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Children's Health, Dietary Preferences, Snack Food Intake, Salt Intake and Obesity

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TABLE OF CONTENTS

TABLES

FIGURES

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Abstract

Children's Health, Dietary Preference, Snack Food intake, Salt intake and Obesity

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Background

Children's food preferences determine their dietary intake and their eating behaviours established during childhood track into adulthood. Therefore, it is important to monitor their dietary patterns in order to explore and prevent the onset of adult health problems.

Objectives

To examine children's food preferences, eating behaviours and dietary intakes, and to investigate their noncore food intakes and its impact on body weight.

Design, methods and subjects

Sixty-three children aged 3-10 years participated in this study. Carers of the children completed questionnaires concerning the children's eating behaviour and dietary intake by Food Frequency Questionnaire and 4-day food records. Data were analyzed by SPSS to calculate descriptive statistics. Independent T-test was used for testing differences between means, and a significance level of $P<0.05$ was adopted.

Results

Twelve participants (21%) were classified as fussy eaters. No significant difference in dietary intake between fussy and non-fussy eaters was found. The most liked and disliked food groups were noncore foods and vegetables respectively. Participant's average intake of all food groups and nutrients exceeded the recommended levels except the cereals intake (in Recommendation Example A) and vegetables intake (in Recommendation Example B) of the 3-7 year-old group. Noncore foods contributed an average of 37% of total energy intake, and no significant difference between healthy and overweight participants was found.

Conclusions

Food preferences and fussy eating existed among the children. They were nutritionally adequate with excessive consumption of noncore foods. Education for parents on children's food preference development and balanced diet is required.

Introduction

It is important to monitor children's food consumption patterns in order to explore and prevent the onset of adult health problems (1-3), since eating behaviors established during childhood track into adulthood (4). Research has shown that children's food preferences predict dietary intake pattern (5-9). The development of food preferences is a result of the interaction between genetic predisposition and different aspects of the eating environment (10). Children are born to prefer foods that are sweet (11) and salty (12) and to reject those that are sour and bitter (13). They also have neophobic reaction to new foods and the ability to learn food preferences based on associations with the contexts and consequences of eating various foods. Parents play an important role in children's eating environment and hence their food preferences, these include eating behaviours, attitudes, and child-feeding practices (14). It is normal that children have their own food preferences, however, if they develop fussy eating behaviours, their dietary intake would be affected. Research (15-17) has found that fussy eaters had less dietary variety and diversity than non-fussy eaters. Parents identify fussy eating behaviour as problematic because fussy eaters may eat too little, and it can be difficult to persuade them to eat a healthy diet (18). Children and parents have many areas of interactions and the influence between them is bi-directional(19). A lot of research has studied how parents affect children's eating behaviours (19-21), but not much has been done on the relationship between children's eating behaviour and parents' emotional status. A study (16) has shown that parents of fussy eaters are more struggle in the families and more concession around food and eating than parents of non-fussy eaters.

Much less research has been conducted on Australian children's food preference and eating patterns. The only detailed report on dietary intake of children was provided from the National Nutrition Survey (NNS), 1995 (22), it indicated the dietary intake of children did not follow the recommended guidelines. The cereals intake of 4-7-year-old girls and 8-11-year-old boys were not enough. The children ate a considerable amount of high-energy dense cereal-based products as biscuits, cakes, pastries, etc, rather than the recommended breads, breakfast cereals, pasta, fruit, grain-based nutritious snacks and rice. Fruit consumption decreased with age and half of the children did not eat fruit on the day before the interview. Both vegetable and dairy products consumption were less than the minimum quantity recommended.

The snacks intake of Australian children is relatively high. According to research group MINTEL, Australians are the fourth largest consumers of snack foods (23). The NNS, 1995 indicated that over a third of 8-11-year-old children ate snack foods (potato crisps, corn chips, etc), half ate confectionery and over a third drank soft drinks, flavoured mineral waters or electrolyte drinks on the day before the interview (22). Previous research (24) which examined noncore food intake of children showed that more than 40% of their energy intake was from noncore foods. A New South Wales study indicated that, of the 90% of children who had a snack at recess, 39% had chips(25). In addition, of the top five food types contributing to energy intake from food eaten by Australian children at school, only bread could be considered a core food (26). The others were fast food, fruit/cordial drinks, fat spreads and sweet biscuits and crackers. A study conducted in 2004 (27) on dietary issues in Austistic Spectrum Disorders (ASD) showed that both the ASD and Control group consumed in excess of the daily recommended level for all food group except Cereals. It also revealed that children from both groups were

consuming over four snack foods per day and had a salt intake markedly higher than recommended in the current Australian Dietary Guidelines.

Sodium intake is often related to blood pressure (28). Blood pressure tracks from childhood into adulthood (29) and early diet with high sodium intake may have long term effects on hypertension(30). The growing number of overweight children and the epidemic of childhood obesity is a major public health concern. There is evidence that the prevalence of overweight and obesity in Australian children is increasing. In 1995, 19%-23% of Australian children aged 2-18 years were overweight or obese, a prevalence more than doubled when compared to 1985 prevalence rates (31). One of the reasons for the increase in the prevalence of childhood obesity is unhealthy eating patterns (32). Increased snack consumption in children is often linked to the cause of obesity, however, the relationship between snack food consumption and body weight remains controversial. In a cross-sectional study of 1562 children in the Bogalusa Heart study found that consumption of sweetened beverages; sweets and total consumption of low-quality foods were positively associated with overweight status. Total amount of food consumed, specifically from snacks, was positively associated with overweight status (33). In contrast, Phillips et al(34) observed no association between snacks intake and either body mass index (BMI) or percent body fat among 196 non-obese premenarcheal girls who were followed annually over a 10-year period. Moreover, a previous Australian research (24) showed that noncore food intake was inconsistent with body weight status, although very young obese children obtained significantly more energy from noncore beverages than children in a healthy weight range. Further study is required to investigate the effect of snack intake and body weight status in children.

Objectives

1. To determine whether dietary preference and fussy eating behaviours affect nutritional intake
2. To assess whether children are meeting their nutritional requirements according to the Australian Dietary Guidelines
3. To investigate the nutritional intake of noncore foods versus meals and their impact on salt intake
4. To determine the relationship of noncore food intake and weight status

Materials and methods

Study participants

The Dietary issues in children with and without Austic Spectrum Disorder (ASD) study was initiated in 2003 to compare the eating behavior and nutritional status of children with and without ASD. The original study design and data collection were described in detail in a previous report (27). Children aged 3-10 attending the Allergy Clinic, Childcare Centres, kindergartens in the Central Sydney Area Health Service region or siblings of subjects were randomly recruited. This study included subjects entering the study from 2003 to September 2005. To date, 207 completed questionnaire booklets and food records were sent back to the Allergy Unit. Of these participants, children with ASD (n=63) and any food intolerance (n=64) or allergy (n=14) were excluded, since they may have restricted dietary intake. Written informed consent was given to the parents or carers of the children for the participation in the study. Ethics approval for the study was granted by the CSAHS Ethics Review Committee of the Central Sydney Area Health Service. (see Appendix 1)

Of the 66 subjects that met the inclusion criteria, those whose food group intake appeared implausible (>6 SDs from the mean for each food group; n=3) were excluded. Data provided by participants (n=21) with missing height and weight measurements were used for analysis of nutritional intake and eating behaviour (i.e. objective 1, 2 and 3).

Data by participants who provided height and weight (n=42) were also used to assess the relationship of food intake and weight status. So the total number of analyses was 63. Table 1 shows the characteristics of the study sample.

TABLE 1 SAMPLE CHARACTERISTICS

Number of participants	63
Age, mean (range)	6 (3 – 10)
Gender	
Male, n (%)	37 (59)
Female, n (%)	26 (41)
Anthropometric characteristics	
Weight (n=42), kg (s.d)	24.5 (7.3)
Height (n=42), cm (s.d)	122 (14)
Overweight, n (%)	8 (19)

Method

After an initial interest, parents or carers of children were given an expression of interest form (see Appendix 2) along with the questionnaire booklet (see Appendix 3) and a 4-day food record diary (see Appendix 4). The questionnaires are aimed to gather information on the development history of the child, general health, current nutritional intake, food fussiness, current and past food restrictions, and impact on the family.

Participant's eating behaviours was assessed by using Children's Eating Behaviour & Appetitie Scale (CEBAS). Parent's depression, stress and anxiety levels were determined by Parent's Depress Anxiety & Stress Scale (PDASS). Data on food consumption was collected using food frequency questionnaire (FFQ) and four-day food records including one weekend day.

Children's Eating Behaviour & Appetitie Scale

It assesses children's eating habits and behaviour related to food. It consisted of 50 questions, each with a multiple choice response, where '0' referred to not at all, '1' just a little, '2' pretty much, and '3' very much. It also allowed the carer to list the five most liked and the five most disliked food of the child.

Parent's Depression Anxiety & Stress Scale

It was used to obtain an indication of the level of stress parents experience in their daily lifestyle. It consisted of 42 questions, each with a multiple choice response, where '0' referred to not at all, '1' just a little, '2' pretty much, and '3' very much.

Food Frequency Questionnaire (FFQ)

The FFQ, based on the CSIRO FFQ, was previously modified and used for this study. When completing the FFQ, carers indicated how often, on average, their child had consumed the amount of each food item in the past 3 months. The 6 response categories available ranged from 'Never Tried', 'Don't Like' or 'Rarely' to the frequency of consuming the food item over either a month, week or day. FFQ was used in this study to detect any differences in reported nutrient intake which may have been apparent between the two dietary intake methodologies.

Four-day food record

The 4-day food diary is considered as a validated method of assessing children's dietary intake and dietary habits (35-37). It includes the dietary intake of the child over 4 consecutive days including one weekend day. The carers were given verbal and written instructions on how to record food intake, brand names, recipes and cooking methods in the food diary. A sample record was provided to the carers, and a contact telephone number was provided if further assistance was required.

Data Analysis

Children's Eating Behaviour & Appetitie Scale

Data was compiled into Microsoft Excess 2002 to assess the child's eating behaviours. Choices 'Not at all' and 'Just a little' were combined to one category (score:0), while 'Pretty much' and 'Very much' were combined to another category (score:1). The scores are inversely related to the subject's eating behaviour. Higher scores indicate poorer eating behaviours. Question 5 was used to classify fussy and non-fussy eaters among the participants. Nutritional status of fussy and non-fussy eaters was then compared to determine whether fussy eating affect nutritional intake. Significant difference was determined by t-test, using Statistical Package for the Social Sciences (SPSS, version 13) with significant interval at $p<0.05$.

Food preference of the participants was determined by their 5 liked and 5 disliked foods provided by the carer. The food items were classified into 5 major food groups based on the Dietary Guidelines to Healthy Eating (AGHE) (38), namely cereals, vegetables, fruit, dairy, meat and alternatives and extra foods.

Parent's Depression Anxiety & Stress Scale

There are three scales to measure the negative emotional states of depression, anxiety and stress of the parents. Each of the three scales contains 14 items. The results were used to compare between parents of fussy and non-fussy eaters. Significant difference was determined by t-test, using Statistical Package for the Social Sciences (SPSS, version 13) with significant interval at $p<0.05$.

Food Frequency Questionnaire (FFQ)

Data from FFQ was entered and analyzed by Microsoft Excel Program 2002 and the average serves per day intake for each food group was calculated, results were then sorted into two age groups (3-7 and 8-10 years old) so that the results could be compared to that of the Dietary Guidelines for Children and Adolescents in Australia (DGCAA)(39). The minimum recommended daily intake was used to determine the nutritional adequacy of the participants.

Four-day food record

Raw data from the food records was entered into a nutrient analysis program (M& H Williams, Sydney, SERVE version 5.3 2003) based on Australian Composition of Foods (National Food Authority, Canberra: Australia Government Publishing Service, 1992) to derive nutrient data for all foods eaten in the four days.

The food items consumed were further separated into core and noncore categories. The classification of food (see Appendix 5) (24) was based on the AGHE (38). Core foods were defined as those included in the following five groups: (1) bread, cereals, rice, pasta and noodles; (2) vegetables, legumes; (3) fruit; (4) dairy products and (5) meat and meat alternatives. Water, coffee and tea were included as core beverages. All other foods and beverages were classified as noncore. Further details have been previously reported (24). The percentage of energy and other nutrients provided by the core and noncore foods and beverages were compared.

Subjects' weight and height were reported by the carers and were then classified as healthy weight (includes underweight and healthy weight) and overweight (includes overweight and obese in this study) using international standards (40). The intake of noncore food group between healthy weight and overweight subjects was compared.

Results

1. Eating Behaviour & Nutritional Intake

1.1 Eating behaviour in general

The CEBAS contains description of 50 eating behaviours. The scores are inversely related to the subject's eating behaviour. Higher scores indicate poorer eating behaviours. Fifty-three of the 62 participants scored less than 10 and only one participant scored higher than 20. The common eating behaviours of the participants were as follows; 40% 'ask for food between meals' and 'make repetitive food choice', 30% 'prefer bland foods', feel that there is a 'lack of variety in food choices' and are 'afraid of trying new foods'.

1.2 Fussy eating and nutritional intake

Based on parental report, 12 participants (21%) were classified as fussy eaters. There was no overweight subject classified as fussy eater. The difference in major food group intake between fussy and non-fussy eaters is shown in Table 2 where similar intake of most food groups was apparent. They met or exceeded the minimum recommended intake for all food groups, with a lower intake of vegetables in fussy eaters. The comparison of nutrient intake between fussy and non-fussy eater is presented in Appendix 6. Fussy eaters had a lower intake of all nutrients except riboflavin and calcium. The intake of vitamin C was especially lower in fussy eaters. Based on the Independent Sample T-test analyses, there was no significant difference ($P>0.05$) for nutrients intake between fussy and non-fussy eaters.

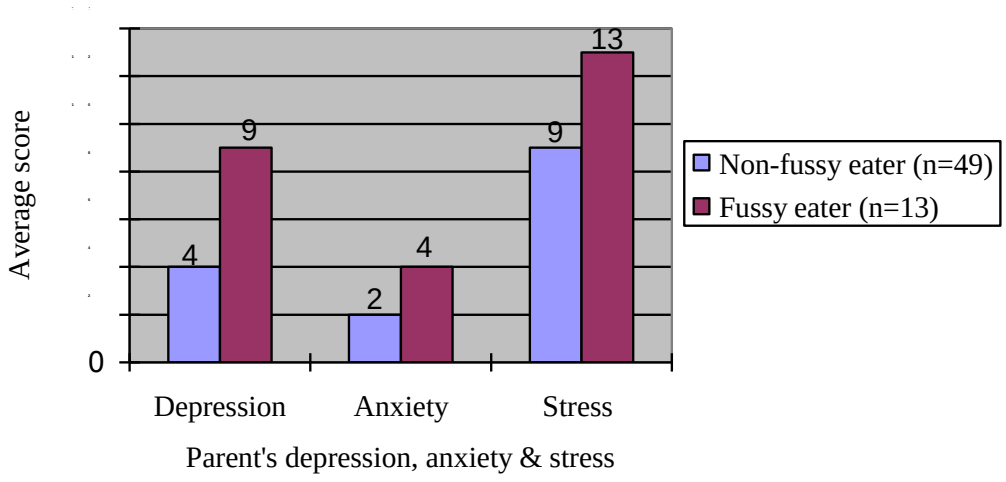
TABLE 2 FOOD GROUP INTAKES OF FUSSY AND NON-FUSSY EATERS (N=56)

	Non-fussy eater (n=44)	Fussy eater (n=12)	
Food groups	**Mean serves ± SD**		**P-value**
Cereals	4.7 ± 2	5.5 ± 1.8	0.23
Vegetables	4 ± 2	2.9 ± 1.2	0.1
Fruits	3.2 ± 2	3 ± 1.7	0.84
Dairy products	3.9 ± 2.2	3.8 ± 2	0.96
Meat & meat alternatives	3 ± 1.6	2 ± 1.3	0.1
Extra foods	6.7 ± 3.5	6.8 ± 4.8	0.88

1.3 Fussy eating and parents' depression, anxiety and stress level

Figure 1 shows the level of parental depression, anxiety and stress between fussy and non-fussy eaters. The average scores for parents of fussy eaters were higher than that of non-fussy eaters' parents, especially for depression and stress. The depression level of fussy eaters' parents was above normal while the stress scores were nearly over the normal level (see Appendix3.1c), however, the differences between groups were not significant.

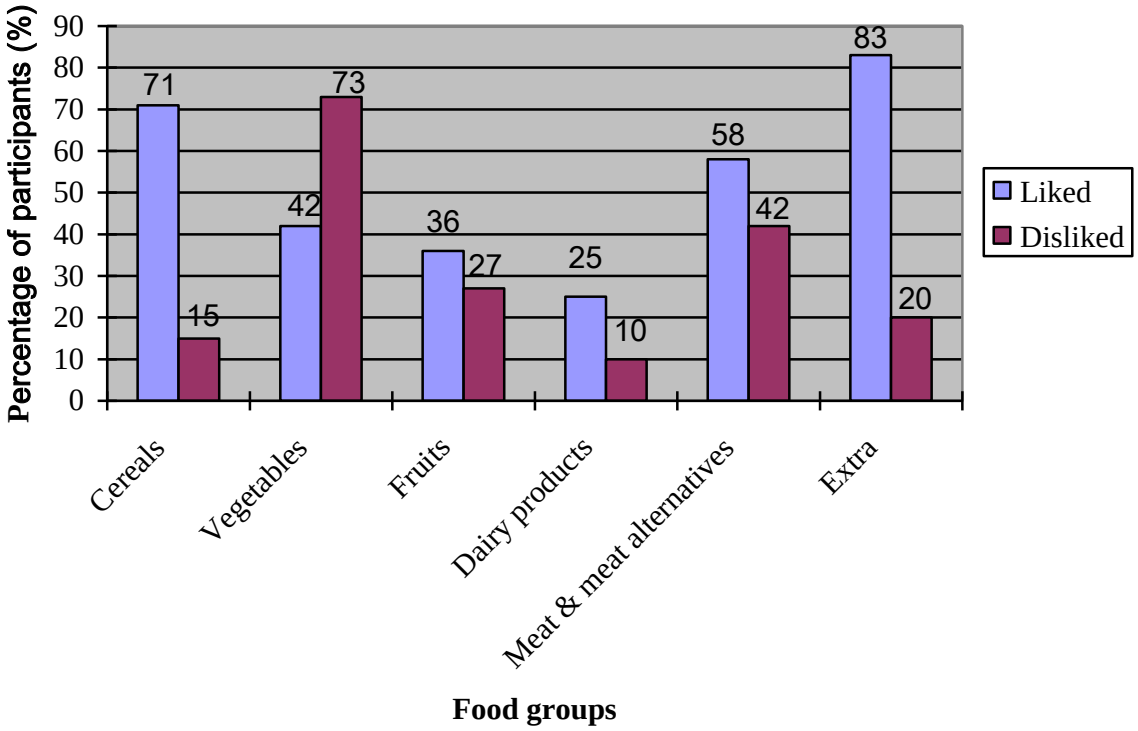
FIGURE 1 LEVEL OF PARENTAL DEPRESSION, ANXIETY AND STRESS BY FUSSY EATING OF PARTICIPANTS (N=62)



2. Dietary Preferences

Figure 2 shows the proportion of liked and disliked food groups among all the participants. The percentage of liked is higher than disliked for all food groups except for the vegetable group. The favourite food group was the extra food group with 49 participants (>80%) liking this group. The second favourite food group was the cereal group where 42 participants (> 70%) liked this food group. The most disliked food group was the vegetable group as 43 participants (>70%) disliked this group.

FIGURE 2 PROPORTION OF LIKED AND DISLIKED OF FOOD GROUPS OF PARTICIPANTS (N=59)



3. Nutritional Adequacy

3.1 Comparison of food group intake with Dietary Guidelines

Table 3 & 4 summarizes the comparison of the major food groups intake of the participants with the Dietary Guidelines for Children and Adolescents in Australia (DGCAA) (39), and the proportion of participants meeting the minimum recommendation. When compared with Recommendation Example A, the average daily intakes of all major food groups exceeded the minimum recommendation for both age groups, except for the cereal group in the younger age group where their intake was just below the minimum recommendation. The proportion of children meeting the minimum recommendation was the lowest in cereal group for both age groups as only 15 participants (35%) from the younger age group and 8 participants (50%) from the older age group met the minimum recommendation. In the older age group, the dairy products group was the second lowest. More participants in the younger age group met the recommendation in the vegetable group than in the older age group.

When compared with Recommendation Example B, the average daily intake of both age groups exceeded the minimum recommendation for all food groups except the vegetable group in the younger age group. The average intake of extra food group was more than five times the minimum recommendation for both age groups. As illustrated, a relatively low proportion of participants (37%) in the younger age group met the recommendation for vegetable intake. The meat and meat alternatives group had the largest proportion of participants (100%) meeting the guideline for both groups. All the participants met the recommendation for fruit consumption in the older age group. Only half the older group participants met the recommendation for the vegetable and dairy products groups.

Regarding the individual food group, only 45 participants (76%) consumed fish in the past 3 months, and the average intake was 1.8 serves per week. Among the participants who consumed fish, only 26 of them (44% of all participants) consumed oily fish, and the average serve was 0.87 serve per week. In the fruit group, the consumption of fruit juice decreased with age where 51% of the younger age group consumed at least one serve of fruit juice daily, while 31% of the older group consumed at least one serve of fruit juice daily.

TABLE 3 COMPARISON OF THE FOOD GROUP INTAKE OF PARTICIPANTS AGED 3-7 WITH THE DGCAA (N=43)

Participants aged 3-7 (n=43)					
Food group	**Example A**	**Example B**	**Mean intake ± SD**	**Proportion meeting minimum recommendation for Example A (%)**	**Proportion meeting minimum recommendation for Example B (%)**
Cereals	5-7	3-4	4.5 ±1.7	35	74
Vegetables	2	4	3.6 ±1.7	86	37
Fruits	1	2	3.1 ±1.8	98	77
Dairy products	2	3	4.1 ±2.1	90	70
Meat and meat alternatives	0.5	0.5-1	2.6 ±1.6	100	100
Extra foods	1-2	1-2	6.6 ±4	98	98

Table 4 COMPARISION OF THE FOOD GROUP INTAKE OF PARTICIPANTS AGED 8-10 WITH THE DGCAA (N=16)

Participants aged 8-10 (n=16)					
Food group	**Example A**	**Example B**	**Mean intake ± SD**	**Proportion meeting minimum recommendation for Example A (%)**	**Proportion meeting minimum recommendation for Example B (%)**
Cereals	6-9	4-6	6.1 ±2	50	94
Vegetables	3	4-5	4.5 ±2.6	75	50
Fruits	1	1-2	3.4 ±23	100	100
Dairy products	2	3	3.6 ±2.6	69	50
Meat and meat alternatives	1	1-1.5	3 ±1.5	100	100
Extra foods	1-2	1-2	7±2.7	94	94

3.2 Comparison of nutrient intake with Recommended Dietary Intakes

The participants' mean daily intake of energy and nutrients are presented in Table 5. On average, mean intakes for all nutrients were above the Recommended Dietary Intakes (RDI). Among the macronutrients, the carbohydrate and total fat intake was just above the RDI, while protein intake was nearly 300 % RDI. The average intake for carbohydrate, protein and fat as a percentage of energy, averaged at 54%, 15% and 32% respectively. The saturated fat contributed nearly half of the total fat intake. Most of the vitamins intake were around 200 to 300% RDI, with Vitamin C being exceptionally high at more than 400% RDI. The minerals intake was also adequate with calcium intake was just above the RDI. Sodium intake of all participants exceeded the recommendation with average daily intake more than 400% RDI.

TABLE 5 DAILY INTAKE OF ENERGY AND NUTRIENTS OF PARTICIPANTS (N=45)

Energy/ Nutrients	Average intake ± SD (% energy intake)	% RDI
Energy (KJ)	7602.2 ± 1953.4	125.9
Carbohydrate (g/d)	236.5 ± 68.2 (54)	116.2
Protein (g)	67.3 ± 21.3 (15)	272.4
Total fat (g/d)	67.9 ± 20.3 (32)	105.1
Saturated fat (g/d)	29.4 ± 12.1 (15)	N/A
Monounsaturated fat (g/d)	23.5 ± 7.8 (12)	N/A
Polyunsaturated fat (g/d)	8.4 ± 3.6 (4)	N/A
Thiamin (mg/d)	1.8 ± 1.8	281.2
Riboflavin (mg/d)	2.1 ± 1.3	192.5
Niacin (mg/d)	28.6 ± 9.4	236.9
Folate (mg/d)	211.7 ± 74.2	168.2
Vitamin C (mg/d)	135.2 ± 146.6	448.6
Calcium (mg/d)	890.1 ± 385.9	109.4
Sodium (mg/d)	2362 ± 1188.2	431.9
Magnesium (mg/d)	244.6 ± 95.7	193.5
Iron (mg/d)	10.6 ± 5.6	151.4
Zinc (mg/d)	8.7 ± 2.8	125.7

3.4 Contribution of sodium in diet

The contribution of sodium from selected foods is shown in Table 6 where bread (21%) was the main contributor of sodium intake in all participants (n=45). Twenty percent of the sodium intake was attributed to salt if participants (n=4) had added salt in their diet. The lowest contributor was from sauce at only 3%.

TABLE 6 PROPORTION OF SODIUM PROVIDED BY SELECTED FOOD GROUPS. (N=45)

Selected food groups	Participants consumed, n (%)	Mean Sodium contribution ± SD (%)
Sauce	22 (48)	3 ± 2
Fast Foods	45 (100)	4 ± 7
Breakfast Cereals	39 (86)	6 ± 5
Dairy products	45 (100)	13 ± 9
Dishes prepared with commercial sauce	22 (48)	14 ± 19
Snack foods	45 (100)	15 ± 11
Processed Meat	23 (52)	16 ± 9
Salt	4 (14)	20 ± 20
Bread	45 (100)	21 ± 12
Others	45 (100)	22 ± 14

4. Noncore Food Group Intake

4.1 Noncore food group consumption of participants

All the participants consumed foods and beverages from the noncore food group. The top five commonly consumed noncore foods were; biscuits/ crackers (98%), spreads (90%), hot chips (74%), ice-cream/dairy desserts (71%) and cake/muffin (62%).

Forty-four percent children in this study consumed sweetened beverages including soft drinks and cordials. Among all the noncore food intake occasions, 50% were between regular meals.

The contribution of energy and nutrients from the noncore food group is presented in Table 7 where nearly 40% of the energy and carbohydrate intakes in participants were from noncore foods. Nearly half of the total fat intake and substantial amount (28%) of sodium intake were contributed by noncore foods.

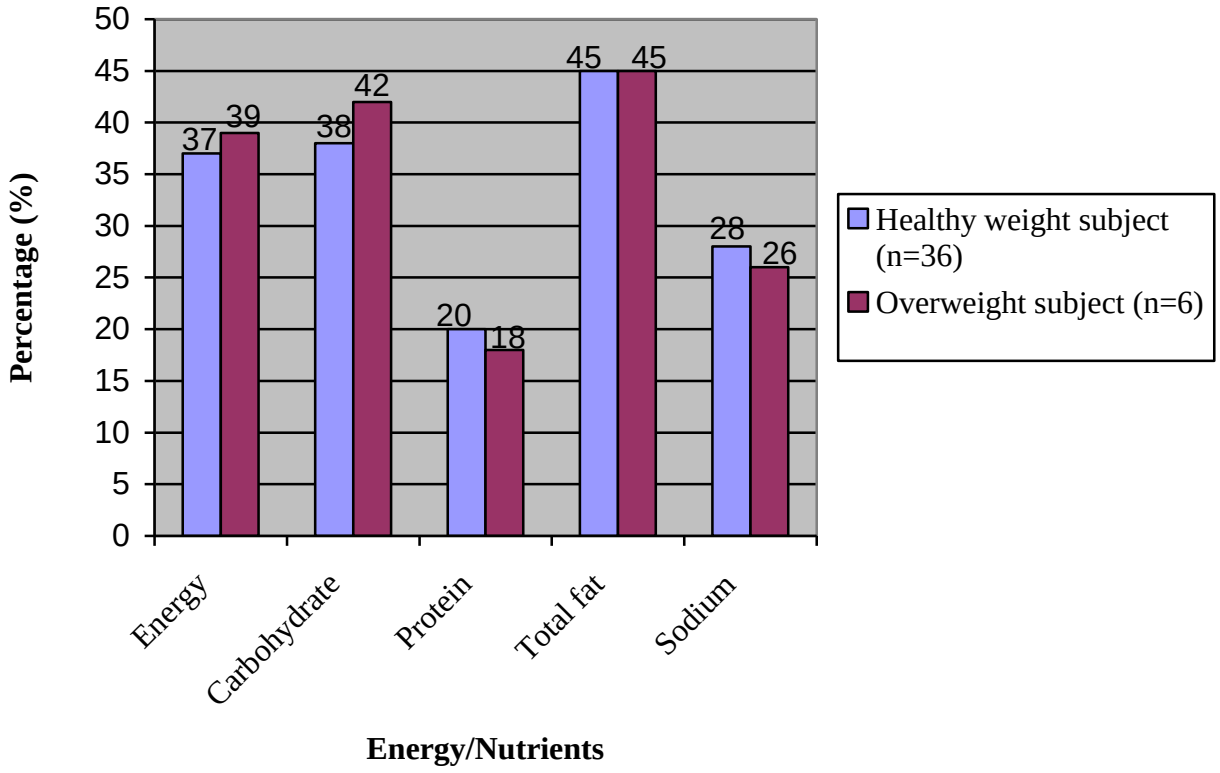
TABLE 7 PROPORTION OF NUTRIENTS INTAKE FROM NONCORE FOOD GROUP (N=45)

Energy/Nutrients	Proportion of intake from noncore food group ± SD (%)
Energy (KJ/d)	37 ± 13
Carbohydrate (g/d)	39 ± 15
Protein (g/d)	19 ± 10
Total fat (g/d)	45 ± 14
Sat fat (g/d)	45 ± 15
MUFA (g/d)	45 ± 15
PUFA (g/d)	43 ± 16
Sodium (mg/d)	28 ± 14

4.2 Noncore food group intake by weight status

The contribution of energy and nutrients intake from noncore food group between healthy and overweight subjects is shown in Figure 3. Overweight subjects obtained slightly more energy and carbohydrate from the noncore food group than the healthy weight subjects. All other nutrient intakes were similar or slightly lower in the overweight subjects. Comparison of major food group and nutrient intakes by weight status are presented in Appendix 7.

FIGURE 3 PROPORTION OF ENERGY AND NUTRIENTS FROM NONCORE FOOD GROUP BY WEIGHT STATUS (N=42)



Discussion

Fussy eating & nutritional intake

This study found that the participants' eating behaviours were generally good as the majority of them scored less than 10 out of 50. Some parents felt that their children's diet lacks variety in food choices because they are afraid of trying new foods, make repetitive food choices and prefer bland foods. It is also common that the children ask for food between meals. Some of these behaviours were classified as fussy eating in another study (16). The results indicate that the diets of fussy and non-fussy eaters were more similar than different. Their average intake met or exceeded the minimum recommendation for all food groups. However, the vegetable intake of fussy eaters was lower than non-fussy eaters. This is consistent with other studies (16, 17), fussy eaters consumed fewer fruits and vegetables thus, their vitamin C intake was much lower in this study. All the nutrient intakes were lower in the fussy eaters except riboflavin and calcium intakes. This may be due to higher milk and diary products intake as these are the main sources for both nutrients. Although fussy eaters, as a group, met or exceeded recommendations, some individuals had marginal intakes of major food groups and nutrients. It is a concern that these children cannot meet their nutritional needs in the long term if their fussy eating continues. A particular interesting finding is that no overweight children in this study was classified as a fussy eater. This is consistent with the finding in another study (17) that fussy eaters were less likely to be overweight.

Parents concerned about fussy eating of children

As shown in Figure 1, parents of fussy eaters were more depressed, anxious and stressed when compared to those of non-fussy eaters. This is because of the influence children and parents have on each other (19). Parents shape children's eating environment and hence their food preferences. In turn, children affect parents' psychological status by their eating behaviours. Fussy eaters make meal time stressful (16), they also tend to eat small meals, to eat slowly and to be less interested in food (15, 41). These factors result in concern and anxiety over the child's dietary intake. This may then lead to parents using pressure as a feeding strategy (42). However, children would actually reduce their liking and intake of the food they are being pressured to consume (17, 43, 44). This may further worsen the fussy eating behaviour of the child. In order to reduce the anxiety of the parents, it is essential to educate them about the development of food preferences in children such as; their predisposititon to sweet and savoury foods, rejection of bitter and sour foods, fear of trying new foods, learning to acquire new food preferences based on the post-ingestive consequences and also the social contexts of eating. It is also important to educate parents that the way they feed their children have a direct impact on their children's food preferences and eating behaviours(14).

Food preferences determine food consumption

The results shown in Figure 2 illustrate that most (>80%) participants liked extra foods and many of them (>70%) disliked vegetables. The dislike of vegetables among the children is consistent with the literature(5, 6, 8, 20). There are two reasons to explain this, firstly, most noncore foods are high in fat, salt or sugar, and children are born with an inherent preference for sweet and savoury tastes (11, 12). They also acquire the

preference for high-fat foods rather quickly(45), therefore, children prefer noncore foods. Secondly, children's preferences for foods that were used as a reward (nonfood related task) was found to be increased (46), such as snack foods. Their preferences for the foods encouraged by their parents (43, 47) such as vegetables was often reduced. It is shown that food preferences in children are important determinants of their food consumption (5-9) thus, their noncore food group intake was well above the recommended level in this study.

Imbalanced diet

As shown in Table 3 and 4, the dietary intakes of the participants were more comparable to Recommendation Example B of the dietary guideline because they include more of all food groups and have a higher intake of animal products in their diet. Overall, when compared with Recommendation Example B, participants were adequately nourished. In the current study, average daily intake of all food groups were above recommended levels except for the vegetable intake in the younger age group. Some food groups' intake greatly exceeded the recommendation, especially meat & meat alternatives group and extra food. One particular concern is that less than half of the participants met the recommendation for minimum vegetable intake, once again reflecting the children's food preferences determine their food intake (9). Another concern is that only half of the participants from the older age group met the recommendation for diary products intake. Dairy products are excellent sources of many nutrients, especially calcium (39). Calcium is important for bone growth and for attaining peak bone mass at adolescence, which is protective against osteoporosis and bone fractures later in life (48). In this study, children appeared to have a high protein, low carbohydrate diet. Their protein intake was nearly

three times the RDI while carbohydrate intake was just above the RDI (see Table 5), in which 40% carbohydrate was from noncore foods. The high prevalence of such eating pattern may be because parents lack sufficient time for meal preparation. The proportions of married women in the workforce have substantially increased in the past years (49). Therefore, convenient meals are served instead of the traditional meals, which may not provide children with enough energy. This may explain why they ask for foods between meals, and most of the time, energy-dense snack foods are provided. For that reason, increasing children's cereals intake in regular meals is recommended such as Recommendation Example A (see Table 3) because it provides more energy in the form of carbohydrate from the cereals group (38). This will in turn allow them to have sustainable energy and hence decrease the consumption of snacks between meals.

Imbalanced type of fat in diet

In this study, total fat provided 32% of the total energy, with 15%, 12% and 4% from saturated fat, monounsaturated fat and polyunsaturated fat respectively. The results are consistent with the NNS 1995 (22) where 33.4% of total energy was from fat and the contribution of saturated fat, monounsaturated fat and polyunsaturated fat was 14%, 12% and 5% respectively. The saturated fat intake was higher than the recommendation of 10% total energy intake (50), this may due to the high consumption of noncore foods and dairy products among the participants. It is desirable to educate parents about the appropriate alternative fat sources such as monounsaturated fatty acids and polyunsaturated fatty acids. The polyunsaturated fat is much lower than the recommended level of 10% of energy intake, so the omega-3 polyunsaturated fatty acid

(ω-3) intake can be considered negligible. This is because the oily fish consumption of the participants is very low with less than one serve per week and more than half of the participants did not include any oily fish in their diet. Oily fish is the main source of ω-3, which is important for brain development. It also reduces the incidence and symptom severity of several neurological, immunological, cardiovascular, and inflammatory conditions (51-53). Many believe that the increased prevalence of atopic diseases, such as asthma, eczema and allergic reactions is due to changes in the typical diet, that includes a decreased consumption of ω-3 (54). A previous study (55) has shown that the consumption of oily fish more than once a week reduces the risk of developing airway hyperresponsiveness.

Reasons for excessive intake of certain nutrients

Results shown in Table 5 indicate that the mean energy and nutrient intakes of the participants were above the RDI. This is inconsistent with the result of NNS, 1995 (22), which indicated that many children's micronutrients intakes were less than 70% of the RDI. In this study, some nutrient intakes such as protein, vitamin C and sodium were exceptionally high. The high protein intake (~300% RDI) is due to the elevated consumption of meat and meat alternatives among the participants with their intake exceeding five times the recommendation. A high fruit group intake contributed to the soaring vitamin C intake (>400% RDI) in this study. Over half of the participants in the younger age group consumed at least one serve of fruit juice daily. Fruit juice is a good source of vitamin C and folate, however, most fruit juices contain added sugars and this may contribute to excessive daily energy intakes. It is a concern that the sodium intake of the participants were remarkably high (>400% RDI), some studies in children and

adolescents have found sodium to be positively associated with blood pressure (56). High sodium intake in early life may cause high blood pressure later in life (30), so it is important to control the sodium intake of children. In this study, salt is a big contributor to the sodium intake if the children had added salt in their diet. However, there are also many sources of 'invisible salt' in their diet. One of the main sources is bread, which is the major component of their diet. All participants consumed bread and it has contributed 21% of their sodium intake. Another main source of sodium is processed foods, such as processed meat and snack foods. The commercial sauce used in cooking is also a major source of sodium in the children's diet. This has important implications for identifying sodium reduction strategies. It is found that responses to salty foods are strongly influenced by environmental factors (57). An early experience with low or high salt diets may have a long-term impact on preferred salt levels (58). Moreover, the acceptance of certain foods increased with repeated exposure to that foods (59-61). Therefore, reduction of salt in the food supply or increasing the availability of low salt food products in the market are important strategies to reduce the sodium intake of children. However, the high percentage RDI of sodium may also be due to the relatively low RDI values set for sodium.

Overconsumption of noncore foods

In this study, the noncore food consumption was tremendously high where it exceeded three times the maximum recommended quantity (see Table 3 & 4). Overconsumption of noncore food has been reported in other studies and similar results were found (22, 24). All participants in this study consumed noncore foods, making up 37% of their total energy intake. The most commonly consumed noncore foods such as biscuits, hot chips,

ice-cream and cake, are all tend to be energy dense and of little nutritional value. They also contributed nearly half the daily fat intake and considerable amount of sodium intake. Despite this, snack foods are still readily available to children in a variety of settings, including homes and schools. As mentioned previously, children did not get enough energy from their main meals, so they asked for foods between meals and many parents give them noncore foods, because they believed that it is acceptable for children to have unhealthy snacks daily as a 'treat', which can be part of a healthy diet (62). A previous study (26) showed that the top five food types contributing to energy intake at school were all noncore foods except for bread. It also revealed that the energy intake from snack foods were greater at school when compared to out of school. In this study, half of the noncore food intake occasions were between regular meals and this implied that noncore foods intake in children were spread throughout the whole day. It is crucial to control the overconsumption of energy-dense food by providing children with a substantial meal and avoid snacking all through the day.

Noncore food consumption inconsistent with body weight

The prevalence of overweight and obese participants was 20%, which is comparable to the national average (19-23%) (31). Snack foods are frequently related to promotion of weight gain in children, this is because, firstly, snack food consumption is very often addition to the regular meals. Besides obtaining energy from the major food groups, the children receive extra energy from the noncore foods resulting in a positive energy balance which leads to weight gain. Secondly, most snack foods are high in fat and dietary fat intake is associated with weight again (63, 64). In this study, there was no significant difference in the contribution of energy and nutrients between different weight

groups. The lack of association of noncore food intake with body weight may be due to under-reporting of energy intakes that has been observed among overweight children (36, 37). The other possible reason is the overweight participants may have modified their dietary intake in response to their weight. A previous study (33) has shown an association between low quality food and overweight status, while other studies have not (24, 34). There are several reasons for the difference in results; it may be due to the difference in age groups studied, length of the study, locations, methodologies, or definition of snack. Even the association of snack food intake and weight status is inconclusive, due to its low nutrient density and high saturated fat content. It is a concern that high intake of noncore foods will lead to other health problems and will affect the health status of the children in long term.

Limitations and further research

In this study, both FFQ and 4-day food records were used to collect the dietary intake of children. This is unlike the other study where only 24 hour recall were used (24). When used exclusively, a 24 hour recall method is inadequate for characterizing the usual eating patterns of an individual (65, 66). The usage of both food diary and FFQ can give a more detailed food intake of the child and it can also improve the confidence in results. However, there are some concerns for these methods. For FFQ, the reported amounts and the frequency of foods might not be correct and in most cases, overestimation occurs (66, 67). For food records, carers may not fill in the type and quantity of food accurately, especially when participants have their meals at childcare centers or in schools. In addition, the unclear descriptions of foods in the food record also lead to a source of error when analyzing children's dietary intake, so detailed explanations on how to fill in the

FFQ and food diary may be needed. It would be better if menus can be obtained from childcare centers and schools with the assistance of staff for the recording of the amount of food consumed by the child. The weight and height of participants were provided by carers and this self-reported height and weight was not considered a big limitation, as it is a validated method (68) and parents can provide valid information. We were unable to detect significant differences in many of the comparisons between groups. This is possibly due to the small sample size, hence resulting in the unexpected statistical results. Increasing the sample size can thus be seen as important as it would allow less variation and consequently more accurate results.

This study shows the general view of children's eating pattern, further research on this study should specifically address the limitations noted in this study. Further investigation on parents' nutrition knowledge, beliefs and attitudes are also crucial for planning strategies for promoting healthy eating in children.

Implications of findings

The results in the current study provide insights that are potentially important to the design of effective behaviour intervention for children such as changing children's eating patterns so to be more in line with dietary guidelines. Since the children are overeating, the message to parents should no longer focus solely on increasing the intake of certain food groups, it should focus more on educating the parents on a healthy diet and how to provide their children with filling regular meals rather than snacking throughout the day.

Conclusion

The data in this study suggest that both of fussy and non-fussy eaters had adequate nutritional intakes. However, the children's diets were imbalanced due to their food preferences. More than half of the participants did not meet the recommendation for cereals (in Recommendation Example A) and vegetable (in Recommendation Example B). In addition, noncore foods were a main contributor to the energy and fat levels. Even though no significant association was found between snack intake and weight status, as a result of poor nutritional content, they should be reduced in children's diet. This study also shows that parents were anxious about their child's eating behaviours, therefore, education is required for parents on children's food preferences development and how to offer their child a healthy diet.

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Appendices

Appendix 1

Ethics Approval

Appendix 2

Expression of interest

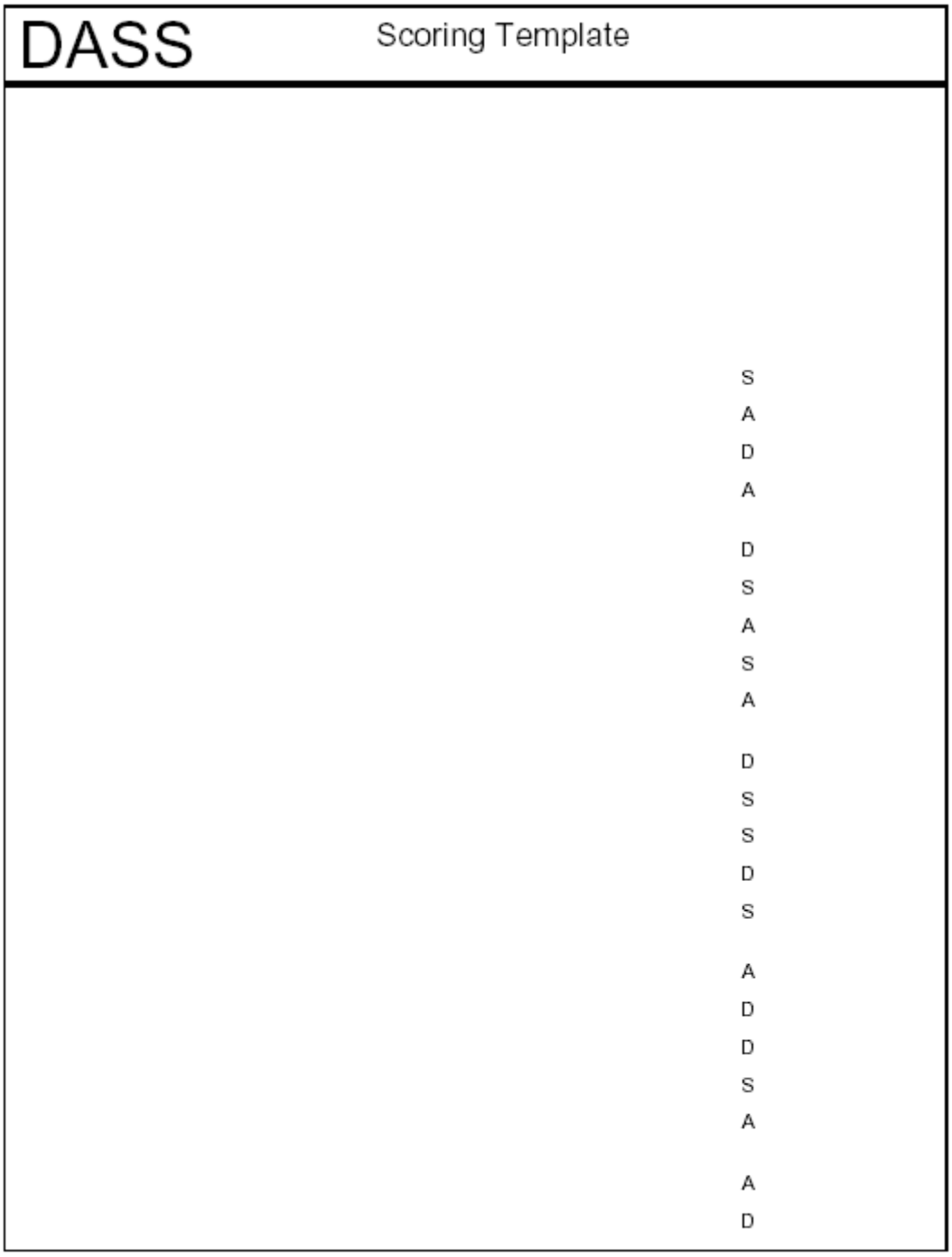
Appendix 3

Questionnaires used this study

Appendix 3.1c Scoring of PDASS

	Depression	Anxiety	Stress
Normal	0 - 9	0 - 7	0 - 14
Mild	10 - 13	8 - 9	15 - 18
Moderate	14 - 20	10 - 14	19 - 25
Severe	21 - 27	15 - 19	26 - 33
Extremely Severe	28+	20+	34 +

Appendix 3.1b Scoring template for PDASS



Apply template to both sides of sheet and sum scores for each scale.

Appendix 4

Four Day Food Intake Diary

Appendix 5

Classification of core and noncore foods

Appendix 6

Energy and nutrients intake of fussy and non-fussy eaters

Appendix 6 Energy and nutrients intake of fussy and non-fussy eaters (calculated from 4-day food records)

	Average daily intake ± SD		**P-Value**
Energy/Nutrients	**Non-fussy eater (n=32)**	**Fussy eater (n=8)**	**Independent Sample T-Test**
Energy (KJ/d)	7762 ± 2092	7054 ± 1320	0.37
Carbohydrate (g/d)	243 ± 74	213 ± 47	0.28
Protein (g/d)	71 ± 22	58 ± 16	0.13
Total fat (g/d)	68 ± 21	68 ± 19	0.94
Riboflavin (mg/d)	2.1 ± 1.4	2.3 ± 1.0	0.778
Thiamin (mg/d)	2.0 ± 2	1.6 ± 0.6	0.57
Niacin (mg/d)	30 ± 10	25 ± 5.9	0.17
Folate (mg/d)	216 ± 74	193 ± 70	0.44
Vitamin C (mg/d)	147 ± 169	96 ± 47	0.42
Calcium (mg/d)	891 ± 362	1005 ± 506	0.47
Phosphorus (mg/d)	1307 ± 445	1251 ± 399	0.75
Sodium (mg/d)	2412 ± 1249	1919 ± 461	0.28
Potassium (mg/d)	2487 ± 996	2351 ± 581	0.71
Iron (mg/d)	11 ± 6	10 ± 6.3	0.74
Mgnisum (mg/d)	254 ± 106	222 ± 62	0.43
Znic (mg/d)	9 ± 3	7 ± 2.3	0.1

Appendix 7

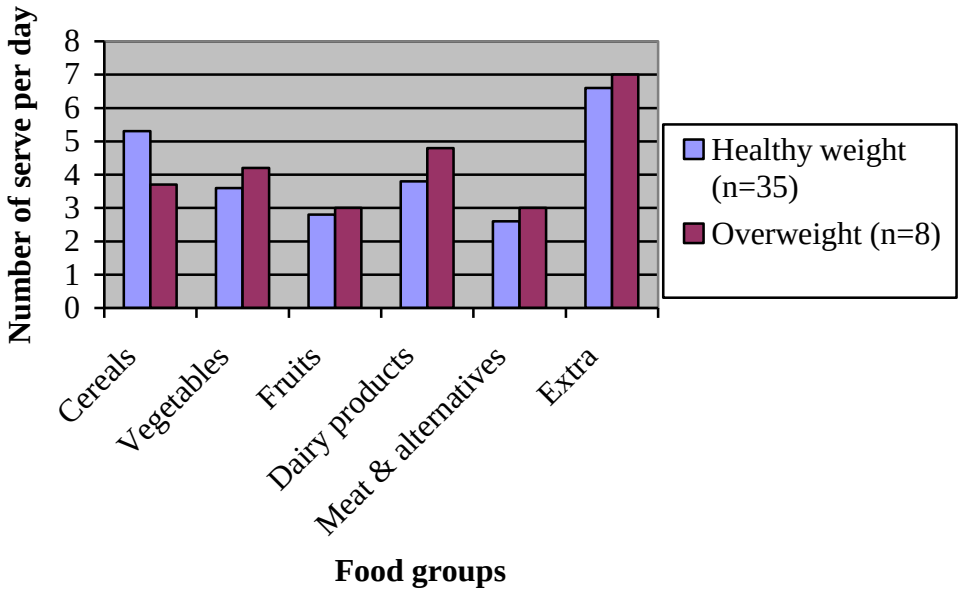
Major food group and nutrient intakes

of

healthy weight and overweight subjects

Appendix 7.1

Comparison of food groups intake by weight status



Appendix 7.2

Energy and nutrients intake by weight status

	Average intake ± SD		P-Value
Energy / Nutrients	**Healthy weight (n=36)**	**Overweight (n=6)**	**Independent Samples T-Test**
Energy (KJ)	7609 ± 2043	7558 ± 1361	0.94
Carbohydrate (g/d)	237 ± 73	236 ± 24	0.98
Protein (g)	67 ± 22	68 ± 19	0.89
Total fat (g/d)	68 ± 20	67 ± 21	0.88
Thiamin (mg/d)	1.7 ± 1.6	2.9 ± 2.3	0.11
Riboflavin (mg/d)	1.9 ± 0.9	3.2 ± 2.5	0.24
Niacin (mg/d)	28 ± 9.6	28 ± 8	0.82
Folate (mg/d)	210 ± 75	222 ± 75	0.71
Vitamin C (mg/d)	142 ± 156	89 ± 25	0.41
Calcium (mg/d)	890 ± 409	893 ± 196	0.98
Sodium (mg/d)	2416 ± 1259	2008 ± 442	0.44
Iron (mg/d)	11 ± 6	10 ± 2	0.71
Zinc (mg/d)	8.5 ± 2.9	9.5 ± 2.5	0.46