indicated

room for improvement (2 points), and answer "C" indicated excellent nutrition (3 points). The maximum amount of points participants could score was 42 points and the minimum amount of points participants could score was 14 points

4.7 Dietary and physical activity questionnaire

At baseline the researcher contacted the parents/caregivers of the participants to make an appointment for the diet and physical activity interview. Parents/caregivers could opt to be interviewed by an interviewer of their own ethnic-group. However, none of the parents/caregivers opted for the latter. The researcher visited all participants and their parents/caregivers at home. The duration of the interview was circa one hour.
The questionnaire used to guide the interview process was based on the questionnaire that was designed for the pilot of the child nutrition survey (permission was given by the Ministry of Health to use this validated questionnaire).

The questionnaire was designed to establish activity levels and eating patterns of the participants. The first part of the questionnaire existed of questions about physical activity, while the second part of the questionnaire existed of questions about nutritional habits (Appendix 10). During the intervention, at the end of the intervention and post-intervention some of the questions of the questionnaire were repeated to determine if the participants changed their physical and/or nutritional behaviour (Appendix 11).

4.7.1 Food Frequency Questionnaire

At baseline the participants were asked by the researcher to complete a self-administered qualitative FFQ (Appendix 12). This FFQ was designed to measure the participant's habitual food and intake by Susan Sharp from Auckland University for the pilot study of the Child Nutrition Survey. Permission was given by the Ministry of Health to use this FFQ.

4.7.2 Three-day diet and physical activity diary

At baseline participants were asked by the researcher to record, in as much detail as possible, all food and beverages consumed over a 3-day period (preferably two weekdays and 1 weekend day). Participants were asked to record:

(1) everything they ate and drunk in as much detail as possible

(2) the time of the day they consumed the food

(3) how the food was prepared

(4) portion size

The table constructed provided participants a systematic way of working through the diary. Also, the participants were asked to record, in as much detail as possible their physical activities over the 3-day period (Appendix 13).

On several occasions the researcher gave detailed instructions on recording food quantification and description of the foods eaten and on recording physical activity (before and after the physical activity sessions and during the home visit).

4.7.3 24-hour recalls

The response to the three-day food and activity diary was very low (only 4 participants returned a food diary after 6 months). While the participants were reminded, by the researcher, of the importance of completing and returning their three-day food and activity diary at least twice a week. Also, the quality of the three-day food and activity diaries was poor (none of the participants managed to fill in the portion size and the method of food preparation). After seeking advice from experts at Massey University the researcher changed the methodology of dietary assessment to three 24-hour recalls. During the intervention and twice post-intervention the researcher interviewed all participants. The multiple-pass interview technique was used. This approach is developed to overcome the dilemma of underreporting that is known to exist with interview techniques. The multiple-pass approach involves three distinct stages of an interview:

(1) quick listing of food consumed,

(1) more detailed description of the specific items, and

(2) review of the information

Serving sizes were based on the serving sizes provided in the food composition tables.

4.8 Statistical analysis

The diet and activity questionnaire, the qualitative dietary habit questionnaire and the behaviour change questionnaire were coded. Those questionnaires plus the anthropometric measurements were double entered onto spreadsheets (Microsoft Exel 97), compared and corrected (with reference to the data information sheets). Dietary data was entered in Food works version 3.0. An independent nutritionist checked more than 10% of the 24-hour recalls.

Descriptive statistics were used for summarising data. Balanced MANOVA for repeated measures was used to compare the changes over time. Also, one sample t-tests on the differences over time were used to determine if data was statistically significant.
All statistical analysis and calculations were performed using Microsoft Excel 97 and Minitab 13 for Windows. Statistical assistance was sought from Dr. Barry McDonnald and Ms Judi Scheffer from Massey University.

Results were not analysed by gender because there were only two girls in the final sample. As the sample size was small (n=16) and 14 of the subjects were Pacific in origin, analysis by ethnicity would not have been useful.

5 Results

5.1 Ethnic and gender characteristics of the participants

A total of 22 participants enrolled in the "Games Galore" feasibility study. The participants were all residents of West Auckland, New Zealand. The schools of the participants; an intermediate (year 7-8) and a full primary (year 1-8) were located in the lower socio-economic areas in Auckland according to the Education Review Office, Ministry of Education [202]. Table 15 shows the ethnicity and socio-economic indicators of the students attending the participating schools.

Table 15 Ethnicity and socio-economic indicators of the participating schools

	Intermediate	Full primary
State school	Yes	Yes
Total students	405	250
Years	7-8	1-8
NZ European students	20%	11%
Maori students	12%	26%
Samoan students	24%	23%
Tongan students	8%	11%
Indian students	8%	7%
Niuean students	5%	5%
Other students	23%	17%
Boys	49%	52%
Decile rating*	2	2

* = The decile rating of a school is determined by the Ministry of Education and takes account of a number of factors including the socio-economic status of the families of the pupils at the school.

Of the students participating in the study 73% (n=16) were male and 27% (n=6) were female. There was a mixture of ethnic groups represented in the study population, however 86% (n=19) of the participants indicated that they were of Pacific and/or Maori descent, 5% (n=1) were of Indian decent and 9% (n=2) indicated that they were of European descent.

After two weeks of the intervention 27% of the participants (n=6) dropped out. The baseline characteristics of the remaining 16 participants are shown in table 16. Seventy five percent (n=12) of those participants were male, and 25% (n=4) were female. Eighty eight percent (n=14) indicated that they were of Pacific and/or Maori descent, 6% (n=1) were of Indian decent and 6% (n=1) were of European decent.

The age of the participants at baseline ranged from 11 to 13 years (inclusive). The mean age was 12 years (± 0.5). All participants were classed as obese according to the cut-off points by BMI for children and adolescents by Cole *et al.* [3] While 81% of the participants were classed as overweight according to the cut-off points by BMI for children by Taylor *et al.* [120] The mean value for BMI was 32.8 (±5.0) with a range from 26.7 to 43.4.

Table 16 Baseline characteristics participants

Characteristics	Mean (± SD)	Range	Percentage [%] (n)
Age [years]	12.1 (±0.5)	11-13	
Weight [kg]	85.8 (±14.8)	62.4-111.0	
Height [m]	1.62 (±0.1)	1.51-1.73	
BMI [kg/m2]	32.8 (±5.0)	26.7-43.4	
Hip circumference [cm]	113 (±9.9)	95-129	
Waist circumference [cm]	105 (±8.6)	87-116	
Male			75 (12)
Pacific / Maori participant			88 (14)
Indian participants			6 (1)
NZ European participants			6 (1)

5.2 Medications

Twenty five percent of the participants (n=4) were using inhaled asthma medications. No one was taking continuous asthma medication. One participant was taking drugs in relation to cardiac surgery (the researchers did not know this at baseline). After several requests, the family did not provide detailed information about the disease and/or the drugs taken by this participant.

5.3 Withdrawal and compliance of participants

The withdrawal rate was high in this study. Two weeks after the start of the "Games Galore" feasibility study, 27% of the participants (n=6) had withdrawn from the study. No intention to treat analysis was performed on those participants because students did not attend several pre-arranged appointments.

Of the remaining group who completed the "Games Galore" feasibility study, the compliance for the activity programme was 81%, while the compliance for the nutrition education programme was only 13%.

5.4 Lost to follow up

Four months post intervention the lost to follow up was 0%. However ten months post intervention the lost of follow up was 25% (n=4). Three participants moved out of the area and one participant failed to attend on four different occasions.

5.5 Anthropometric indicators

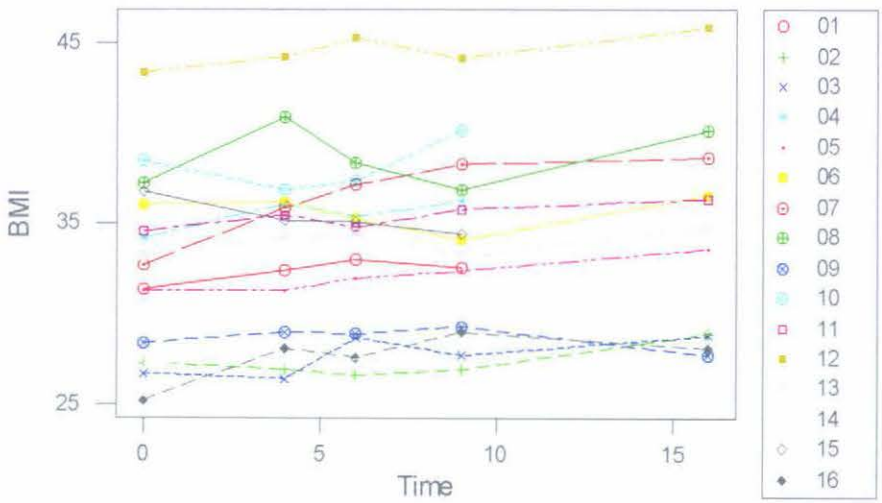
No significant change was seen in anthropometric measurements from baseline to 10 months post intervention, see Table 17. Throughout the study the mean value for both the males and females remained between 85th and 97th percentile for weight and between 53rd and 55th percentile for height (NCHS growth curves for children) [203].

Table 17 Weight, height, BMI, hip and waist circumference of the participants at baseline, 4 and 6 months during the intervention and 4 and 10 months post intervention (mean, ±SD)

	Baseline (start intervention)	4 Months	6 Months (end intervention)	10 Months (4 Months post intervention)	16 Months (10 Months post intervention)
	n=16	n=16	n=16	n=16	n=12
Weight [kg]	85.8 (±14.8)	89.1 (±17.1)	90.4 (±16.3)	94.0 (±16.3)	96.8 (±19.1)
Height [m]	1.62 (±0.1)	1.63 (±0.1)	1.64 (±0.1)	1.67 (±0.1)	1.68 (±0.1)
BMI [kg/m2]	32.8 (±5.0)	33.5 (±5.2)	33.6 (±5.0)	33.7 (±4.9)	34.1 (±5.8)
Hip [cm]	113 (±9.9)	113 (±9.4)	114 (±10.6)	114 (±10.1)	115 (±10.7)
Waist [cm]	105 (±8.6)	106 (±7.3)	108 (±8.2)	107 (±8.4)	111 (±10.6)

No significant difference was seen for BMI with a balanced MANOVA (p=0.79). However, a one sample t-test on the differences for BMI showed that at 10 months post intervention the BMI is significantly *higher* (CI=95%; 3.13-1.12, p=0.001).
Figure 7 shows the change in BMI of the participating students at baseline, during the intervention, 4 months and 10 months post intervention.

Figure 7 Change in BMI from baseline for all participating students



5.6 Sedentary behaviour patterns

During weekdays the mean waking time of the participants was 07.08 hours in the morning (±0.60) with a range between 06.00 and 08.20 hours. The mean bedtime on weekdays was 21.27 (±0.71) with a range between 20.00 and 22.00 hours.

The mean waking time during weekends was 08.35 hours (±1.27) ranging between 05.45 and 10.00 hours. The mean bedtime was 21.08 (±5.37) ranging between 20.00 and 01.00 hours.

Nineteen percent of the participants (n=3) claimed that they slept during the day on weekdays, ranging between 45 and 60 minutes. During the weekend 25% (n=4) of the participants slept during the day, ranging between 45 and 120 minutes.

At baseline the mean time of watching television during weekdays was 148 minutes per day (±120.7) ranging between 0 and 390 minutes per day. During the weekend the mean time of watching television was 253 minutes per day (±129) ranging from 0 to 450 minutes per day (Figure 8).

Figure 8 The mean amount of hours of television watched per day by the participants on weekdays and weekends at baseline

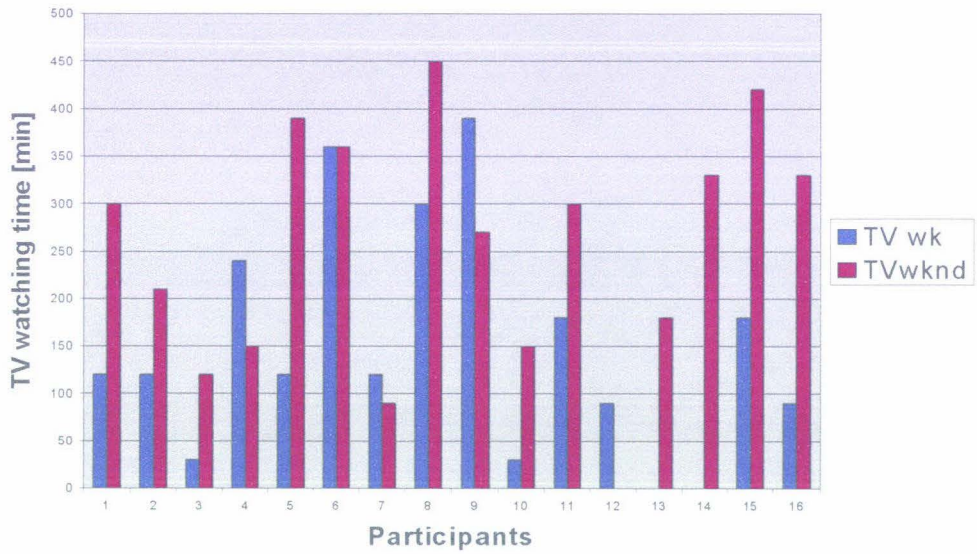


Figure 9 The mean amount of hours of television watched per day by the participants on weekdays at baseline, 6 months, 10 months and 16 months

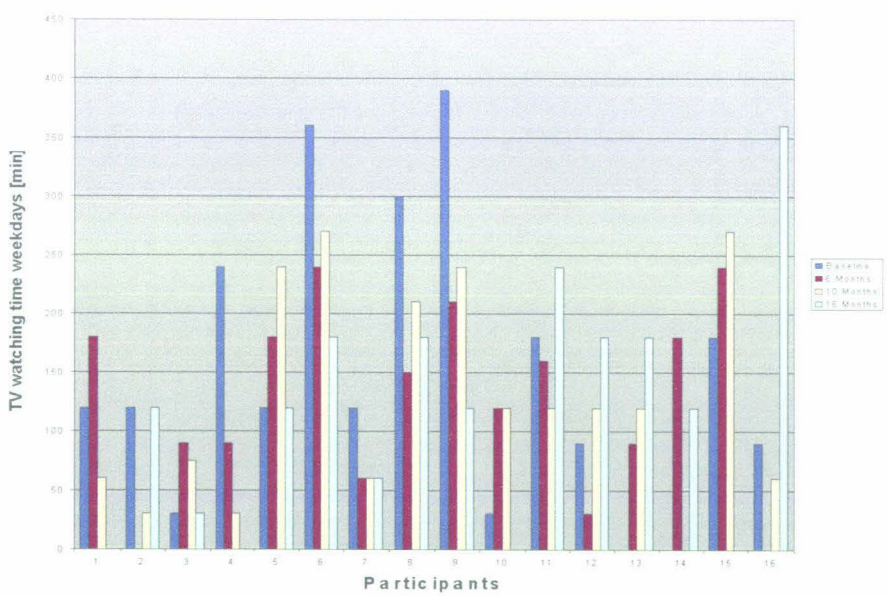
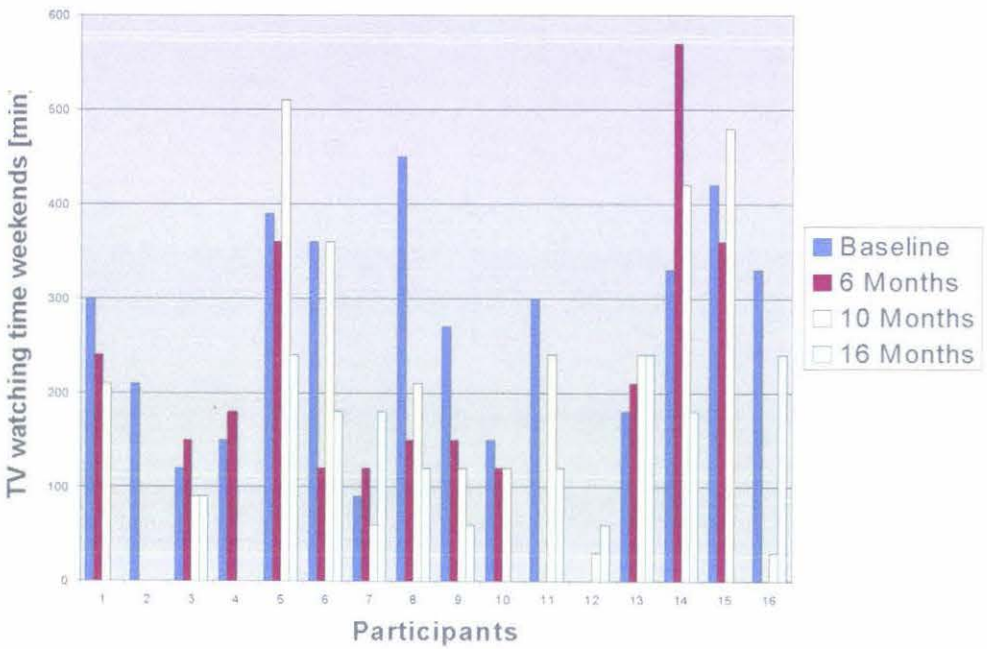


Figure 10 The mean amount of hours of television watched per day by the participants on weekends at baseline, 6 months, 10 months and 16 months



At baseline 37% (n=6) of the participants used the computer during weekdays, ranging between 20 and 120 minutes. During the weekend 56% (n=9) of the participants used a computer, ranging between 60 and 300 minutes.

During the intervention and 4 months post intervention the usage of computers during weekdays did not change. Ten months post intervention 25% (n=4) of the participants used the computer during weekdays. During the weekend 38% (n=6) used the computer during the intervention, 31% (n=5) used the computer 4 months post intervention and 25% (n=4) used the computer 10 months post intervention. Figure 9 and 10 show the television habits of the participants on respectively weekdays and weekends.

5.7 Activity patterns

Fifty six percent (n=9) percent of the participants traveled less than 5 minutes to school, 25% (n=4) traveled for 5 to 15 minutes, 12.5% (n=2) traveled for 16 to 30 minutes, and 6% (n=1) traveled for more than an hour. Participants had the same travel pattern from school to home. Most participants (69%, n=11) traveled to and from school by foot.

At baseline the mean time of the participants to play outdoors during weekdays was 62 minutes (±50.8), ranging from 0 to 180 minutes. The mean time spent outdoors during the weekend was 158 minutes (±131.7) ranging from 5 to 480 minutes.
The intervention showed a significant difference with a balanced MANOVA for outdoor play during weekdays (p=0.02). However, a one sample t-test on the differences for outdoor play during weekdays showed that there was no significant difference (CI=95%; -68,34: p=0.48) at the last measurement point (10 months past intervention). But at the end of the intervention and 4 months post intervention the one sample t-test on the differences for outdoor play during weekdays showed a significant difference, respectively (CI=95%; -276, 65: p=0.00) and (CI=95%; 149,254: p=0.01).
For outdoor play during the weekends the MANOVA showed no significant difference (p=0.12). A one sample t-test on the differences for outdoor play during the weekend showed that there was no significant difference (CI=95%; -21, 181: p=0.11).

Ninety four percent (n=15) of the participants were involved in one or more physical activities outside school hours (e.g. rugby, league, touch rugby, basketball, volleyball, unihoc, karate, boxing, church sport, taikwando, biking, softball, netball, soccer). The mean time spent on those physical activities at baseline is 23 minutes per day (±15), ranging from 0 to 51 minutes per week. During the intervention the mean time spent on physical activities is 35 minutes per day (±34), ranging from 0 to 120 minutes per day. At 4 and 10 months post intervention the mean time spent on physical activities is respectively 46 minutes per day (±98), ranging from 0 to 390 minutes per day, and 35 minutes per day (±36), ranging from 0 to 96 minutes per day. The intervention showed no significant difference with a balanced MANOVA (p=0.73) in the participation of participants in physical activities outside school hours. The one sample t-test on the differences showed that there was no significant difference at all measurement points (the end of the intervention, 4 months and 10 months past intervention), respectively (CI=95%; 29, 6: p=0.19), (CI=95%; 77, 31: p=0.38), and (CI=95%; 37, 9: p=0.21).

5.8 Nutritional status participants

The assessment methods to assess nutritional status during this study were:

- Qualitative dietary habit questionnaire
- Diet and activity questionnaire
- FFQ
- 3 Day diet and physical activity diary
- 24 Hour recall

5.8.1 Qualitative dietary habits questionnaire

Table 18 shows the results of the qualitative dietary habits questionnaire at baseline. The table shows the dietary habits reported by the participants, compared with the National Food and Nutrition guidelines of the Ministry of Health [201].

Table 18 Percentage of participants reporting their dietary habits, compared with the National Food and Nutrition guidelines of the Ministry of Health

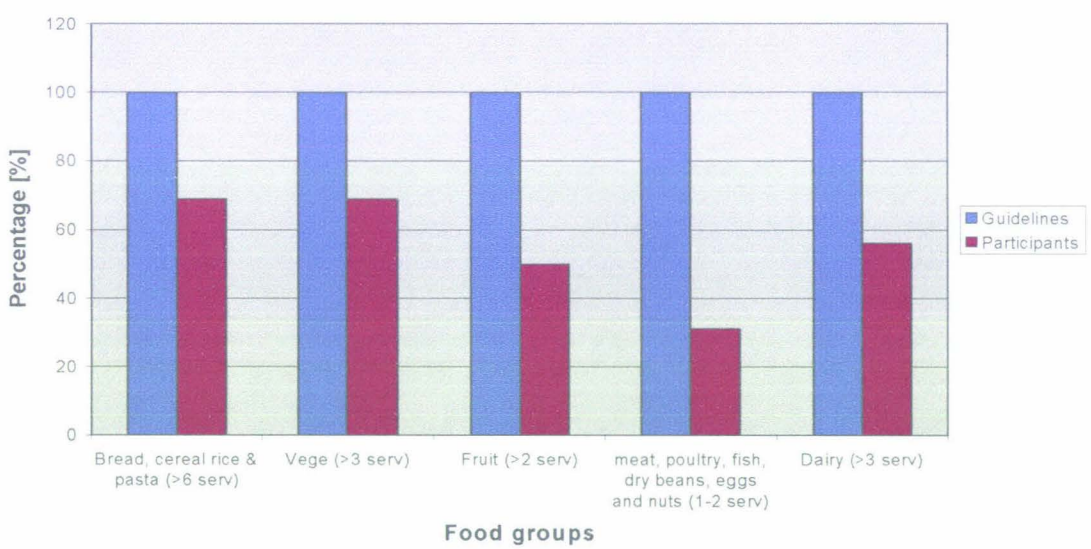
	Indicating excellent nutrition [%]	Indicating nutrition can improve [%]	Indicating poor nutrition [%]
Servings of bread	25	44	31
Breakfast consumption	25	56	19
Type of spread	56	31	19
Amount of butter / margarine	25	69	06
Servings of dairy	25	50	25
Servings of fruit	44	43	13
Servings of vegetables	37	50	13
Servings of sausages, mince and luncheon	50	37	13
Dietary habits (trim the fat off meat)	31	50	19
Servings of fried foods	50	31	19
Servings of takeaways	37	44	19
Servings of snacks	50	31	19
Servings of caffeine containing drinks	63	19	17
Dietary habits (skipping of breakfast)	38	31	31

The mean score of the participants was 30 points (±5.01) ranging from 22 to 38 points. Maximum amount of points participants could score was 42 points, while the minimum amount participants could score was 14 points.

5.8.2 Diet and activity questionnaire

Results of the baseline diet and activity questionnaire compared with the National Food and Nutrition guidelines [201] are shown in Figure 11. All participants were classed as omnivores. Sixty nine percent (n=11) reported to consume two or more servings fruit each day, while 50% (n=8) reported to consume three or more servings of vegetables each day. Sixty eight percent (n=11) of the participants reported that they ate more than 6 servings of bread, cereal, rice and pasta. Fifty six percent (n=9) of the participants consumed more than 3 servings of milk and milk products each day. The majority of the participants drank milk (88%, n=14); 44% (n=8) homogenised milk, 38% (n=6) reduced fat milk and 18% (n=1) super trim milk.

Figure 11 Percentage of participants that reported consumption of food groups per day in accordance with the servings advised by the nutrition guidelines for adolescents

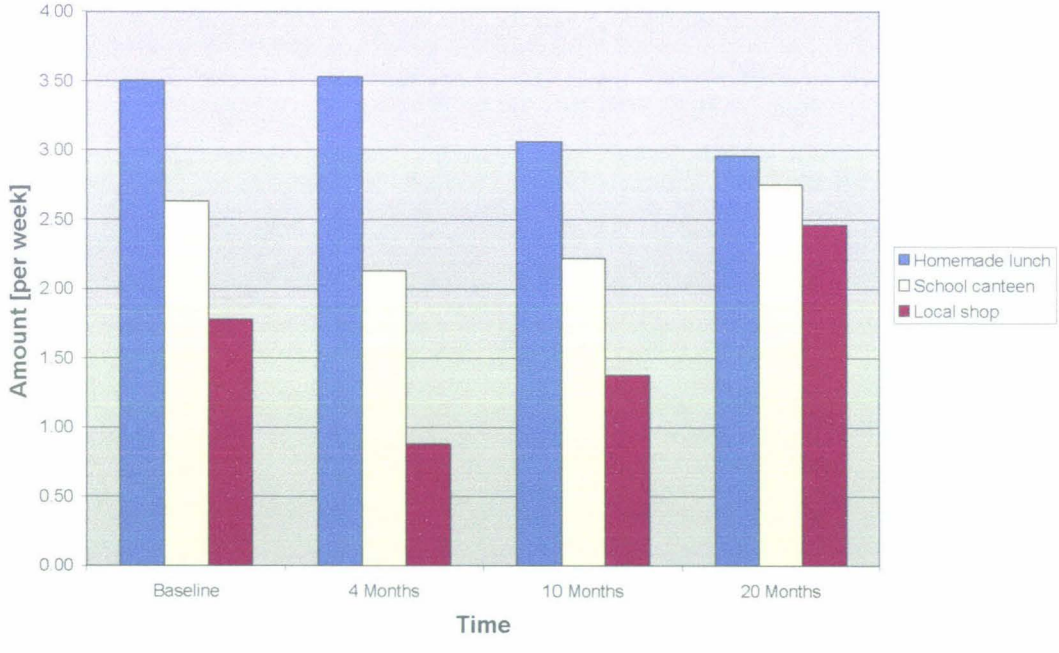


Nineteen four percent (n=15) of the participants used butter or margarine on bread or crackers. But 69% reported that they used polyunsaturated margarine, 19% (n=3) reported that they used monounsaturated margarine, and only 13% (n=2) reported that they used butter. Thirty one percent of the participants (n=5) reported that they consumed between 1 to 2 helpings of meat, chicken, fish, seafood, eggs, dried beans, baked beans, nuts and lentils each day.

At baseline and during the intervention 56% (n=9) of the participants consumed breakfast, 4 months post intervention 88% (n=14) of the participants consumed breakfast and 10 months post intervention 67% (n=8) of the participants consumed breakfast. There was no significant difference for breakfast consumption with a balanced MANOVA (p=0.20). The one sample t-test on the differences for breakfast consumption showed that there was no significant difference (CI=95%; -0.53, 0.20: p=0.34).

Most participants bought their food while at school: 81% (n=13) at baseline, 94% (n=14) at 6 months, 88% (n=14) at 10 months, and 92% (n=11) at 16 months. Figure 12 shows the average amount of food per week made at home, bought from the local shop, and bought from the school canteen at baseline, 6 months, 10 months and 16 months.

Figure 12 Origin of the food eaten at school



The average amount of times the participants visited the local shops, to buy lunch, over the whole study period was 1.8 (±1.2), ranging from 0.25 to 4.3 times a week. There was no significant difference for the amount of times participants visited the local shops with a balanced MANOVA (p=0.19). A one sample t-test on the differences for the amount of

times participants visited the local shops showed that there was no significant difference (CI=95%; -2.53, 1.11: p=0.41).

The mean amount of visits to the school canteen was 2.5 (±1.9), ranging from 0.4 to 7 times a week. There was no significant difference for the amount of times participants visited the school canteen with a balanced MANOVA (p=0.80). A one sample t-test on the differences for the amount of times participants visited the school canteen showed that there was no significant difference (CI=95%; -1.46, 1.23: p=0.78).
There was also no significant difference for the consumption of home made lunches with a balanced MANOVA (p=0.74). A one sample t-test on the differences for home made lunches showed that there was no significant difference (CI=95%; -0.61, 1.78: p=0.31).

At baseline 25% (n=4) of the participants reported to eat takeaways 1-3 times a month, 38% (n=6) reported to eat takeaways 1-2 times a week, 31% (n=5) reported to eat takeaways 3-4 times a week and 6% (n=1) reported to eat takeaways daily. The mean consumption of takeaways at baseline is 2.0 (±1.8) ranging from 0.05 to 7 times per week. At 6 months mean takeaway consumption was 1.3 (±1.5) ranging from 0 to 5.5 times per week. Four and 10 months post intervention the takeaway consumption was respectively 1.4 (±1.2) ranging from 0.05 to 3.5 times per week, and 2.0 (±1.7) ranging from 0 to 5.5 times per week. There was no significant difference for takeaway consumption with a balanced MANOVA (p=0.42). A one sample t-test on the differences for takeaway consumption showed that there was no significant difference (CI=95%; -0.13, 0.20: p=0.67).

5.8.3 FFQ

At baseline the participants completed a qualitative self-administered FFQ. At least 31% of the participants (n=5) poorly understood the FFQ, e.g. they reported that they consumed two or more servings a day of *all* the listed mixed dishes. Surprisingly, 17% (n=2) of the males reported that their child was fed breast milk daily in the last 4 weeks.

The data provided by the participants was unreliable. Therefore, this data was *not* used for further analysis. After consulting Sue Sharp from Auckland University the researchers understand that the interviewers from the Child Nutrition Survey had similar problems. However, this was only revealed at the end of this study.

5.8.4 Three-day diet and physical activity diary

Four participants returned a food diary after 6 months. The quality of the returned food and activity diaries was poor (none of the participants managed to fill in the portion size and the method of food preparation). After seeking advice from experts at Massey University the researcher changed the methodology of dietary assessment to 24-hour recalls.

5.8.5 24 Hour recalls

No significant change was seen in energy and macronutrient intakes, assessed with a 24-hour recall, at the end of the intervention and post intervention. Table 19 shows the energy and macronutrient intakes (mean and standard deviation) of the participants at the end of the intervention, 4 and 10 months post intervention.

Sixteen percent (n=7) of the 24-hour recalls was checked by an independent nutritionist. The mean error was 8.6 (±3.7) for the energy intake (kJ).

During the study period some of the subjects ate excessively. E.g. the mother of subject eight worked evening shifts at a pizza parlour, and brought home leftovers each night. Every night the mother woke the subject to partake in a shared meal of leftovers. This occurred after the consumption of a substantial dinner with other members of the family. Therefore the energy and nutritional intake of this subject is exceptionally high.

Table 19 Energy and macronutrient intakes of the participants (mean, ±SD)

	6 Months (end intervention)	10 Months (4 Months post intervention)	16 Months (10 Months post intervention)
	n=16	n=16	n=12
Energy [MJ]	11.8 (±5.7)	14.0 (±4.7)	15.0 (±10.5)
Carbohydrates [g]	307 (±103)	375 (±126)	468 (±366)
Protein [g]	113 (±69)	121 (±39)	122 (±98)
Total fat [g]	128 (±85)	154 (±80)	138 (±80)
Polyunsaturated fat [g]	13 (±8)	15 (±11)	17 (±17)
Monounsaturated fat [g]	46 (±33)	56 (±31)	49 (±29)
Saturated fat [g]	56 (±39)	67 (±36)	57 (±26)

Standard recommended dietary intakes (RDI), the recommended dietary allowances 10th edition (US RDA) and the dietary reference values for food energy and nutrients for the United Kingdom (DRV) are given in Table 20 [73].

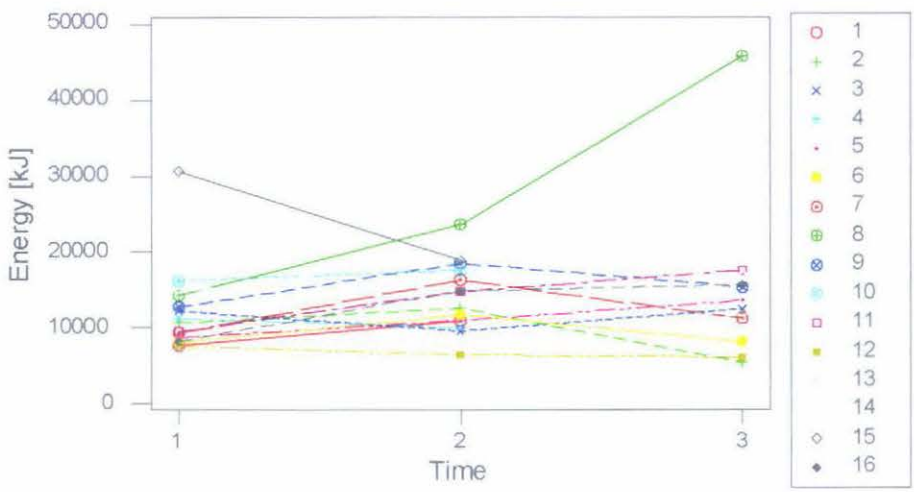
Table 20 Standard RDI's, RDA's, and DRV's

	RDI*			RDA♦			DRV♦		
	Male	Female	%	Male	Female	%	Male	Female	%
E (MJ)	9.2-11.8	8.1-9.8		12.5	9.2		11.51	8.83	
Pro (g)	42-60	44-55	12-14	59	44	12-14	55.2	45.0	12-14
CHO(g)			50-55			50-55			50-55
Fat (g)			30-35			30-35			30-35

* = Age (years); 12-15, ♦ = age (years); 11-14

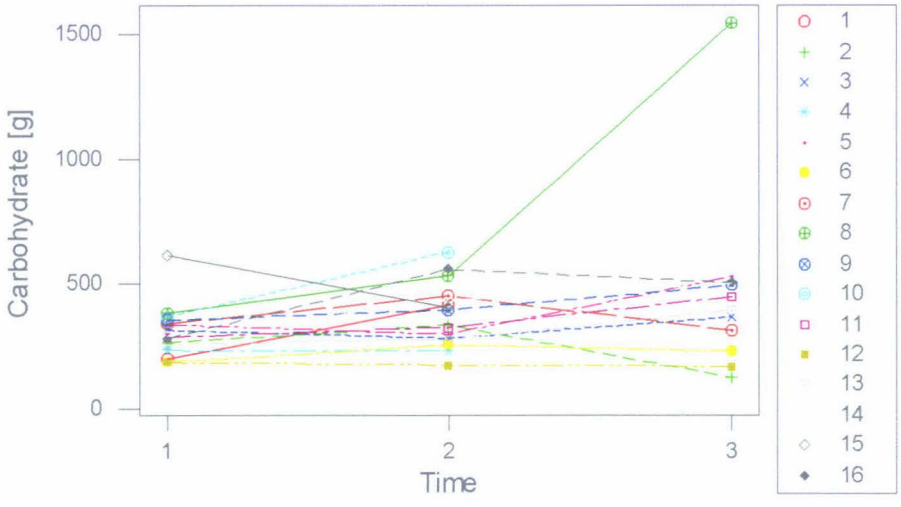
The mean energy intake at the end of the intervention is 11.795 kJ (±5.747) ranging from 7.144 kJ to 30.604 kJ. The mean energy intake at 4 months post intervention is 14.036 (±4.735) ranging from 6.438 kJ to 23.627 kJ and the mean energy intake at 10 months post intervention is 14.966 (±10.461) ranging from 3.020 kJ to 5.384kJ. There was no significant difference for energy intake with a balanced MANOVA (p=0.47). A one sample t-test on the differences for energy intake showed that there was no significant difference (CI=95%; -10541, 1126: p=0.10). Figure 13 shows the change in the energy intakes of the participants at the end of the intervention (1), 4 months past intervention (2) and 10 months post intervention (3).

Figure 13 Energy intakes of the participants at the end of the intervention (1), 4 months (2) and 10 months (3) post intervention



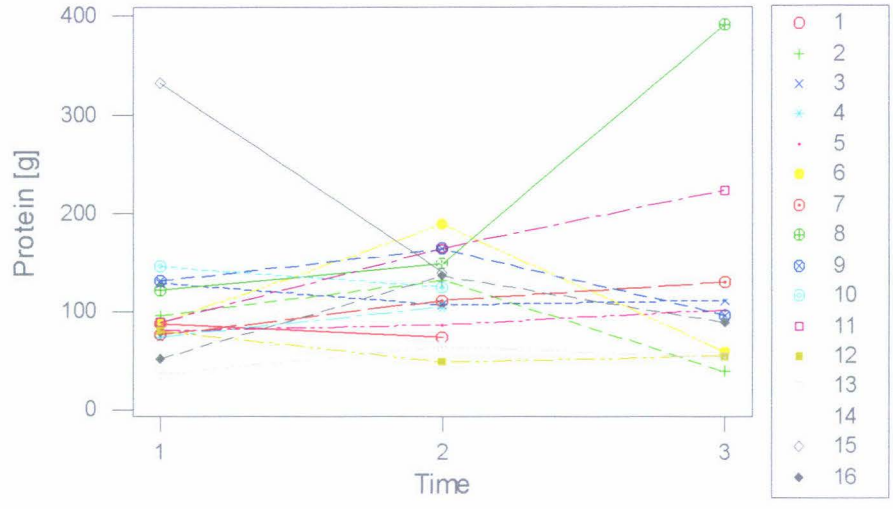
The mean carbohydrate intake at the end of the intervention is 307 (±103) ranging from 186 gram to 613 gram. The mean carbohydrate intake at 4 months post intervention is 375 (±126) ranging from 174 gram to 629 gram and the mean carbohydrate intake at 10 months post intervention is 468 (±366) ranging from 106 gram to 124 gram. There was no significant difference for carbohydrate intake with a balanced MANOVA (p=0.15). A one sample t-test on the differences for carbohydrate intake showed that there was no significant difference (CI=95%; -386, 32: p=0.09). Figure 14 shows the change in carbohydrate intake of the participants at the end of the intervention (1), 4 months post intervention (2) and 10 months post intervention (3).

Figure 14 Carbohydrate intakes of the participants at the end of the intervention (1), 4 months (2) and 10 months (3) post intervention



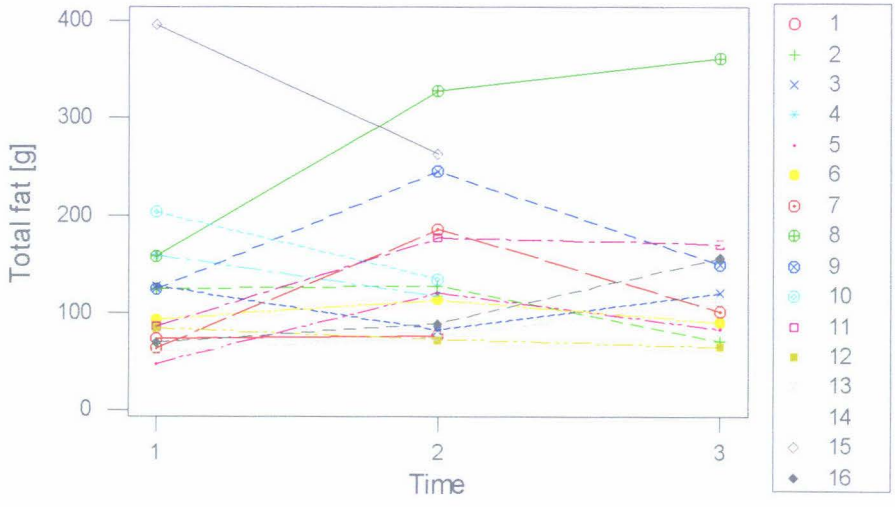
The mean protein intake at the end of the intervention is 113 (±69) ranging from 36 gram to 332 gram. The mean protein intake at 4 months post intervention is 121 (±39) ranging from 49 gram to 189 gram and the mean protein intake at 10 months post intervention is 122 (±98) ranging from 28 gram to 39 gram. There was no significant difference for protein intake with a balanced MANOVA (p=0.92). A one sample t-test on the differences for protein intake showed that there was no significant difference (CI=95%; -86, 35: p=0.37). Figure 15 shows the change in protein intake of the participants at the end of the intervention (1), 4 months post intervention (2) and 10 months post intervention (3).

Figure 15 Protein intakes of the participants at the end of the intervention (1), 4 months (2) and 10 months (3) post intervention



The mean total fat intake at the end of the intervention is 128 (±85) ranging from 48 gram to 397 gram. The mean total fat intake at 4 months post intervention is 154 (±80) ranging from 73 gram to 328 gram and the mean total fat intake at 10 months post intervention is 138 (±80) ranging from 23 gram to 65 gram. There was no significant difference for total fat intake with a balanced MANOVA (p=0.67). A one sample t-test on the differences for total fat intake showed that there was no significant difference (CI=95%; -79, 7: p=0.09). Figure 16 shows the change in total fat intake of the participants at the end of the intervention (1), 4 months post intervention (2) and 10 months post intervention (3).

Figure 16 Total fat intakes of the participants at the end of the intervention (1), 4 months (2) and 10 months (3) post intervention



6 Discussion

This study "Games Galore" was designed to investigate:

- The effect of the physical activity intervention on the development of an ongoing self motivated participation in physical activity.
- The effect of the nutrition education intervention on the development of healthy eating habits.
- To determine whether this feasibility study had a positive effect on anthropometric indicators.
- To determine whether this feasibility study is effective and/or feasible for the treatment of overweight or obese children of this age.

This study shows that there was *no* beneficial effect of the participation of the feasibility study "Games Galore" on physical activity patterns, healthy eating habits and anthropometric indicators. There was *no* positive difference between baseline, during the intervention, and post intervention.

This age-group (10-14) was chosen as previous studies have shown that physical activity habits, dietary habits and food preferences which affect energy consumption and nutrient intake are generally developed during adolescence [73]. Research suggests that adolescents respond with greater relative weight loss and better maintenance of weight loss to nutrition education and physical activity interventions, although there was still considerable relapse [197]. Treatment of paediatric obesity can take advantage of growth and increases in lean body mass as well as weight change [189, 197, 204, 205]. Instead of shrinking adipose cells, treatment at an early age prevents the development of excess adipose cells. Therefore this study targeted 10 to 14 year old overweight and obese children.

6.1 Physical characteristics and demographic data

All the participants in the "Games Galore" study attended schools from a lower socio-economic area and were asked to participate. The results therefore can not be generalised

to other New Zealand children. The Public Health Nurse, the teachers and the principals of the participating schools made potentially eligible participants aware of the programme and the children self-selected to participate. This caused a selection bias and the participants who volunteered could have been the ones who were already contemplating changing their physical activity and/or nutrition habits. Although it is likely that participants enrolled for different reasons, e.g. filling in time.

This feasibility study looked at the effect of the "Games Galore" on the development of an ongoing self-motivated participation in physical activity and the effect on the development of healthy eating habits. As the children were required to participate in a sports programme for six months they had to like playing games. Also, the children and parents/caregivers were required to participate in nutrition education sessions for a similar amount of time, therefore they had to be willing to gain nutrition information.

The study group was selected from the intermediate and the full primary school; the only two schools willing to participate and near the Unitec campus (circa 20 minutes). The latter made it easier to pick up and return the participants.

Both male and female students were included. Currently, obesity has been shown to be a concern in both adult males and adult females in New Zealand [206]. Also, a study of Auckland based school children [6] indicates that obesity rates are high in both boys and girls.

In the "Games Galore" feasibility study the majority of the participants were male (75%). This distribution of male and female agrees with research that shows that males are approximately 15-20% more active than females [207]. The 1998 New Zealand Physical Activity Survey [208] found significantly more boys (74%) achieved the physical activity guidelines compared to girls (64%). Also, the Life in New Zealand survey [209] observed higher levels of male participation in both leisure-time physical activity and vigorous activity, than female participants. Similar results of participation in sport and physical activity by five to fourteen year olds were seen in a recent Australian survey [210, 211].

Most participants in the feasibility study identified themselves as Pacific / Maori decent. Pacific and Maori carry a heavier burden of obesity related diseases e.g. heart disease and NIDDM than do other New Zealanders [212]. Genetic factors, diet and physical activity patterns are likely to play a role. However little is known of these risk factors in Pacific and Maori children in New Zealand.

6.2 Medical and family history

One of the determinants for overweight and obesity is the participants' familial susceptibility to weight gain (e.g. number of overweight parents). Research shows that obese parents more frequently have obese children. If both parents are obese there is an 80% probability that their children are obese. The probability declines to 40% if there is one obese parent [60]. The "Games Galore" feasibility study did not control for familial overweight and obesity.

Some medications are known to influence weight gain / loss. The main medication participants of the "Games Galore" feasibility study were using was steroids (inhaled) for the treatment of asthma (25%). All the participants who used asthma medication had mild asthma and most were taking it when necessary. Currently there is no strong evidence to suggest that modern pharmacological asthma treatment contribute to the development of obesity in either men or women. Obesity may be an independent risk factor for asthma since there is a significant higher risk for self-reported asthma medication in woman, and an almost significant relationship in men even after control for BMI and other related co-variables [213]. There is no data about the effects of asthma medication in children.
The researchers were unsure what medication the participant who had undergone cardiac surgery took. It is likely that the drugs in relation to his surgery had side effects e.g. weight gain.

6.3 Withdrawal and compliance

The retention of subjects in a long-term nutrition and activity intervention can be difficult. In this study there was a high number of withdrawals (27%) after the first two

weeks. No intention to treat analysis could be performed because participants did not attend the several pre-arranged appointments.

Studies with higher levels of support [189, 214] reported slightly lower withdrawal rates (20%). The children from these studies were recruited from a largely white, middle-class, two-parent families and the participants received financial incentives for participating.

In order to test the feasibility of the "Games Galore" study compliance must be monitored. In this study the researcher recorded the compliance by ticking an attendance sheet at the beginning of every physical activity and nutrition education session. Maintaining compliance is difficult in an intervention of this length. Compliance in the children who attended the physical activity sessions was high (81%), however the compliance in the children who attended the nutrition education sessions was poor (13%). Because of the latter the methodology had to be changed. The introduction of nutrition topics before and after every physical activity session (instead of an evening session) was important for maintaining compliance. Limitations of this change were limited time and a limited attention span from the participants (straight after school). Also, the new nutrition education sessions did not influence parental attitudes. For example the participants and their parents/caregivers could not experience the cooking and tasting sessions. The researcher does recognise that this method does not influence the family (environment) of the participants. However, it was important to maintain compliance in the nutritional education part of the intervention.

6.4 Loss to follow up

From the 22 participants enrolled in the "Games Galore" feasibility study 55% (n=10) were lost to follow up. Most of the available studies involving physical activity and nutrition education did not report lost to follow up [180, 192-195]. Reybrouck *et al.* [191] reported that follow-up at eight months was available for only 4 children (equals 36%) of the diet group and 8 (equals 57%) in the diet/exercise group. In contrast, Epstein *et al.* [189] reported only a 20% lost to follow up after 10 years. This low number might be due to the payments participants received for participation in follow-up (US$ 100 for

anthropometric measurements taken at the researchers' office, US$ 50 for doctor report and US$ 25 for self-report). The "Games Galore" feasibility study did not financially reward participants for participation.

6.5 Anthropometric indicators

It is widely accepted that obesity results from the imbalance between declining energy expenditure due to physical inactivity and high energy in the diet (excess calories whether from sugar, starches or fat). Increasing physical activity, plus reducing the intake of foods high in fat and foods and drinks high in sugars is likely to prevent unhealthy weight gain. Although taking these simple goals to concrete action requires major social and environmental changes in order to effectively promote and support healthier choices at the individual level. The feasibility study "Games Galore" tried to increase the physical activity by the participation in a games programme and decrease the intake of high-energy dense foods by participation in nutrition education sessions. However, at various measurement points the anthropometric indicators taken during and post the "Games Galore" intervention showed no significant positive affect.

To date there is confusion about the use of several assessment tools to classify paediatric obesity [3]. However this discussion is primarily about the defining of standardised cut-off points. All participants of the "Games Galore" feasibility study are classed by BMI as obese according to the cut-off points for children and adolescents by both Cole *et al.* [3] and Taylor *et al.* [120]. The "Games Galore" feasibility study showed no positive change in BMI from baseline to 10 months post intervention.

Another anthropometric indicator, waist circumference, is found to be an effective index of central adiposity in children and adolescents, particularly in girls. Recent research [215] showed that during the last 10-20 years the standard deviation scores for waist circumference increased much more than for BMI. This suggests a steeper rise in abdominal obesity than whole body obesity based on weight and height. Waist circumference probable reflects both visceral and subcutaneous fat and hence total fatness. Taylor *et al.* [110] also showed that waist circumference was a useful tool to

assess truncal adiposity in children and adolescents. They suggested cut-off points for identifying high trunk fat mass and waist circumference [110]. All participants of the "Games Galore" feasibility study had waist circumferences higher than these suggested levels. The study also showed no significant change in waist circumference from baseline to 10 months post intervention.

6.6 Sedentary behaviour patterns

Electronic entertainment (e.g. watching television and playing computer games) takes a significant proportion of children's total leisure time [216]. The time spent on this kind of sedentary behaviour did not significantly change during the "Games Galore" feasibility study. On weekdays the participants watched on average 140 minutes of television a day and during the weekends the participants watched on average 191 minutes of television a day. While in 2002 Nielsen Media Research reported that New Zealand 5 to 14 year old children watched on average only 125 minutes of television each day [217].

The results of the feasibility study "Games Galore" agree with those reported by other studies. A substantial number of epidemiological studies have examined the association between television viewing and childhood obesity. In general, these studies consistently have found relatively weak, positive associations [218]. Dietz and Gortmaker [46] examined data from more than 13,500 children and adolescents in the National Health Examination Surveys. They reported statistically significant associations between hours per day of watching television and prevalence of obesity. Similar results have been reported subsequently from several other samples. For example a cross-sectional national sample of 2,372 third and fourth graders [219], 2,379 nine and ten year old black and white girls participating in the National Heart, Lung, and Blood Institute Growth and Health Study [220], 4,063 eight to sixteen year old children in Mexico [221], and 746 ten to nineteen year old children and adolescents participating in a four year longitudinal study [222]. In contrast, several other studies have found no significant association between television viewing and obesity [167, 223-226] or mixed results [227-229].

Epstein *et al.* [230] have performed an experimental study of reducing sedentary behaviour as part of their intensive family-based weight loss programme. After one year, obese children who were reinforced for decreasing sedentary activity lost significantly more weight than did children reinforced for increasing physical activity or those reinforced to both. After two years [231], all groups demonstrated decreases in percent overweight and body fatness although differences between the two approaches were not statistically significant. However, the results of these studies are somewhat inconsistent and do not test the effects of reducing sedentary behaviours alone. These findings still lend support to the argument that reducing television viewing and other sedentary behaviours, as part of a comprehensive weight control program, can help to promote weight loss in obese children. A study of Gortmaker *et al.* [232] showed similar results. The feasibility study "Games Galore" did not have reducing sedentary behaviour patterns as an outcome. This might be considered if a similar study were to be repeated.

Three potential mechanisms have been suggested to link television viewing and obesity:

1. Reduced energy expenditure from television viewing displacing physical activity. Studies found small, but statistically significant, inverse associations between reports of television viewing time and physical activity [167, 233] and fitness [225].
2. Also, watching television might decrease metabolic rate. Klesges et al found that resting metabolic rates in eight to twelve year old children were significantly greater when they were asked to sit still with the television off than watching television [234]. While others [235, 236] found no significant difference.
3. Another potential mechanism of television viewing is the increased dietary energy intake from eating during viewing or from the effects of food advertising. Exposure to food advertisements tends to emphasise high-calorie foods and may produce incorrect nutritional beliefs [237]. Although marketing to children has been seen as acceptable only in the past decade or so, corporations have seized the advantage quickly. In 1999 they spent approximately US$12 billion on advertising in the US [237]. Part of the philosophy is not to appeal directly to parents, but to teach children to influence their parents purchases. The food industry links food with entertainment, especially with movie and cartoon characters. Brand-name foods and drinks appear on toy cars and

helicopters and fast-food chains issue "educational" card games. To date, in a report on diet and health, the WHO [37] is challenging the food industry. The WHO criticises the food and drink industry for "heavy marketing practices of energy-dense, micronutrient-poor foods". The report claims that children's exposure to such marketing should be limited, but does not specify who should do this and how. Currently, the New Zealand Ministry of Health is developing a new Public Health Bill to replace the Health Act 1956 and associated legislation. A discussion paper to guide the process [238] states that issues to do with the advertising and promotion of food (especially for children) will be considered. This new bill aims to help people make healthier choices through controlling access to products and advertising.

Thirty seven percent of the participants of the "Games Galore" feasibility study reported spending time behind the computer. To date, no study has investigated the association between playing computer games and childhood obesity. However, studies reporting on the causes of childhood obesity [216] mention an increase in electronic entertainment. This involves playing computer games *and* television viewing. It is likely that playing computer games and television viewing have similar links with childhood obesity. However, with an increasing number of children spending (more) time behind computers more research is needed to understand the effects of playing computer games on overweight and obesity.

6.7 Activity patterns

The high rate of compliance in the children who attended the physical activity sessions might be due to the fact that participants were picked up and returned to their schools. If they did not attend two sessions in a row the researchers would inform the principal. The principal then approached the participants and questioned them about their absence.

To date, most New Zealand studies investigating the activity patterns of children have used questionnaire methodologies using either self or proxy reporting [208, 209, 239]. A recent proxy report survey conducted by the Hillary Commission found that 73% of 9-12 year olds meet the minimum guideline that subjects be active for 2.5 hours per week

[208]. Those findings are consistent with international studies using questionnaires, which report 60-70% of children undertake appropriate amounts of physical activity [240]. However, a New Zealand study by Calvert *et al.* [241] using more reliable physiological techniques reported that only 53% of 10-13 year olds met the Ministry of Health's guidelines for participation in physical activity in order to gain health benefits. There were no assessments of fitness incorporated in the "Games Galore" feasibility study. The researchers have to rely solely on self-reported physical activity. And it is generally understood that questionnaires tend to overestimate the actual amount of time participants are active [242]. Therefore, it is difficult to determine if the participants attained the ministry of Health's physical activity guidelines [183]. These guidelines recommend that children accumulate a minimum of 30 minutes of moderate intensity physical activity on most, preferably all, days of the week.

On average the participants of the feasibility study reported 34 minutes of moderate intensity physical activity outside school hours per day. However, it is likely that some participants overestimated their amount of physical activity. Also, circa 40% of the participants reported physical activity levels far below the recommended levels.

Most studies that have examined the effects of physical activity on adiposity in children include programs that typically involve aerobic types of activities but often are used in conjunction with other components, such as strengthening or muscular-type training, behavioral techniques, and diet therapy. Childhood activity is often intermittent and sporadic,[243] thus children will not participate in prolonged exercise without rest periods. However, if given the opportunity, young children will perform relatively large volumes of intermittent, non-structured physical activity [243, 244]. Epstein *et al.* [245] examined the efficacy of three different types of exercise treatment programs for obese children. They found no differences in the weight maintenance of obese children participation in aerobic exercise, calisthenics, and lifestyle during the first year of treatment. During the second year follow-up, however, the lifestyle exercise group maintained the weight loss, whereas the other subjects gained significant amounts of weight. Those results agree with the results from the "Games Galore" feasibility study

where participants reported an increase in their intermittent, non-structured physical activity but no change in BMI or other anthropometric indicators.

Although the effect of physical activity on body composition has been a major area of research in adults, there have been fewer well-controlled physical activity intervention studies in children. Results from physical activity intervention studies are controversial, with some studies showing beneficial changes in body composition [230, 246-248] and others showing no effects [249, 250]. The results of the "Games Galore" programme agree with both outcomes. The participants reported a significant difference for outdoor play in the weekends. Although the one sample t-test on the differences only confirm a difference at four months and at the end of the intervention. There was however, *no* significant difference for either the reported outdoor play during the weekends or the reported involvement in physical activities outside school hours.

Walking and biking to school can increase physical activity among children. Unfortunately motor-vehicle traffic and other factors can make these activities difficult. In our study most participants (69%) reported walking to school. This amount is high compared to the 2000 New Zealand Household Travel survey [251]. This survey reported that one third of the children reported walking or biking to school. The same study revealed that 75% of the trips in New Zealand is by motor vehicle [251], and that vehicle-kilometers traveled more than doubled between 1979 and 1998 while the average distance traveled by motorcycle fell by 33 percent over the same period.

Common barriers [252] for walking and cycling are long distances, weather and traffic danger. Although, Auckland traffic is dangerous during term time, especially during peak traffic (from 15.00 to 18.00 hours) [251], 69% of the "Games Galore" participants still walked to and from school. Therefore, other barriers for example distance to school and weather might not be applicable in this particular group.

6.8 Nutritional status participants

Traditionally dietary treatment of paediatric overweight focuses on the implementation of a low-fat, energy-restricted diet. However, research demonstrates that this approach is fraught with potential problems and has not resulted in any demonstrable success. For example, a multicenter study [253] using a nutrition intervention with more than 1300 children was deemed a failure when the dropout rate exceeded 90%. Therefore, the "Games Galore" nutrition sessions aimed to focus on the family and aimed to improve dietary habits by using consciously and systematically motivational communication strategies in combination with educational strategies and behavioural change strategies to influence nutrition behaviour. However, this strategy also resulted in a poor compliance to the fortnightly nutrition education sessions. Signing a contract agreeing to attend at least 75% of the nutrition education sessions did not appear to make any difference.

The researchers changed the programme and introduced a nutrition education topic before and after every physical activity session. This decision was backed by several studies [254] that showed that parental power over food choice might be displaced by the effects of advertising and peer pressure during adolescence. The age, at which these power shifts occur appears to be diminishing, with 10 year olds in the USA now reported to make approximately 250 food purchases a year without parental control.

The main focus of the nutrition education sessions was to improve the nutritional quality of the diet. The results of the "Games Galore" feasibility study showed that the participants consumed less than the minimum recommendations for *all* mean number of servings per day. The diets of the participants were inconsistent with the recommendations in the Food Guide Pyramid, and they do not conform to the Dietary Guidelines for Healthy Adolescents [73]. Those results agree with the results of Munoz *et al.* [255] Munoz examined the food intakes of US children and adolescents compared with recommendations. They found that the mean number of servings per day was less than the minimum recommendations for all food groups, except for the dairy group, for children aged 2 to 11 years.

It is widely accepted that obesity results from the imbalance between declining energy expenditure due to physical inactivity and high energy in the diet (excess energy whether from sugar, starches or fat). Increasing physical activity, plus reducing intakes of foods high in fat and foods and drinks high in sugars is likely to prevent unhealthy weight gain. In the "Games Galore" feasibility study 24-hour recalls were used to measure energy intake of the participants. Weight, height and activity factors were used to calculate energy expenditure (in FoodWorks) of the participants. The BMR was estimated from weight by using equations published by Schofield *et al.* [256] Figure 17 shows the mean energy expenditure of the participants compared with the mean energy intake at 6, 10 and 16 months. Although, these results do *not* agree with the results of previous interventions involving combined physical activity and dietary education [180, 189, 191-195]. These results *do* agree with studies suggesting that reduced energy expenditure may be involved in the cause of childhood obesity [257].

Figure 17 The mean energy expenditure (E exp) compared with the mean energy intake (E int)

One of the factors influencing energy expenditure is BMR. Roberts *et al.* [258] examined the relationship between energy expenditure and weight gain in children of underweight and overweight mothers from birth to one year of age. Energy expenditure at three months of age was 20.7% lower in infants who later became overweight. This result

suggested that lowered energy expenditure contributed to alter weight gain in infants who became overweight.

However, studies by Davies *et al.* [259] and Stunkard *et al.* [260] could not reproduce this finding. Also, other cross-sectional studies in pre-pubertal children [261] and adolescents [262] do not support the concept that reduced energy expenditure was related to obesity.

A major limitation for most studies that have examined the role of energy expenditure in the cause of obesity is their cross-sectional design. Because growth of individual components of body composition is likely to be a continuous process, longitudinal studies are more efficient to evaluate the rate of body fat change during the growing process. Two longitudinal studies [263, 264] suggest that energy expenditure is important in the development of overweight and obesity.

The other factor that influences energy expenditure is physical activity levels. As mentioned before (paragraph 6.7) physical activity plays a significant role in the cause of childhood obesity. In the Framingham Children's Study,[265] children with low activity levels gained substantially more subcutaneous fat than did more active children. Several other studies [243, 244] suggest that the time devoted to physical activity is important for energy regulation and obesity. The results of the "Games Galore" feasibility study show that the activity levels of the participants were too low compared with their energy intake. Therefore, if this study were to be repeated more methods should be explored to increase the participant's levels of physical activity.

The "Games Galore" feasibility study also showed no significant difference in the consumption of foodstuffs over which participants had purchasing power (e.g. take-aways, snacks and beverages). Those results show that the eagerness of children to take on responsibility for food choice is not necessary matched with their ability, through knowledge or motivation, to make healthy food decisions. Therefore, if this study were to be repeated more efforts and strategies should be explored to involve the

parents/caregivers. The influence of the parents should be assessed at all stages of the 'control hand over' period to assist the development of intervention programmes.

6.9 Validation of nutritional intake

The nutritional assessment methods to assess nutritional status during this study were:

- Qualitative dietary habit questionnaire
- Diet and activity questionnaire
- FFQ
- 3 day diet and physical activity diary
- 24-hour recall

The "Games Galore" feasibility study is a small-scale study (n=16). Therefore the ability of the technique to measure the intake of each individual with adequate precision is important. However, all the above assessment methods are lacking this precision and have major flaws. Poor precision is a function of the variability of food intake. The chosen assessment methods recorded nutrient intake and not actual intake of the participants. Every day individuals make choices that vary widely, both in terms of foods eaten and the daily pattern of meals and snacks. Foods chosen vary in kind and quantity from day to day, week to week and season to season. Consequently, the energy and nutrient intakes also vary widely.

Also, the above nutrition assessment methods do not control for the validity of the data. Participants were likely to provide answers to please the researchers. For cost reasons the "Games Galore" feasibility study did not include nutrient biomarkers or direct calorimetry to check if the by the participants provided answers are accurate.
Several studies suggest [266, 267] a widespread and substantial bias to the under-estimation of food intake. Also, obese people are known to under-estimate their energy intake and probably their intake of high-fat foods [196]. The dietary data is therefore compared with expected energy expenditure (Figure 17).

Another limitation of nutrition assessment methods is the error in quantifying portion sizes. Until portion size estimation is improved, quantification of food and nutrient intakes will include a largely unknown component of error. Research shows [268] that between 1977 and 1996, food portion sizes from individuals aged two years and older living in the USA increased both inside and outside the home. For example, over this period the energy intake and portion size of salty snacks increased by 93 kcal, soft drinks by 49 kcal, hamburgers by 97 kcal, French fries by 68 kcal, and Mexican food by 133 kcal. Currently there is no data available about the portion sizes of New Zealand children.

The quality of the data is further reduced by the currently available food-composition databases (including FoodWorks) which are missing many commonly available foods. Therefore assumptions had to be made and validity has to be questioned. There is a need to upgrade the quality, scope, and availability of the food-composition databases (including incorporation of algorithms for estimating nutrient bioavailability to permit adjustment of total intake to reflect available intake).

6.9.1 Qualitative dietary habit questionnaire and diet and activity questionnaire

Questionnaires are known to be useful tools for assessing individuals dietary and activity behaviour. Although, the precision of the individual level of questionnaires is usually excellent, a dietary tool is only as useful as the validity of it. In the case of the questionnaires it is important to compare the method with one or more reference methods that are assumed to have better validity. In this study a 24-hour recall was used as the validation comparison. However, some major sources of error in the questionnaires; e.g. perception of a serving and dishonesty are likely to be duplicated in the 24-hour recall. However, without using nutrient biomarkers or direct calorimetry this is an accepted method for validation.

6.9.2 Qualitative FFQ

The self-administered qualitative FFQ are known to be useful tools for classifying individuals by rank, identifying groups at extremes of intake, and monitoring trends in

dietary patterns over time. Although the precision on the individual level of qualitative FFQ is poor the advantages of low respondent burden and ease of administration make the FFQ an attractive option for collecting dietary data on the habitual or usual consumption. Therefore, the qualitative FFQ developed for the Child Nutrition Survey seemed an excellent option for the slow responding participants of the "Games Galore" feasibility study. However, the major disadvantages (dependence on memory and ability to do the exceedingly complex cognitive task of converting very variable dietary patterns into frequencies of consumption over a usually extended time period) were a problem for every "Games Galore" participant (n=16). Therefore, the dietary intake was hugely overestimated and the questionnaires were useless. For future research it is advisable to have trained interviewers apply the FFQ.

6.9.3 3-Day diet and physical activity diary and 24-hour recall

There were problems with the 3-day diet and physical activity diary. Participants neither had the knowledge nor the motivation to fill in their records accurately or to fill them in at all. Therefore the researcher changed the dietary assessment from a 3-day diet and physical activity diary to a 24-hour recall. There is experimental evidence that self-monitoring results in greater short term weight losses [269]. By changing the dietary assessment method to 24-hour recalls this benefit was lost. Therefore, participants own understanding about their nutrition behaviour did not change because they did not monitor their own nutrient intake during the "Games Galore" programme.

A major advantage of the 24-hour recall is the minimal burden on the participants (15-30 minutes). Therefore, this assessment method was ideal for the slow responding participants of the "Games Galore" feasibility study. Also, 24-hour recalls can be repeated at intervals over time to improve precision at the individual level. However, the days must be carefully chosen to represent the different kinds of day in the participants' lifestyle. Some flaws are that this method depends on memory, the accuracy of the food composition data, and the estimated portion sizes.

6.10 Limitations of the study

The "Games Galore" feasibility study failed to include the parents/caregivers. Although the parents/caregivers were invited to the programme most failed to show (n=15). This might have reduced the chance of seeing a significant difference. The non significant results agree with the results of other studies [172, 204, 270, 271] who show that many participants found it impossible to avoid temptations at home when the change in weight was a result of the participants own efforts, e.g., self-control and exercise. Previous studies [172, 204, 270, 271] demonstrated the potential power of parental role modeling. The parents/caregivers' food preferences, the quantities and variety of foods in the home, the parents' eating behaviour, and the parents' physical activity behaviour, all establish an emotional environment in which obesity may or may not be discouraged. During the last measurements of the "Games Galore" feasibility study one of the parents was still waking their child, after returning from work (23.00 hours), to have a "feast" together.

The researchers failed to include the school environment. Both schools had a canteen/lunchroom located within the school hall. Both canteens were privately operated and had a variety of food available, including hot pies, filled rolls, hot noodles, club sandwiches, muesli bars, cookies, fresh fruit, drinks and chips. The researchers did not involve and cooperate with the canteen operator to introduce healthier food choices. Therefore failed to incorporate several steps of the social Learning Theory and the Stage of Change/Transtheoretical Model. For example the programme did not address the step "reciprocal determinism" (availability of healthy products).

However, the researchers made the principals of the participating schools aware of "The School Food Programme" of the National Heart Foundation [272]. This programme provides a framework for identifying and addressing a wide range of nutrition issues in schools. The programme incorporates achievement objectives from Health and Physical Education in the New Zealand Curriculum and Technology in the New Zealand Curriculum. It assists schools in implementing the curriculum and developing an environment that supports and reinforces health enhancing behaviours. The programme aims to improve the health of the community by; (1) influencing policy development that

promotes healthy food choices, (2) assisting students in developing the attitudes and skills, which will enable them to make food choices consistent with the Food and Nutrition Guidelines, (3) increasing student access to food which is nutritious, safe and sufficient in quantity. To date no action was taken by the participating schools.

Participants of the "Games Galore" feasibility study attended decile two rating schools. This indicated that participants came from lower socio-economic groups. The justification for using these schools was that they were the only schools willing to participate. However, this might also have reduced the chance of seeing a significant change. Previous studies have suggested that a better economic status is related to a better treatment outcome [152]. Those studies suggest that families with a higher socio-economic status may benefit more from nutrition and activity interventions than families from a lower socio-economic level. Therefore the results cannot be generalised to all New Zealand children, but only to children from low socio-economic areas and schools. The "Games Galore" feasibility study failed to include sufficient behavioural change components for this particular group. The incorporated components e.g. use of role models for the exercise sessions, exposure to healthy foods and new skills, providing of "healthy" alternatives, and the distribution of gifts, were not sufficient to create a significant change. The use of monetary incentives might be considered for future research to create behaviour change. Several studies [273] suggest that the cost of food relative to household income is a major impediment to healthy dietary choices. Financially disadvantaged households put rent or mortgage, transport and telephone cost ahead of food. These are paid for first, the remainder of their income being left for food and other expenses. In the United Kingdom, it has been claimed that unemployment beneficiaries require an average of 35% increase in weekly payments in order to consume a diet consistent with the recommendations of the National Advisory Committee on Nutrition Education [273]. Similar financial limitations have been found in Western Sydney [273] and are likely to be found in lower socio-economic area's in Auckland.

The high number of withdrawals during the first two weeks of the "Games Galore" feasibility study was a limitation in the ability to see a difference. Since the original

sample size was border-line it might be better for future interventions to over-select and have a run in period of four weeks. During this period participants who have dietary or activity restrictions that could interfere with participation are screened out of the intervention, as are children who do not want to participate. Participants who are overweight or obese but not motivated to change first need interventions specifically designed to shift them from earlier stages in the stages of change model to action stages. Currently the reason for the high withdrawal rate is not known but one can assume that the programme did not offer what they expected. For future interventions more communication about the participants and the researchers expectations should be incorporated in the programme.

The "Games Galore" feasibility study did not measure physical activity and sedentary behaviour accurately. The researchers had to rely on self reported physical activity patterns and self reported sedentary behaviour patterns. Several studies [242] suggested that participants overestimate their time spent at physical activities and underestimate their time spent at sedentary activities. Despite being the most common method for assessing physical activity, it was difficult for the researchers to determine if the participants attained the Ministry of Health's physical activity guidelines. Future research should consider the use of combined approaches (e.g. pedometer and/or accelerometers verses self reporting) to assess and interpret physical activity.

The nutrient assessment methods used in the "Games Galore" feasibility study were lacking precision and did not control for the validity of the data. The two major flaws of the assessment methods used were that they recorded nutrient intake and not actual intake of the participants and the participants were likely to provide answers to please the researchers. Also, used assessment methods do not control for the widespread and substantial bias to the under-estimation of food intake and the error in quantifying portion sizes. The use of a self-administered qualitative FFQ and 3-day diet and physical activity diary are not advised for future research. The self-administered FFQ could not be used for analysis because the dietary intake of the participants was hugely overestimated. And

the participants of the "Games Galore" feasibility study had neither the knowledge nor the motivation to fill in their records accurately or fill them in at all.

6.11 Recommendations

Some recommendations can be made based on the information from the literature review combined with the data from the study.

1. When introducing intervention programmes involving behaviour change in children it is essential to involve the parents/caregivers. To ensure that participants are motivated and stimulated to incorporate a "healthy" lifestyle family involvement is required. All parents/caregivers must agree in writing to attend all group nutrition education sessions. Also, all parents/caregivers have to agree to stimulate and motivate the participants during the intervention and in the home situation (not only by signing a form). They should be taught positive reinforcement techniques, praise and a point system, to help participants learn new behaviours and maintain these changes. Parents/caregivers should also modify the home environment e.g. reduce access to high-fat, low-nutrient-dense foods; shop differently; cook healthier foods; reduce television watching or computer time. Ideally, the whole household should be involved, therefore future research might consider to use monetary incentives and/or the participants' schools or church plus influential role-models e.g. the priest.

2. To implement programmes to treat adolescent overweight or obesity it is important to embrace a multi-factorial approach. Interventions should include as many predictors of childhood overweight as possible. For example, interventions should aim to moderate dietary intake, reduce sedentary behaviour and increase physical activity (games programme, walking busses). But also other predictors that influence the development of childhood obesity have to be acknowledged. For example: parenting styles and family characteristics (e.g. parents' dietary intake and activity patterns, nutritional knowledge, child feeding practices, and peer and sibling interactions). Also, characteristics of the school environment (e.g. structured periods for activity and the dietary quality of school lunches). Larger environmental factors, such as

parent work related demands (i.e. work hours and leisure time), ethnic background and the availability and accessibility of recreational facilities also influence child weight status and should be incorporated in the programme wherever possible.

3. When implementing a programme involving behaviour change monetary or other incentives could be considered. To date trials with a monetary incentive in relation to positive health outcomes are rare. Epstein *et al.* showed positive outcomes with the assistance of monetary incentives for follow-up. Several studies [274-278] showed that pricing strategies are effective to change behaviour. For example, monetary incentives are effective in vending machines [275, 276, 279] and for the promotion of healthful foods in canteens [274, 277, 278]. However, when implementing monetary incentives during an intervention, long-term implications have to be considered. For example, is it possible to implement the (monetary) incentive in a "normal" environment?

4. Finally if this study was to be repeated it would be important to:
   - Recruit a larger population sample with participants from all social classes and both genders. Also, include a pilot period to allow for any withdrawals from the study. The larger population sample would allow for greater numbers to be followed up after the intervention.
   - Incorporate an assessment method to test the stage of change of the participants during the pilot period.
   - Incorporate more assessment methods to test the physical activity of the participants.
   - Incorporate and develop dietary data-collection methods that are sensitive to different cultures, different ages, communication styles, and cognitive abilities. Consider different (less labour intensive) nutrient assessment methods e.g. collecting supermarket receipts to assess dietary intake. Also, research is needed to determine if underreporting is systematic and which foods and nutrients are most affected by underreporting.

- Introduce interventions to reduce sedentary behaviour patterns of the participants. For example placing of a timer on the television of the participants to reduce the television watching time.
- Introduce more effective interventions to increase the physical activity levels of the participants.
- Introduce more effective interventions to implement life long healthy eating habits.
- Cooperate with other organisations; e.g. National Heart Foundation (The School Food Programme), Hillary commission (Push and Play; green prescription, KiwiWalks) etc.

7 Conclusion

Paediatric obesity is increasing world-wide. This is a critical health concern because obesity in childhood increases the risk for adult obesity. This is concerning because of the well-established relationship between excess body weight in adult life and medical conditions such as type 2 diabetes, hypertension, and ostearthritis.

The current literature suggests that lifestyle interventions can improve the body composition of young people. If overweight and obese adolescents are encouraged to maintain their weight while their height growth continues, eat healthy diets and be more physically active, they may realise benefits in addition to improved body composition, including enhanced social interactions and well-being.

However, the results of treatment programmes are generally disappointing. Some interventions might be of limited value during the intervention in individuals who are overweight or obesity. But, there is a limited long-term success of treatment in childhood obesity. The results from the "Games Galore" feasibility study suggest that there was *no* significant change, for this particular group, for the participation in a physical activity programme and a nutrition education programme. In addition, no significant change was seen in any of the anthropometric indicators during and post intervention.

In order to carry out an intervention study involving a behaviour change, participants must be pre-contemplating to change their dietary habits and physical activity habits. Participants who are overweight or obese but not motivated to change first need interventions specifically designed to shift them from the earlier stages in the "stages of change" model to action stages. The high withdrawal rate and the low compliance rate of both participants and parents/caregivers during the nutrition education session's limits the ability to see significant differences during and post the "Games Galore" feasibility study. Family involvement is essential to ensure that participants are motivated and stimulated to incorporate the by the "Games Galore" advised lifestyle. Lack of parental support limits the results due to lack of stimulation and motivation for the participants to participate at the nutrition education sessions and incorporate a "healthy" lifestyle.

Also, in order to modify eating and exercise behaviour it is important to develop a programme that includes as many predictors of childhood overweight as possible (embrace a multi-factorial approach). Besides from focussing on changing eating and exercise behaviour, it is necessary to change the environment that influences and determines it. The school environment of both participating schools promoted obesity by providing frequent opportunities for the participants to consume large quantities of highly palatable, energy dense, inexpensive foods.

The methods of dietary assessment, chosen and used, for determining energy intake will determine how accurate the dietary intake is assessed. In this study several assessment methods were used (qualitative dietary habit questionnaire, diet and activity questionnaire, FFQ, 3-day diet and physical activity diary, 24-hour recall). All of the assessment methods are lacking precision and did not control for the validity of the data.

Finally, these results suggest that further work is needed to develop and implement effective intervention programmes to treat adolescent overweight and obesity.

Limitations of this study included:

- The study population were from low socio-economic areas. Therefore, the results can not be generalised to other New Zealand children.
- There was a high number of withdrawals and therefore a limited number of participants participating in the "Games Galore" feasibility study.
- The majority of the study population was not contemplating to change their nutrition or physical activity behaviour.
- The feasibility study did not manage to include the parents/caregivers sufficiently.
- There were no efforts included to modify the school environment.
- The behaviour change components were not sufficient to create change in this particular group.
- There were no assessment methods (besides form self-reporting) to measure physical activity.

- The used nutrient assessment methods were not appropriate for this particular group.

Future research is needed to:

- Incorporate a multi-factorial intervention that includes as many predictors of childhood overweight as possible (environment, behaviour).
- Investigate the use of the participants' schools and or churches plus influential role models (e.g. the priest, principal) for the development of an ongoing self motivated participation in physical activity and healthy eating habits.
- Investigate the cultural and environmental factors, which might influence the prevalence of obesity.
- Investigate the use of monetary incentives to develop an ongoing self motivated participation in physical activity and healthy eating habits.
- Increase the availability of foods that are low in fat and low in energy density. Simply telling people to eat such diets will bring only limited success, given the current food supply. Foods that are naturally low in fat and energy density, such as fruits, vegetables, and whole grains, should be made easily available and affordable. The development of more low-energy density foods that taste as good as the high-energy density versions may also facilitate consumption of low-energy density diets.
- Develop a multi-factorial education programme to reduce portion sizes. This may help to limit opportunities for "passive overeating". The food industry, Tuck shops at schools and restaurants should be encouraged to take responsible actions by reducing portion sizes, especially of high-energy dense food.
- Develop a multi-factorial education programme to decrease sedentary behaviour.
- Stimulate physicians to diagnose obesity in children and adolescents where it occurs and to diagnose potential health risk associated with obesity in an individual. It would be of great advantage to establish a network between hospitals, outpatient clinic therapist and scientific groups working in the field of childhood obesity.
- Examine the regulation of energy balance during childhood and adolescence, especially to explain the changes in relative energy stores during physical development and the factors inducing adiposity rebound and onset of obesity. Following children of obese parents during pregnancy and the first year of life

(Barker Hypothesis) could detect critical periods for development of obesity. Clinical and genetic markers should be established which identify individuals and populations at risk for obesity. Although various co-morbidities of childhood obesity are known, data on the prevalence of these co-morbidities and their relationship to time of onset and degree of obesity are lacking. Cross-sectional studies and health surveys within a population would help to obtain these data which could then be the basis for specific interventions.

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9 Appendices

9.1 Appendix 1: Letter sent to schools

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka
UNITEC INSTITUTE OF TECHNOLOGY

March 2001

Dear Sir, Madam,

UNITEC the School of Sports is planning a research project to develop a programme to improve the health of 10-14 year old overweight and obese children. The programme aims to decreasing obesity levels by increasing physical activity and modifying dietary behaviour.

Our project consists of a physical activity and a nutrition education programme. The physical activity component involves games programme guided by "role models" and students of UNITEC. The nutrition education programme aims at the children and their families and involves nutrition information and cooking sessions.

The physical activity programme will run twice a week after school at UNITEC in the ETA O'Ryans Recreation Centre supervised by staff from the School of Sport. In will be free for participants. Transport to and from UNITEC will be provided.

We are looking to recruit Intermediate age children (10-14 years) who are overweight to the programme and would like to involve children from your school.

We would appreciate the opportunity to discuss this and share more details with you. Therefore, we would like to call you for an appointment in the near future.

Thanks for your time and consideration and we look forward to meeting you.

Yours sincerely,

Christine King
Lecturer Sport Nutrition
UNITEC School of Sport
815 4321 xtn 8492

9.2 Appendix 2: Information sheet

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka
UNITEC INSTITUTE OF TECHNOLOGY

Games Galore

Information Sheet

Why are we doing this research?

Overweight and obesity are major health problems in New Zealand and the levels are increasing.
Being overweight or obese increases the likelihood of developing diabetes, heart disease, cancer and joint problems. Studies with overweight and obese children have shown that childhood obesity increases the likelihood of adult obesity. Overweight children are more likely to suffer from broken bones.

This research is focusing on helping children who are overweight or obese control their weight by increasing physical activity and through nutrition education. Also we will be looking at physical activity and healthy eating to prevent children becoming obese.

Who is in the study?

Children at intermediate school age (10 – 13years) are invited to join the programme.
Children can be recommended by their Public Health Nurse, Doctor, Teacher or family.

What is involved?

The programme will run at UNITEC Institute of Technology for the school year.
Participation is initially for one term. However, students may wish to return for a second term.
The participants will be asked to complete a short questionnaire about food and activity at the beginning and end of the programme.
Participants will also be asked to keep short food diaries at the beginning, middle and end of the programme. Activity records will be kept for the days when you do not come to UNITEC.
At UNITEC there will be a games programme for one hour two times per week after school.
Afternoon tea will be provided at UNITEC and transport from school to UNITEC can be arranged.
Measurements for height, weight and waist, to check growth, will be taken at the beginning, in the middle and at the end of the programme.
Parents and families are invited to attend seminars and cooking demonstrations.

Families can be visited at home or be interviewed at UNITEC for the first and final visits.

Do I have to take part in the study?

Participation in this research is entirely voluntary for the children and their families. If you agree to participate in the study, you may withdraw at any time and this will not disadvantage you in any way or affect the future health care of your child. You do not have to answer all the questions and you may stop the interviews at any time.

It will not cost you anything to take part in this study.

What will happen to the results?

The information collected is completely confidential. No information which could identify you or your family will be used in any reports on the study.
The results will be stored by code number in a computer at UNITEC and the questionnaire will be stored in a locked cabinet. Information is destroyed after 10 years.
You will receive a copy of your personal diet and measurements results.

If you have any questions?

If you have any questions about the project, either now or in the future please feel free to call us at UNITEC. If you need an interpreter one can be provided.

Contact numbers:

Christine King	815 4321 ext. 8492 or 021 612 416
Christel Dunshea	815 8238
School of Sport Office	815 4321 ext. 7340

If you have any queries or concerns about your rights as a participant in this study you may wish to contact Health Advocates Trust phone: 0800 205 555 or 623 5799
PO Box 9983, Newmarket, Auckland.

9.3 Appendix 3: Contract

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka
UNITEC INSTITUTE OF TECHNOLOGY

Contract

I ..... wish to participate in the Unitec "Games Galore" Programme.

I agree that I will attend 75% of the organised sessions at Unitec.

I agree that I will exercise/play outside or go for a walk or swim for at least 30 minutes on 3 of the days I do not go to Unitec.

I will try to make healthy food choices everyday.

Signed: .....

Date: .....

PARENTS

I/We agree to exercising with ..... for at least 30 minutes on 3 of the days when there is no programme at Unitec.

I/We will encourage ..... to make healthy food choices.

Signed: .....

Date: .....

9.4 Appendix 4: Invitation letters

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka
UNITEC INSTITUTE OF TECHNOLOGY

15th August 2001

Dear "Games Galore" players and parents/caregivers

As part of the "Games Galore" project we are about to start our cooking and food sessions. These will be fun, one-hour long sessions running once week for the next ten weeks. Both student and parent/caregivers are invited to come along.

At the sessions we will talk about different foods, nutrients, ways of preparation and conclude the session with a cooking demonstration. They will be fun sessions and it would be great to see you there with your child. For the success of the session students must be accompanied by a parent or caregiver.

The first session will be on the 28th August at 7 o'clock p.m. The sessions will be held in the building behind the gymnasium; room 54. Note that there is plenty of parking outside the room.
The sessions are free and as I said are designed to be fun and interactive.

For organisation purposes please fill in and return the attached form as soon as possible. I look forward seeing you all at the first session. If you have any questions don't hesitate contacting me, my phone number is 815 8238, or Christine King at 815 4321 ext. 8492.

Regards,

Christel Dunshea
"Games Galore"

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka
UNITEC INSTITUTE OF TECHNOLOGY

4th September 2001

Dear "Games Galore" players and parents/caregivers,

Last Tuesday we started the cooking and food sessions. It was great to see several "Games Galore" players and their parents attending. However we still like to see a few more of you!

Christine and I decided to organise the food and cooking sessions every **other** week. The second session will now be held on the 11th September. Hopefully you can be there! The session starts at 7 o'clock p.m. and will be held in the building behind the gymnasium; room 53.

I look forward seeing you all at the second session. If you have any questions don't hesitate contacting me, my phone number is 815 8238, or Christine King at 815 4321 ext. 8492.

Regards,

Christel Dunshea
"Games Galore"

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka
UNITEC INSTITUTE OF TECHNOLOGY

2 October 2001

Dear "Games Galore" players and parents/caregivers,

Last month we started the cooking and food sessions. It was great to see several "Games Galore" players and their parents attending. However a lot of you were still absent. It is really **important** to attend the cooking and food sessions as well as the activity sessions. We like to see more of you!

Please all come and attend the third session. This session will be held on the 9th October, 7 o'clock p.m. and will be held in the building behind the gymnasium; room 53.

I look forward seeing you all at the third session. If you have any questions don't hesitate contacting me, my phone number is 815 8238, or Christine King at 815 4321 ext. 8492.

Regards,

Christel Dunshea
"Games Galore"

9.5 Appendix 5: Nutrition education sessions

Introduction

Adolescents are able to understand some of the links between eating and health. Planning an education program for adolescents will help to increase their awareness of these foods and may influence the foods they choose to eat.

In this program we have brought together a range of activities which we believe children will find fun, interesting and informative. Learning outcomes, materials and methods are linked to each activity.

	Activity	Goals	Object
1	No one food contains all the nutrients we need. Eating a wide range of foods in moderation each day ensures us to obtain all the necessary nutrients for health and growth. Group foods into different levels of the Food Pyramid. (Computer program/video) Make a scone & pizza.	To use the food pyramid as a basis for independent food selection. Make a pizza and a scone and identify it as a healthy snack or lunch food.	Identify a wide range of foods and locate these at the correct levels of the Food Pyramid. Mini meals and snacks ore O.K.
2	Survey the most popular sandwich fillings. Check where they fit on the food pyramid. Write a sensational sandwich menu using the results of the survey. Make a sandwich & muffin	Use the food pyramid as a basis for independent food selection. Eat many different foods. Make a sandwich and a muffin and identify it as a healthy snack or lunch food.	Investigate popular food selections and relate these to the Food Pyramid. Mini meals and snacks ore O.K.
3	Compare the cost of a piece of fruit to a bag of potato chips and a packet of lollies. How many pieces of fruit can you eat for the same amount of money? Where do these foods fit on the Food Pyramid. Find out how much your favorite drink cost. How often do you drink this? Calculate how much is spent by you or your family each week on this drink? Multiply by 4 to find out how much you spend each month on this drink. Multiply by 12 to find out how much you spend each year on this drink.	Use the food pyramid as a basis for independent food selection. Have plenty of water and other drinks each day.	Make simple cost comparisons between foods from different levels of the Food Pyramid. Drink at least 6 to 8 glasses of water each day.

	Make a smoothie and identify and taste new fruits and vegetables.	Make a smoothie and identify it as a healthy snack, experience textures and new healthy snacks.	
4	Identify all sorts of products that belong under the group "breads and Cereals". Identify what is eaten during breakfast (different approaches). Make fruit salads and identify and taste new fruits.	Start the day with breakfast. Choose at least 6 servings of breads and cereals. Make fruit salad and identify it as a good option for a quick breakfast.	Acknowledge that Breakfast is good. Eat more rice, pasta, cereals and bread (use spread thinly, if at all). Breakfast is the most important meal of the day.
5	Identify all sorts of products that belong under snacks. Active teenagers need snacks; snacks help provide the extra energy you need for growth and physical activity. Snacks should be low in fat, salt and sugar. Identify what is eaten during morning and afternoon tea (different approaches). Make pancakes.	Consume healthy snacks, now and then a treat food is O.K as long as it is in moderation. Choose at least two servings of milk and milk products. Make pancakes and identify it as a healthy snack.	Know that there are different types of fat Use trim milk, low fat yogurt and lower fat cheeses such as edam, cottage cheese and light cheese slices. Recognise the heart foundation tick. Try to avoid high fat foods and snacks such as fish and chips, meat pies, potato crisps, salted nuts.
6	Learn to read labels. Show different food products and ask participants to class them in catagories according to the label. Low fat products should contain less than 10% fat. Make different sandwiches and toasties.	Use the food labels to identify the percentage fat and sugar used in food products. Use this tool as a basis for independent food selection. Make many different lunchbox fillings.	Identify a wide range of foods containing a range of different nutrients. Use the labels to identify if foods are "healthy".
7	Identify all sorts of products that belong under lean meats, chicken, seafood, eggs, dried beans, peas and lentils. Those products are valuable sources of protein, iron and other nutrients. Discuss the Iron needs for adolescents (specially girls). Explain the meaning of a serving. Make home made hamburger and compare the price of used ingredients with price of the take-away version.	Never skip a meal. Choose at least one serving of lean meat, chicken, fish, seafood, eggs, nuts, legumes. Make home made hamburger and identify it as a healthy and cheap alternative for a take-away version.	Choose foods low in fat. Trim visible fat from meat and remove chicken skin. Aim for palm size servings of lean mea and chicken. Grill, bake, stir fry, BBQ or microwave – try not to fry.

8	Role play a family feast and provide the participants tools how to control their energy intake during those situations. Suggest healthy alternatives. Make Sapasui (chicken chop suey)	Identify triggers that may cause you lose control over eating and learn to manage them. Make Sapasui and introduce the cookbook of the National Heat Foundation "Pacific Recipes for the Heart".	Identify a wide range of foods containing a range of different nutrients and regognise personal triggers that may cause you lose control over eating and learn to manage them.
9	Role play a family feast and provide the participants tools how to control their energy intake during those situations. Suggest healthy alternatives. Make Tapioca and vegetable pie.	Identify triggers that may cause you lose control over eating and learn to manage them. Make Tapioca and mention again the cookbook of the National Heat Foundation "Pacific Recipes for the Heart".	Identify a wide range of foods containing a range of different nutrients and regognise personal triggers that may cause you lose control over eating and learn to manage them.
10	Repetition of all the covered materials.	Maintenance – the future Summary sessions	Repetition of all the covered materials.

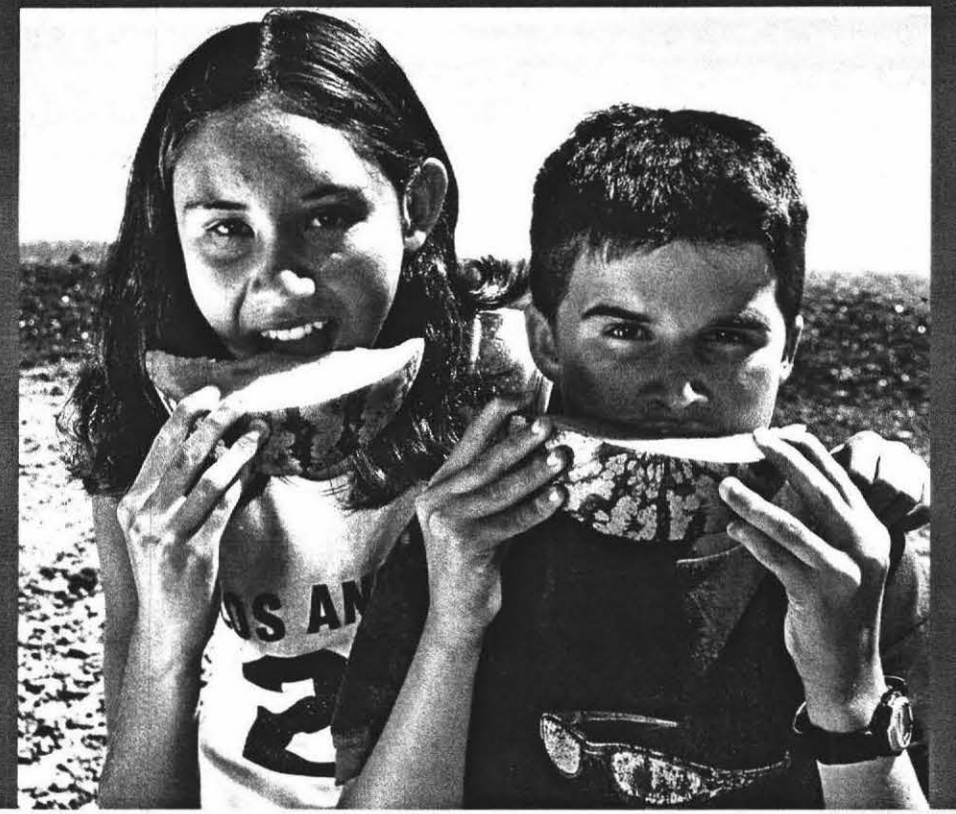
9.6 Appendix 6: Selection of provided information materials

Food Fantastic

EATING FOR HEALTHY ADOLESCENTS

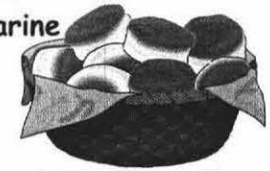
NGĀ KAI TŌTIKA MŌ TE HUNGA KŌHUNGAHUNGA

EATING *for* Healthy Children aged 2 to 12



EVERYDAY EATING for health

Snack Ideas
Scones

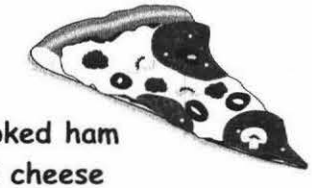


2 cups self raising flour
½ cup butter or margarine
½ cup milk

sift flour into bowl
rub in butter/margarine with fingertips
make a hole in centre
add milk into hole to make soft dough
turn onto floured board
knead slightly
press out to 2cm thick
cut into even shapes
place on floured baking tray
bake 10-15 minutes at 220°C

Mini Pizzas

Cut a hamburger bun in half
Spread with canned spaghetti,
Baked Beans or tomato sauce.
Add your choice of topping



- onion
- pineapple
- tomato
- chopped cooked ham

Top with grated cheese
Bake in oven at 180° for 15-20 minutes

Hā Ora
Resource Centre
Public Health Promotion
Auckland Healthcare Services Ltd

Community Child Health
& Disability Service

GET REAL WITH FOOD

Heart Foundation
Te Hotu Manawa Whanui

9.7 Appendix 7: Ethics approval

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka

4 December 2000

UREC Ref: 026/2000

Christine King
School of Sport
HST
UNITEC

Dear Christine

I refer to your application for ethics approval for the research project "Games Galore : Weight Managmenet and Obesity Prevention in Children – a lifestyle intervention".

The Readers have now granted Conditional approval for three years from the date of this letter and your project can now commence. Formal approval will be conferred by the Committee at its meeting on 6 December 2000.

I will advise you when Formal approval is granted by UREC. In the meantime, we wish you every success with your project.

Yours sincerely,

Chris Hodkinson
SECRETARY, RESEARCH ETHICS COMMITTEE

cc. School of Sport
HST

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka

07 December 2000

UREC Ref: 026/2000

Christine King
School of Sport
HST
UNITEC

Dear Christine

I refer to your application for ethics approval for the research project "Games Galore : Weight Management and Obesity Prevention in Children – a lifestyle intervention" and my letter of 04 November in which I advised that Conditional Approval to your research project had been given.

Formal approval to your research project was given by the UNITEC Research Ethics Committee at its meeting on 6 December 2000.

We wish you every success with your project.

Yours sincerely

Chris Hodkinson
SECRETARY, RESEARCH ETHICS COMMITTEE

c.c. HST

9.8 Appendix 8: Consent form

UNITEC
INSTITUTE *of* TECHNOLOGY
Te Kura Puukenga o Wairaka

UNITEC INSTITUTE OF TECHNOLOGY

"Games Galore"

Weight management and obesity prevention in children – a lifestyle intervention.

Consent Form

This research project is to investigate the development and effectiveness of an integrated physical activity and nutrition education programme for the management of weight and prevention of obesity in children as described in the information sheet.

The research is being done by the School of Sport, UNITEC Institute of Technology.

Name of Participant:.....

I have seen the Information Sheet for people taking part in the "Games Galore" Project. I have had the opportunity to read the contents of the information sheet and to discuss the project with the "Games Galore" team and I am satisfied with the explanations I have been given.

I understand that taking part in this project is voluntary (my choice) and that I may withdraw from the project at any time and this will in no way affect my access to the services provided by the UNITEC or any other support service.

I understand that I can withdraw from the programme if, for any reason, I want this.

I understand that my participation in this project is confidential and that no material that could identify me will be used in any reports on this project.

I have had enough time to consider whether I want to take part.

I know whom to contact if I have any questions or concerns about the project.

The **research co-ordinator** for this project is Christine King School of Sport UNITEC Institute of Technology. Phone: 815 4321 ext 8492. Fax: 815 4326 email cking@unitec.ac.nz

Signature..... participant .....(date)

Parent/Guardians Signature..... ..... (date)

Project explained by.....

Signature..... .....(date)

This study has been approved by the UNITEC Research Ethics Committee from (1.1.01) to (1.12. 03). If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the Secretary Ph: 09 849-4180). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

9.9 Appendix 9: Qualitative dietary habit questionnaire

Qualitative dietary habit questionnaire

1. How much bread do you eat per day?
   More than 4 slices a day
0 At least 3-4 slices a day
∇ Never

2. How often do you eat breakfast cereal (or extra slice of bread)
   Every day
0 At least 2-4 times a week
∇ Never

3. What type of spread do you use?
   Margarine
0 Both butter and margarine
∇ Butter

4. Do you spread your butter/margarine?
   Scraping – or none ½ -1 tsp
0 Thin – up to 1 tsp
∇ Thick – greater than 1 tsp per slice

5. How often do you use milkproducts
   Daily, 3 or more servings
0 Daily, one serve
∇ 2-4 servings a week or less

6. How often do you eat fruit?
   Daily, 2 or more pieces
0 Daily, one piece
∇ 2-4 pieces a week or less

7. How often do you eat vegetables?
   Daily, 3 or more servings
0 Daily, one serve
∇ 2-4 servings a week or less

8. How often do you eat sausages mince and lucheon?
   Less than once a week
0 2-4 times a week
∇ Five or more times a week

9. How often do you trim the fat off meat and remove skin from chicken?
   Always
0 Sometimes
∇ Rarely/never

10. How often do you eat fried food?
    Less than once a week
0 2-4 times a week
∇ Five or more times a week

11. How often do you eat takeaways such as fried fish or chicken, pizza, pies, nachos and chips?
    Rarely (less than once a month)
0 Once a week
∇ Daily

12. How often do you eat pastries, chocolate, muesli bars, croissants, potato crisps, cakes, biscuits and desserts including ice-cream?
    Once or less times a week
0 2-4 times a week
∇ 6 or more times a week

13. How often do you drink tea, coffee, hot chocolate, coke or caffeine containing drinks?
    Less than 4 cups/glasses per day
0 4 cups/glasses per day
∇ More than 4 cups/glasses per day

14. How often do you skip a breakfast, lunch or dinner meal?
    Once or less times a week
0 2-4 times a week
∇ 6 or more times a week

9.10 Appendix 10: Diet and activity questionnaire I

"Games Galore" Questionnaire I

Personal:

1. Name

2. Male/Female

3. DOB/age

4. Address

5. Phone

6. Do you currently have a long term (6months) medical condition or disability? YES/NO

   If YES please specify:

7. Are you currently taking any pills or medicines prescribed by a doctor? YES/NO

   If YES please specify:

Physical Activity

1. In the last 4 weeks what time did you usually get out of bed in the morning?
   During the week:
   During the weekend:

2. In the last 4 weeks what time did you usually go to bed at night?
   During the week:
   During the weekend

3. In the last 4 weeks did you usually sleep during the daytime? YES/NO

   If YES, how long each day?

During the week:	During the weekend:
30 minutes	30 minutes
30–60 minutes	30–60 minutes
60–90 minutes	60–90 minutes
90–120 minutes	90-120minutes
120 minutes	120 minutes

4. In the last 4 weeks how much time did you usually spend watching TV/videos:
   During the week:
   During the weekend:

5. In the last 4 weeks how much time did you usually spend playing computer or video games at home:
   During the week:
   During the weekend:

6. In the last 4 weeks how much time did you usually spend outdoors during the day:
   During the week:
   During the weekend

6. How long does it usually take you to travel to school from home?
   Less than 5 minutes
   5-15 minutes
   16-30 minutes
   31 minutes –1hour
   More than 1 hour

7. In the last 4 weeks how did you usually travel to school?
   On foot
   By bicycle
   By bus
   By car
   By train
   By motorcycle
   Other

8. How long does it usually take you to travel home from school?
   Less than 5 minutes
   5-15 minutes
   16-30 minutes
   31 minutes – 1 hour
   More than 1 hour

9. In the last 4 weeks how did you usually travel home from school?
   On foot
   By bicycle
   By bus
   By car
   By train
   By motorcycle
   Other

9. In the last 4 weeks have you taken part in sports or physical activities before or after school during the week, or at weekends? (do not include school-time activities)
   YES/NO

   If YES list activities and time spent each day in each activity.
   Activity: Time spent:

Food

1. Are there any sorts of foods and drinks you do not eat or drink because you are allergic to them?
   YES/NO

   If YES which foods/drinks do you not eat?
   Please list:

2. Are there any other foods you do not eat for health or family reasons?
   Food: Reason:

3. Do you usually eat something before you leave home for school in the morning?
   YES/NO

4. Do you usually eat something on the way to school?
   YES/NO

4. Do you usually eat food while you are at school?
   YES/NO

5. Which of the following times do you usually eat or drink?
   Morning break
   Lunch time
   Afternoon break

6. How often do you eat food brought from home at school?
   Daily
   3-4 time a week
   2-3 times a week
   1-2 times a week
   Rarely
   Never

7. Do you buy food while you are at school?
   YES/NO

8. How often do you eat food bought from the local shops?
   Daily
   3-4 times a week
   2-3 times a week
   1-2 times a week
   Rarely
   Never

9. How often do you eat food bought from the school canteen?
   Daily
   3-4 times a week
   2-3times a week
   1-2 times a week
   Rarely
   Never

10. Do you usually eat something on the way home from school
    YES/NO

11. Do you buy food on the way home from school?
    YES/NO

12. Do you usually eat at home straight after school?
    YES/NO

13. Do you usually eat at home later? e.g. dinner, snacks etc.
    YES/NO

14. How would you describe your eating habits?
    Eat a variety of foods, including animal products
    Eat eggs, dairy products, fish and chicken but avoid other meats.
    Eat eggs, dairy products, fish but avoid chicken and other meats.
    Eat eggs and dairy products but avoid all meats and fish.
    Eat eggs but avoid dairy products, all meats and fish.
    Eat dairy products but avoid eggs, all meats and fish.
    Eat no meat, fish, milk and eggs.
    Other (specify)

15. How many helpings of fruit (fresh, frozen, canned, preserved or stewed) do you usually eat each day? (do not include fruit juice).
    (a helping is the amount of fruit that will fit into the palm of your hand).
    I do not eat fruit
    Less than one helping each day
    One helping each day
    Two helpings each day
    Three or more helpings each day

16. How many helpings of vegetables (fresh, frozen, canned) do you usually eat each day. Do not include vegetable juices.
    (a helping is the amount of vegetable that will fit into the palm of your hand)
    I do not eat vegetables
    Less than one helping each day.
    One helping each day
    Two helpings each day
    Three helpings each day
    Four or more helpings each day

17. How many helpings of noodles, pasta or rice do you usually eat each week?
    (One helping of cereals =one cup cooked rice/pasta/noodles)
    I do not eat cereals
    Less than one helping each week
    1-2 helpings a week
    3-4 helpings a week
    5-6 helpings a week
    7 or more helpings a week

18. How many helpings of breakfast cereals do you usually eat each day?
    (one helping of breakfast cereals = 1 cup cereal or 2 weetbix)
    I don't eat breakfast cereals
    Less than one helping each day
    1-2 helpings a day
    3-4 helpings a day
    5-6 helpings a day
    7 or more helpings a day.

19. How many slices or rolls of bread (or toast or pita) do you usually eat each day?
(one helping of bread = 1 medium slice of bread or 1 roll or 1 small pita bread)
I don't eat bread
Less than one helping each day
1-2 helpings a day
3-4 helpings a day
5-6 helpings a day
7 or more helpings a day

22. What type(s) of bread do you eat most often?
White
White – high fibre
Grain breads e.g. Molenberg, Vogels
Wholemeal (brown bread)
Others (specify)

23. How many helpings of milk and milk products do you usually eat each day?
(milk, yoghurt, dairy food, icecream, cheese)
(one helping = 1 cup milk or 1pottle of yoghurt or 2 scoops of icecream or 2 slices of cheese)
I don't eat milk and milk products
One helping each day
Two helpings each day
Three helpings each day
Four helpings each day
Five or more helpings each day

24. Do you drink or use any type of milk?
YES/NO

25. What type do you have most often?

Whole or powdered milk (silver top)	Calci trim (yellow)
Standard, homogenised milk (dark blue top)	Trim milk (dark green top)
Reduced fat (light blue top)	Super trim (light green top)
Bought flavoured milk e.g. Primo	Soy milk
Skim milk or low fat powdered milk	Other (specify)

26. Do you use butter or margarine on bread or crackers?
YES/NO

27. What types do you use most often?
    Butter or home-made butter
    Butter and margarine blend
    Margarine (oil type not specified)
    Polyunsaturated margarines e.g. Miracle, Sunflower.....
    Monounsaturated margarines – Praise, Olivio, Olivani margarines
    Other (specify)

28. How many helpings of meat, chicken, fish, seafood, eggs dried beans e.g. baked beans, nuts and lentils do you usually eat each day?

    (One helping = ½ tin or ¾ cup baked beans OR 2 slices cooked meat OR 2 chicken drumsticks Or ¾ cup mince or casserole OR 1 medium fillet of fish OR 5 medium mussels OR 3 kina OR 1 medium steak OR 1 egg OR 1 sausage.
    I don't eat those
    Less than one helping each day
    1-2 helpings a day
    3-4 helpings a day
    5 or more helpings each day

29. How often do you eat takeaways e.g. bought fish and chips, KFC, McDonalds?
    Daily
    5-6 times a week
    3-4 times a week
    1-2 times a week
    1-3 times a month
    Never or less than once a month

9.11 Appendix 11: Diet and activity questionnaire II

"Games Galore" Questionnaire II

Name:

Physical Activity

1. In the last 4 weeks how much time did you usually spend watching TV/videos:
   During the week:
   During the weekend:

2. In the last 4 weeks how much time did you usually spend playing computer or video games at home:
   During the week:
   During the weekend:

3. In the last 4 weeks how much time did you usually spend outdoors during the day:
   During the week:
   During the weekend

4. In the last 4 weeks have you taken part in sports or physical activities before or after school during the week, or at weekends? (do not include school-time activities) **(any change)** Yes/No

   If YES list activities and time spent each day in each activity.
   Activity: Time spent:

Food

1. Do you usually eat something before you leave home for school in the morning?
   YES/NO

2. Do you usually eat something on the way to school?
   YES/NO

3. Do you usually eat food while you are at school?
   YES/NO

4. Which of the following times do you usually eat or drink?
   Morning break
   Lunch time
   Afternoon break

5. How often do you eat food brought from home at school?
   Daily
   3-4 time a week
   2-3 times a week
   1-2 times a week
   Rarely
   Never

5. Do you buy food while you are at school? YES/NO

6. How often do you eat food bought from the local shops?
   Daily
   3-4 times a week
   2-3 times a week
   1-2 times a week
   Rarely
   Never

7. How often do you eat food bought from the school canteen?
   Daily
   3-4 times a week
   2-3times a week
   1-2 times a week
   Rarely
   Never

8. Do you usually eat something on the way home from school?
   YES/NO

9. Do you buy food on the way home from school?
   YES/NO

10. Do you usually eat at home straight after school?
    YES/NO

11. Do you usually eat at home later? e.g. dinner, snacks etc.
    YES/NO

12. How often do you eat takeaways e.g. bought fish and chips, KFC, McDonalds?
    Daily
    5-6 times a week
    3-4 times a week
    1-2 times a week
    1-3 times a month
    Never or less than once a month

9.12 Appendix 12: Food Frequency Questionnaire

Office use only

Study number: ☐☐☐☐☐☐☐

Date completed: ☐☐ ☐☐ ☐☐☐☐ (day month year)

Name: _____

Date of birth: ☐☐ ☐☐ ☐☐☐☐ (day month year)

Food Questionnaire

Different eating patterns may affect people's health. To help us understand these eating patterns, we would like you to **think back over the past 4 weeks** and answer the following questions about the foods you usually eat.

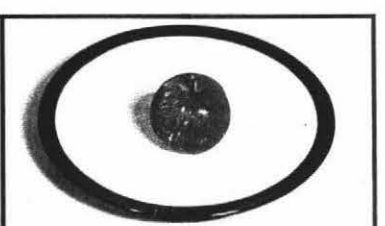
Put a tick in the box which best tells **HOW OFTEN** you usually eat the foods.

Example

If you eat apples on 3 or 4 days each week, put a tick in the '3-4 times a week' box.

2. Apples or pears

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☑	☐	☐	☐



If you never or rarely eat a food, tick in the box 'never or less than once a month' and go to the next question.

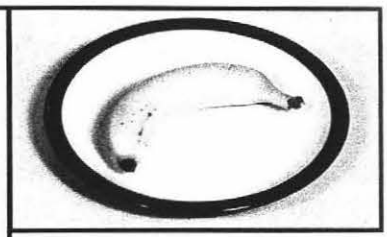
It may be helpful to ask the person who does the cooking and shopping in your household to help you fill in the questions.

PLEASE DO NOT SKIP ANY FOODS

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

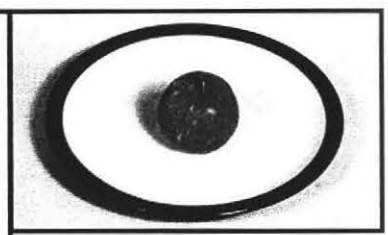
Fruit

1. Banana, raw



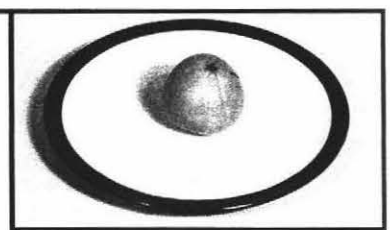
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

2. Apples or pears



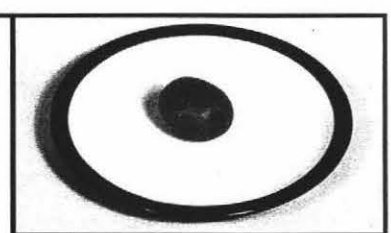
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

3. Oranges or mandarins



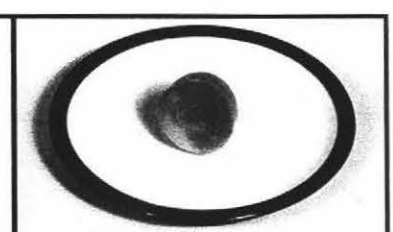
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

4. Kiwifruit



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

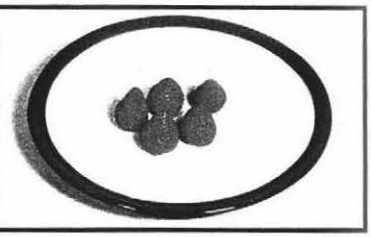
5. Nectarines, peaches, plums or apricots



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

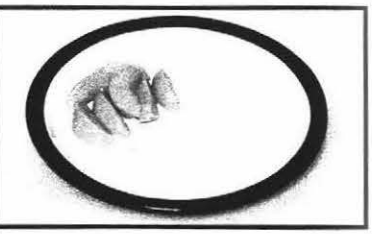
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

6. **Strawberries or other berries**



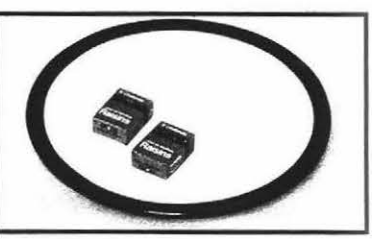
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

7. **Tinned or cooked fruit,** eg. tinned peaches



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

8. **Dried fruit,** eg. raisins



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

9. **Other Fruit (1)** If you often have another fruit, not listed - give the name and tick a box to show how often you eat it

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

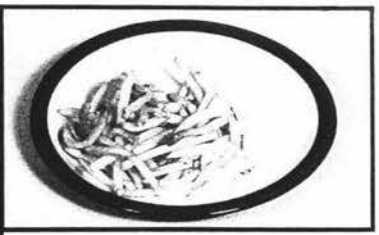
10. **Other Fruit (2)** If you often have another fruit, not listed - give the name and tick a box to show how often you eat it

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

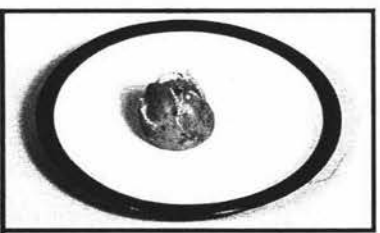
Vegetables

11. Fried potatoes, eg. hot potato chips, kumara chips, french fries, wedges or hash browns



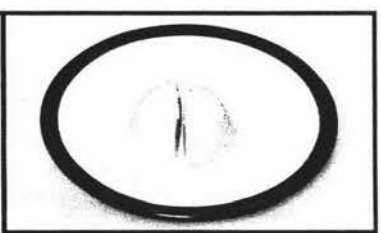
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

12. Other potatoes, eg. boiled, mashed, baked or roasted



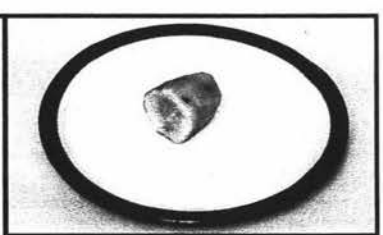
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

13. Taro



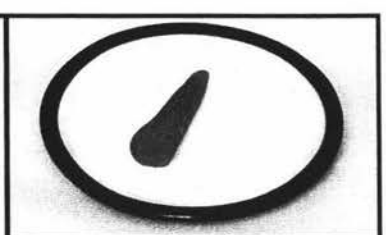
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

14. Kumara



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

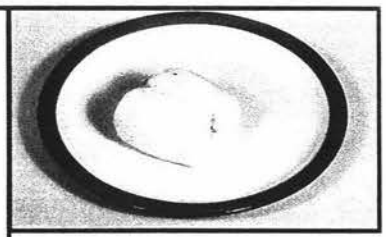
15. Carrots (raw or cooked)



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

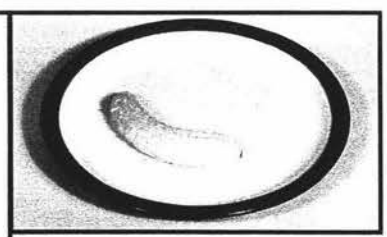
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

16. Cassava



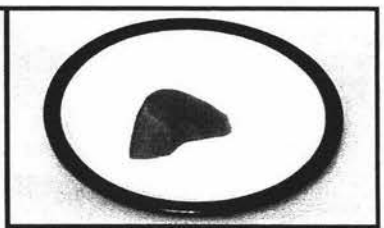
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

17. Cooked green banana



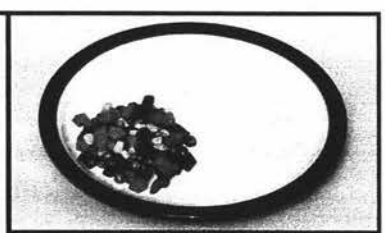
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

18. Pumpkin



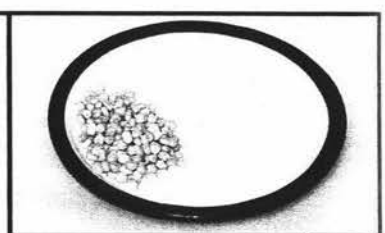
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

19. Mixed vegetables



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

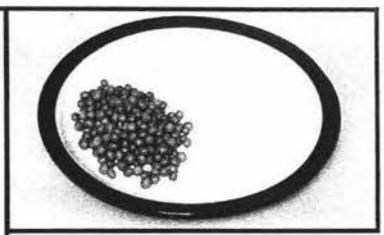
20. Corn



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

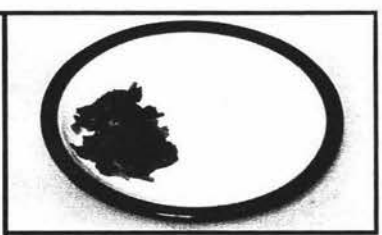
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

21. Peas



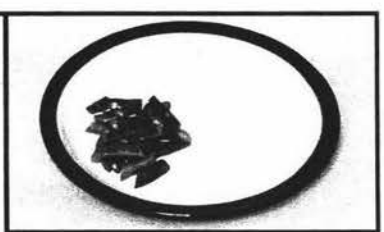
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

22. Silverbeet, spinach, puha or watercress



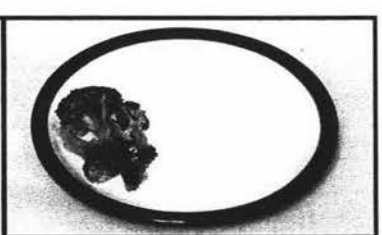
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

23. Green beans



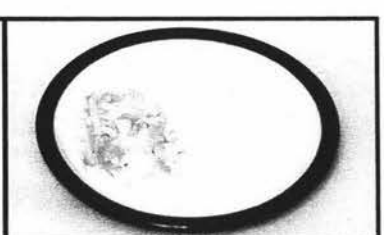
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

24. Broccoli



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

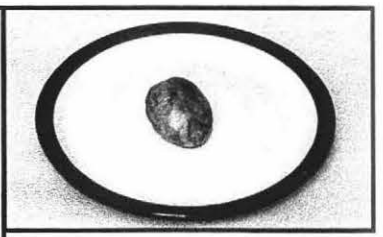
25. Cauliflower or cabbage



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

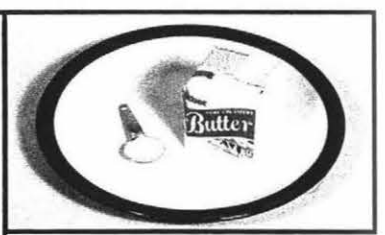
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

26a. Thinking about **cooked vegetables,** how often would you have **roast vegetables?**



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

26b. Thinking about **cooked vegetables** again, how often would you have **butter or margarine** on them?



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

26c. Which of these do you usually have on vegetables? *(tick one box)*

☐ butter

☐ low-fat spread

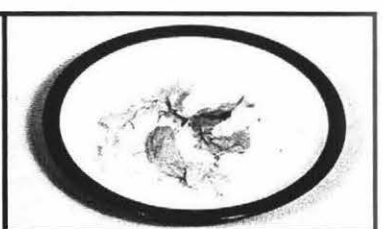
☐ margarine

☐ blend (margarine and butter)

☐ Don't have either

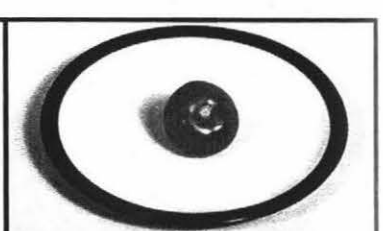
Name of margarine or blend _____

27. **Lettuce or green salad**



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

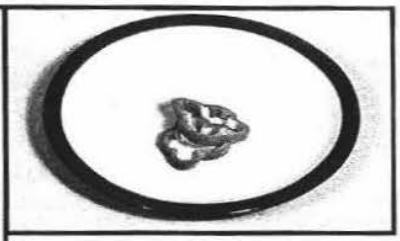
28. **Tomatoes** (raw or cooked)



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

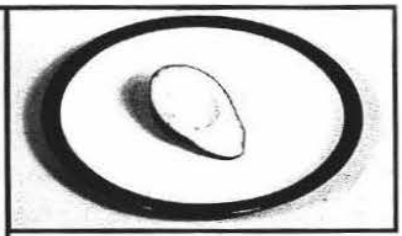
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

29. Capsicum (green, red or yellow peppers)



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

30. Avocado



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

31. Other Vegetable (1) If you often have another vegetable, not listed - give the name and tick a box to show how often you eat it

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

32. Other Vegetable (2) If you often have another vegetable, not listed - give the name and tick a box to show how often you eat it

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

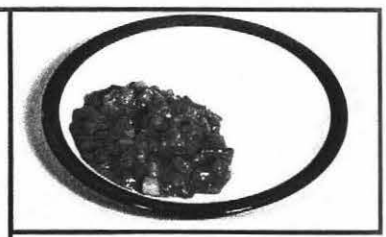
Mixed dishes

33. Meat and vegetable 'boil-up', eg. puha, povi masima, brisket, mutton flaps, pork bones

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

34. Meat stew or casserole with vegetables

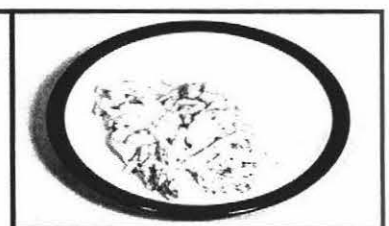


Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

35. Pasta with meat and tomato sauce, eg. lasagne, spaghetti bolognaise

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

36. Pasta with cream, white sauce or cheese sauce



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

37. Chinese type dishes, stir-fry meat or chicken and vegetables

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

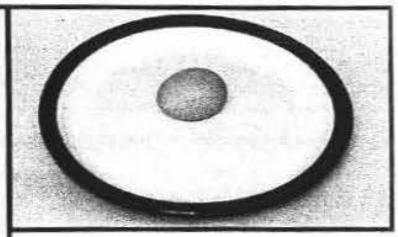
38. Other Mixed Dish If you often have another mixed dish, not listed - give the name and tick a box to show how often you eat it

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

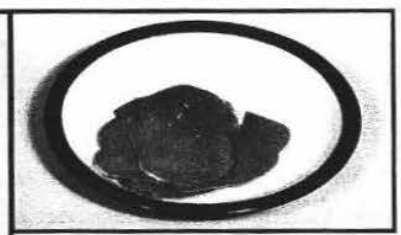
Eggs, meat, poultry and fish

39. Eggs, boiled, poached, fried or scrambled, etc



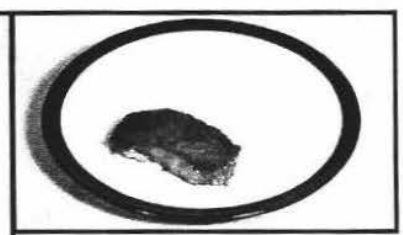
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

40. Roast beef, lamb or pork



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

41. Steak

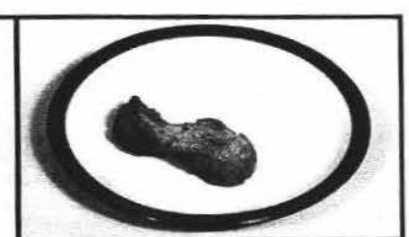


Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

42. Lamb or mutton chops

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

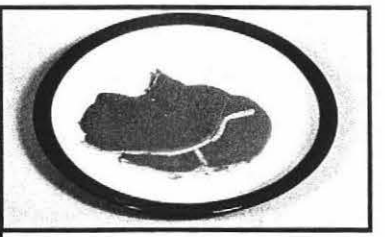
43. Pork chop (or other pork small cuts)



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

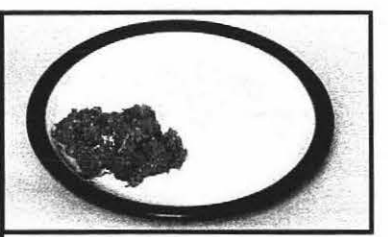
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

44. Boiled corned beef/silverside



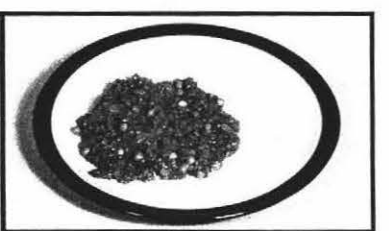
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

45. Tinned corned beef



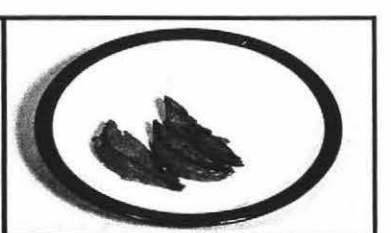
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

46. Mince, including rissoles, patties, Shepherd's Pie, etc



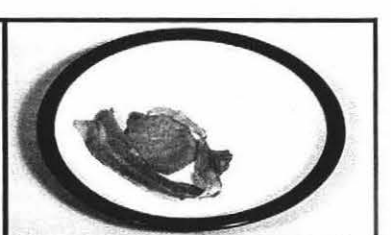
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

47. Liver or liver paté



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

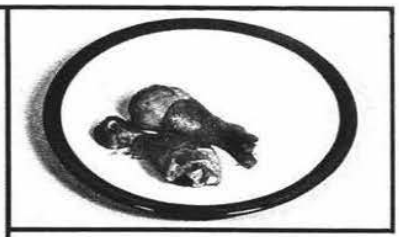
48. Bacon or ham



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

49. Chicken

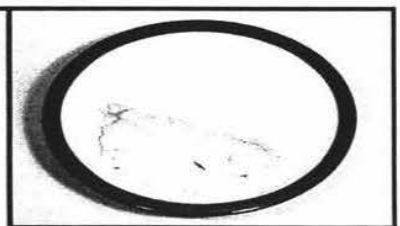


Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

49a. How often was the **chicken** you ate **fried chicken or chicken nuggets**? *(tick one box)*

- ☐ almost never or never
- ☐ ¼ of the time
- ☐ ½ of the time
- ☐ ¾ of the time
- ☐ almost always or always

50. Fish

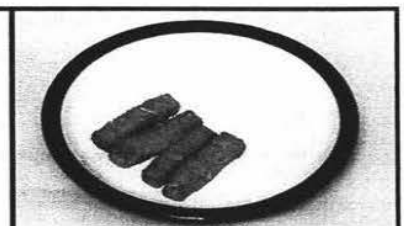


Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

50a. How often was the **fish** you ate **fried fish or takeaway fish**? *(tick one box)*

- ☐ almost never or never
- ☐ ¼ of the time
- ☐ ½ of the time
- ☐ ¾ of the time
- ☐ almost always or always

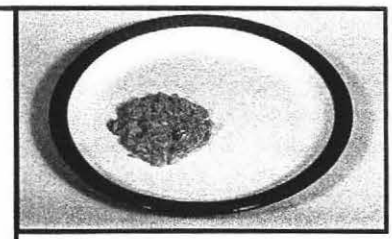
51. Fish cake, fish fingers or fish pie



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

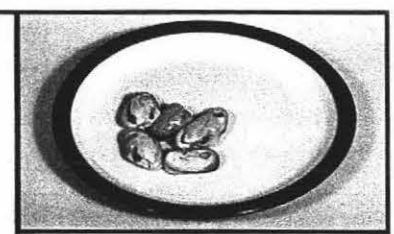
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

52. **Tinned fish,** eg. tuna or salmon



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

53. **Shell fish,** eg. mussel, paua or crabmeat



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

54. **Other item of the 'Eggs, meat, poultry and fish' group** If you often have another item from this group, not listed - give the name and tick a box to show how often you eat it

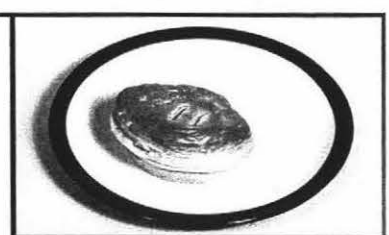
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

55. Which of the following **fats** were regularly used to cook your **meat, poultry or fish**? *(mark all that are used)*

- ☐ Don't know
- ☐ Margarine
- ☐ Butter
- ☐ Lard, dripping
- ☐ Kremelta type fat
- ☐ Canola oil
- ☐ Corn oil
- ☐ Olive oil
- ☐ Safflower oil
- ☐ Sunflower oil
- ☐ Other vegetable oil

Pies, fastfoods, sausages

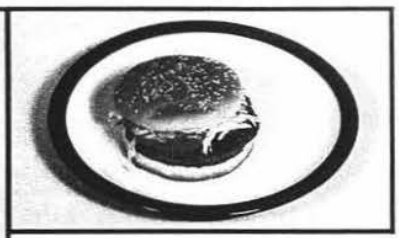
56. **Meat pie**



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

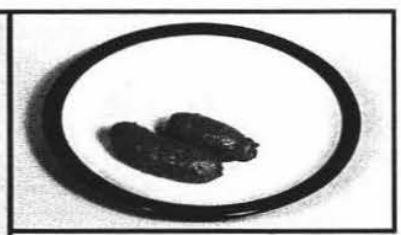
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

57. Burgers



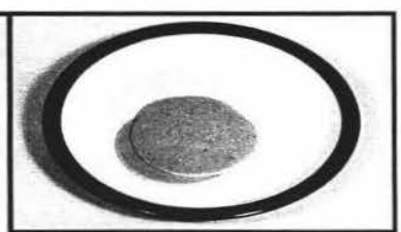
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

58. Sausages (all types)



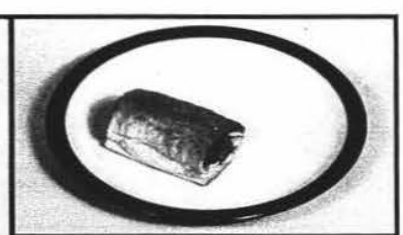
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

59. Luncheon, ham and chicken



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

60. Sausage rolls



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

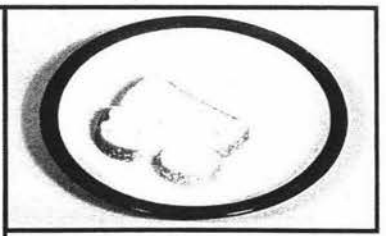
61. Other item of the 'Pies, fast foods, sausages' group If you often have another item from this group, not listed - give the name and tick a box to show how often you eat it ☐

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

Bread and Cereals

62. Bread, including toast and bread rolls

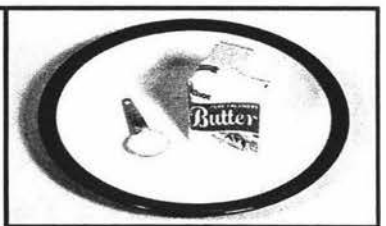


Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

62a. What **type of bread** do you **usually** eat? (tick one box)

- ☐ white
- ☐ wholemeal
- ☐ mixed grain

62b. How often do you have **butter** on your bread?



- ☐ rarely or never
- ☐ ¼ of the time
- ☐ ½ of the time
- ☐ most of the time

62c. How often do you have **margarine or margarine blend** on your bread?

- ☐ rarely or never
- ☐ ¼ of the time
- ☐ ½ of the time
- ☐ most of the time

62d. Which type of **margarines** do you **usually** have?

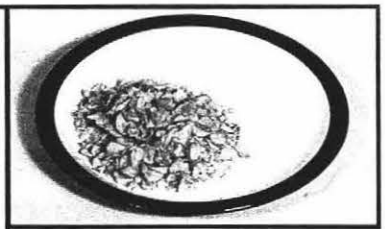
- ☐ Polyunsaturated margarine, eg. Miracle, Meadowlea, Flora, Sunrise
- ☐ Canola margarine, eg. Gold'n Canola, Vraise Canola, Canola Harvest, Country Crock
- ☐ Olive oil, margarine, eg. Olivio, Olivani, Oliveta
- ☐ Blend of butter and margarine, eg. Countrysoft, Dairysmooth
- ☐ Don't know

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

62e. Is the **margarine** you usually have **reduced fat** or **lite**?

- ☐ Yes
- ☐ No
- ☐ Don't know

63. Breakfast cereal



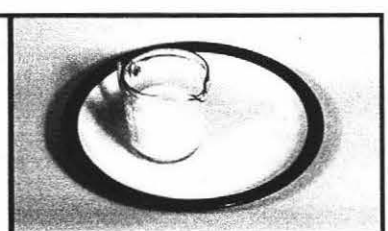
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

63a. What type of cereal do you usually have? *(tick one box)*

- ☐ Weetbix type
- ☐ Cornflakes type
- ☐ Rice bubbles
- ☐ Cocopops
- ☐ Muesli
- ☐ Multi-grain typ
- ☐ Porridge
- ☐ Other (Please give name) _____

63b. Was **milk** added to your **cereal**?

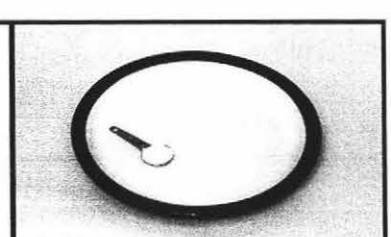
☐ Yes ☐ No



What **kind** of **milk** was usually added?

- ☐ Standard milk/dark blue
- ☐ Trim (green)
- ☐ Soy milk
- ☐ Light blue
- ☐ Extra calcium

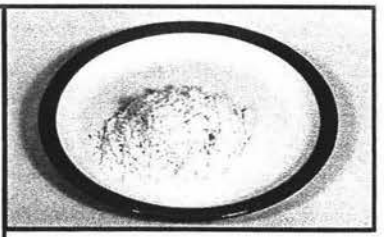
63c. Was **sugar, honey or syrup** added to your cereal?



☐ Yes ☐ No

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

64. Rice



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

65. Other Bread and Cereals If you often have another item from this group, not listed - give the name and tick a box to show how often you eat it

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Spreads, sauces

66. Jam or honey

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

67. Nutella

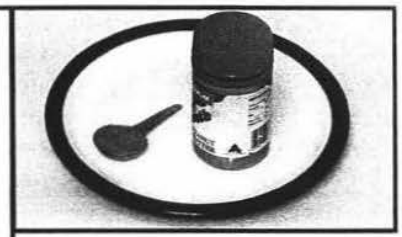
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

68. Marmite or Vegemite

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

69. Peanut butter



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

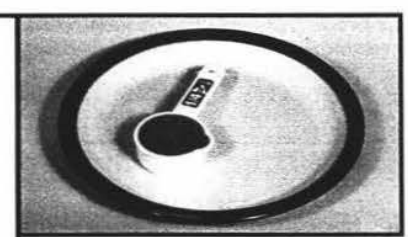
70. Mayonnaise or salad dressing

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

71. Tomato sauce or ketchup

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

72. Gravy



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

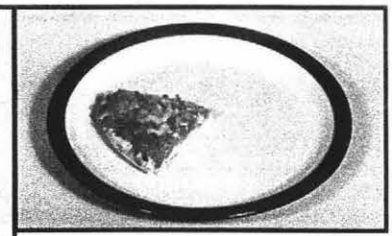
73. Other item of the 'Spreads, sauces' group If you often have another item from this group, not listed - give the name and tick a box to show how often you eat it ☐

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more. times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

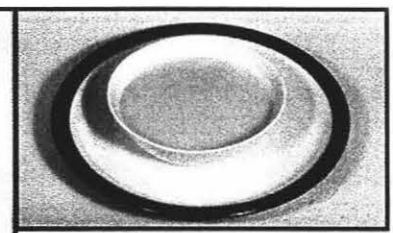
Convenience meals/snacks

74. Pizza



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

75. Soup

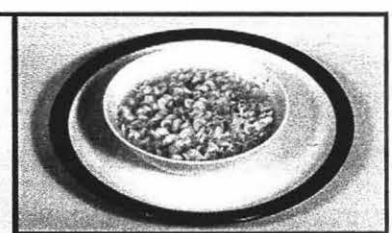


Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

75a. What **type of soup** do you usually have? *(tick one box)*

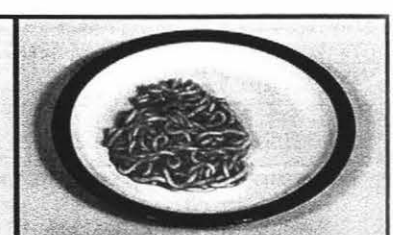
- ☐ Tomato soup
- ☐ Vegetable soup
- ☐ Cream soup
- ☐ Ham and pea soup
- ☐ Other soup

76. Noodles



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

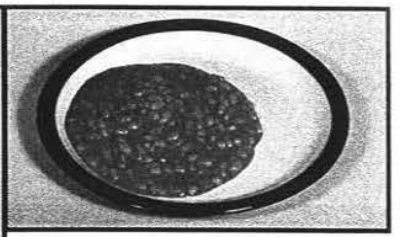
77. Tinned spaghetti with tomato sauce



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

78. Baked beans



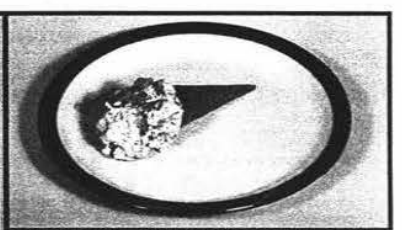
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

79. Other item of the 'Convenience meals/snacks' group If you often have another item from this group, not listed - give the name and tick a box to show how often you eat it _____

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

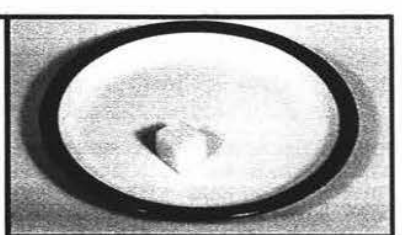
Dairy

80. Ice cream



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

81. Cheese, eg. cheddar, colby, etc.



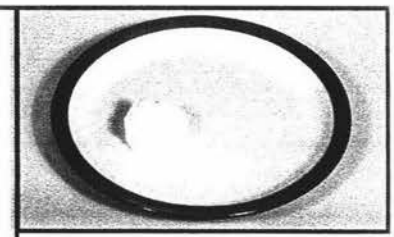
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

82. Yoghurt or Dairy food (all types)

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

83. **Cream**



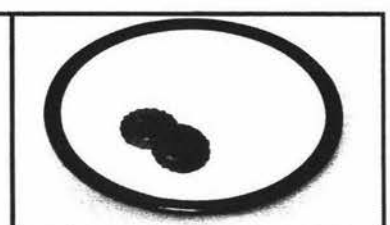
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

84. **Other item of the 'Dairy' group (not milk drinks)** If you often have another item from this group, not listed - give the name and tick a box to show how often you eat it ____

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

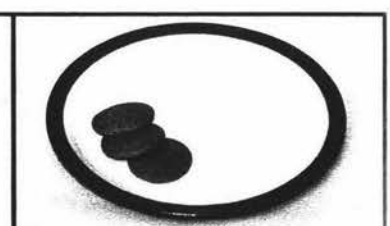
Biscuits/cakes

85. **Chocolate coated or cream filled biscuits**



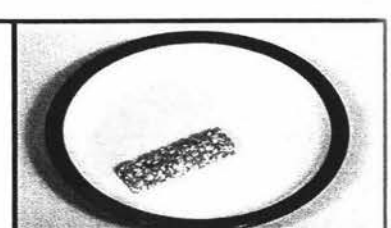
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

86. **Biscuits,** eg. plain, chocolate chip, semi-sweet, ginger nut, shortbread



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

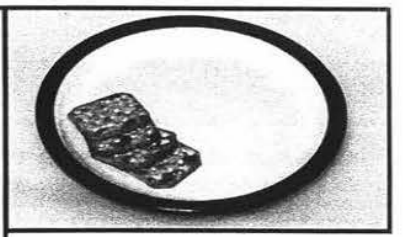
87. **Muesli bars**



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

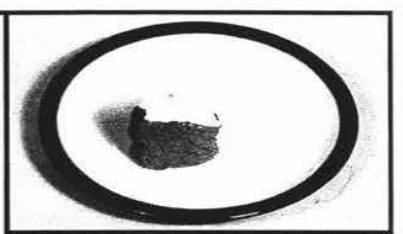
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

88. Crackers or crispbreads



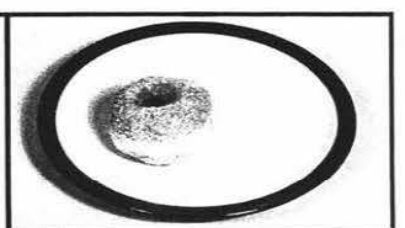
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

89. Cake



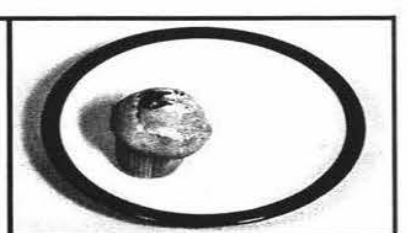
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

90. Doughnuts or croissants



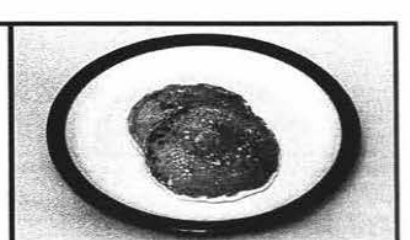
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

91. Scones, muffins or sweet buns



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

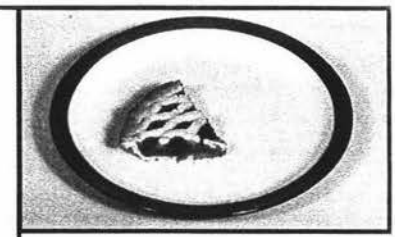
92. Pancake or pikelets



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

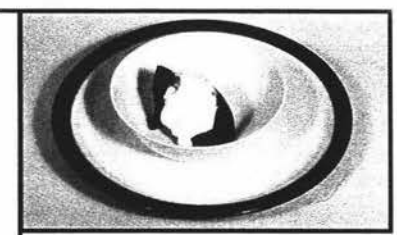
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

93. **Fruit pie, fruit crumble or tart**



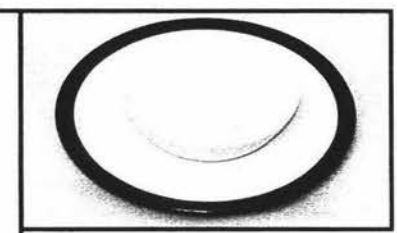
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

94. **Pudding,** eg. sponge pudding or steamed pudding



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

95. **Custard or custard puddings**



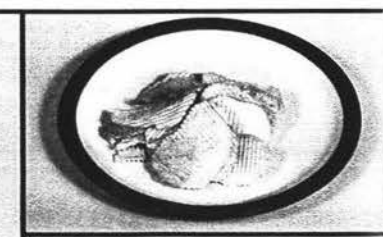
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

96. **Other item of the 'Biscuits/cake' group** If you often have another item from this group, not listed - give the name and tick a box to show how often you eat it ☐

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Snacks and sweets

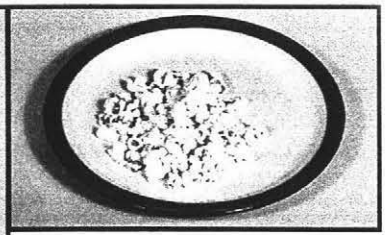
97. **Potato crisps, corn snacks or chips,** eg. burger rings, rashuns, etc



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

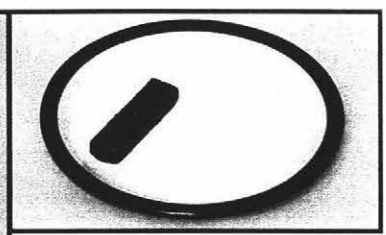
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

98. Popcorn



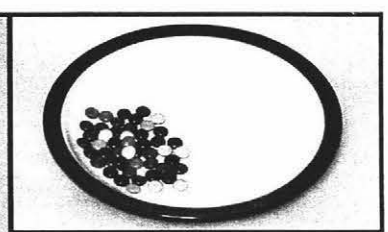
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

99. Chocolate, eg. Moro bar



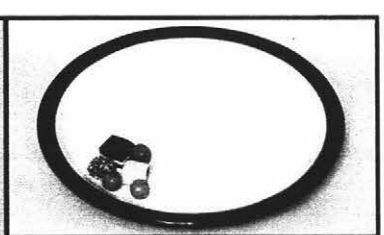
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

100. Candy coated chocolate, eg. pebbles



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

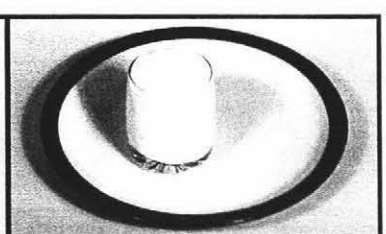
101. Other sweets



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Milks

102. Milk (not flavoured)



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

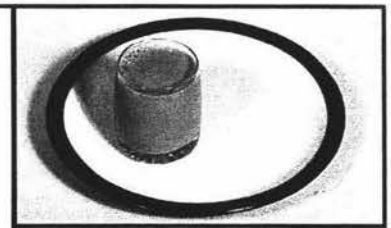
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

102a. What **kind of milk** do you usually drink?

☐ Standard milk (dark blue) ☐ Trim (green) ☐ Soy milk

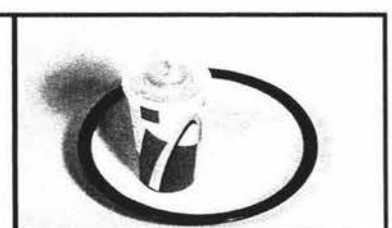
☐ Low fat (light blue) ☐ Extra calcium

103. Flavoured milk



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

104. Milk shake



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

105. Milo powder, Quik or Drinking chocolate

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

105a. With this drink did you use?

☐ All milk

☐ 1/2 milk

☐ 1/4 or less milk

Was **sugar** added?

☐ Yes ☐ No

Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

Infant milks

106. Was your child fed **breast milk** daily in the last 4 weeks?

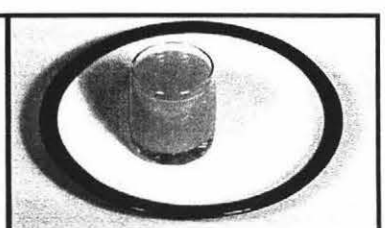
☐ Yes ☐ No

107. Was your child fed **Infant formula** daily in the last 4 weeks?

☐ Yes ☐ No

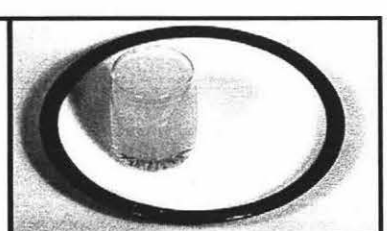
Other drinks

108. **Juice,** eg. fresh orange juice, Just Juice, Freshup, Pams, Ribena diluted



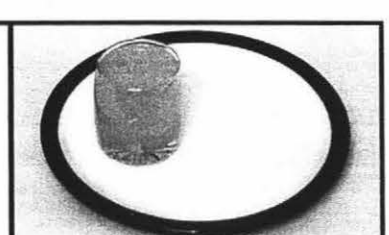
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

109. **Powdered fruit drink,** eg. Refresh, Raro



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

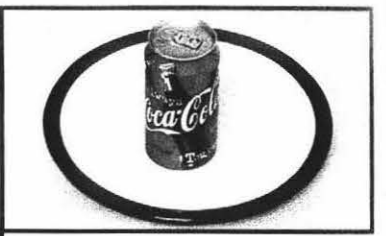
110. **Fruit drink concentrate, cordial**



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

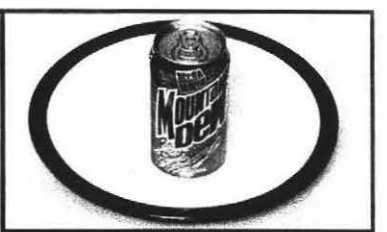
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

111. **Coca cola or other cola drinks**



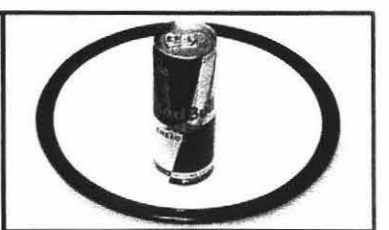
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

112. **Mountain Dew**



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

113. **'Energy' drinks,** eg. V, E_2, Red Bull

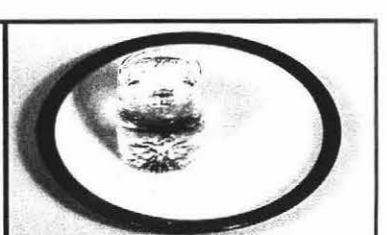


Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

113a. If you have **'energy' drinks**, which **type** do you usually have? (tick one box)

☐ V
☐ E2
☐ Lift
☐ Red Bull
☐ Liquid B
☐ Ikon
☐ Bullrush
☐ Other (Please name) _____

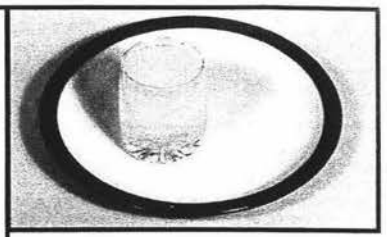
114. **Soft drinks,** eg. lemonade, orange



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

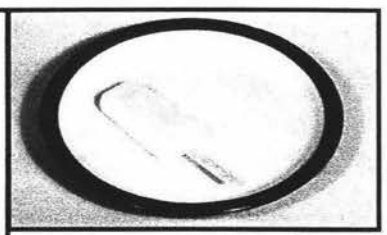
Put a tick ☑ in the box which best tells HOW OFTEN you eat the food.

115. **Sports drinks,** eg. Gatorade, Powerade



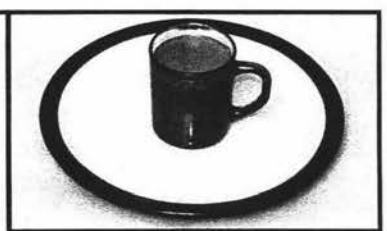
Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

116. **Ice blocks**



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

117. **Tea**



Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

117a. **Was milk added to your tea?** ☐ Yes ☐ No

Was **sugar** added? ☐ Yes ☐ No

118. **Other item of the 'Other drinks' group** If you often have another item from this group, not listed - give the name and tick a box to show how often you eat it _____

Never or less than once a month	1-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	Once a day	2 or more times a day
☐	☐	☐	☐	☐	☐	☐

Dietary supplements

1. During the past month have you taken any vitamins or minerals?
   ☐ Yes ☐ No

2. If **YES,** what do you take fairly regularly? (Choose from the list of dietary supplement types below).

	Number of tablets						
Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
Multivitamin mineral	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

	Number of tablets						
Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
Vitamin C	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

	Number of tablets						
Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
Haliborange	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

	Number of tablets						
Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
Vitamin A	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
				Number of tablets				
Iron	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
				Number of tablets				
Zinc	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
				Number of tablets				
Calcium	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
				Number of tablets				
Omega 3 fatty acids	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
				Number of tablets				
Herbal/Homeopathic	☐	☐	☐	☐	☐	☐	☐	☐

Supplement name:

Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
				Number of tablets				
Other (1)	☐	☐	☐	☐	☐	☐	☐	☐

Name:

Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
				Number of tablets				
Other (2)	☐	☐	☐	☐	☐	☐	☐	☐

Name:

Supplement type	None	1-3 per week	4-6 per week	1 per day	2 per day	3 per day	4 per day	5+ per day
				Number of tablets				
Other (3)	☐	☐	☐	☐	☐	☐	☐	☐

Name:

Thank you very much for filling out this questionnaire.

Please take a moment to fill in any questions you have skipped.

9.13 Appendix 13: 3-Day diet and physical activity diary

Day:..... Date:.....

FOOD

TIME	WHAT YOU ATE	SERVING SIZE	DRINKS

EXERCISE

TIME	TYPE	DURATION

COMMENTS