A Comparison of Adolescents Consumption of Micro and Macro Nutrient Rich Foods

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Abstract: The study involves a comparison of pupils' consumption of macro and micro nutrient rich food as well as healthy and less healthy snacks after being exposed to a teaching model on balanced diet developed by the researcher which takes into cognisance pupils' prior knowledge of healthy eating. Healthy snacks are snacks that are low in fat and sugar while less healthy snacks are snacks that are high in fat and sugar. The study was carried out in Britain, United Kingdom in summer term of 2007. Participants were year 7 pupils of Ceredigion Local Education Authority in rural Mid-Wales, they were requested to fill-in a Food Diary of food consumed at breakfast, lunch and dinner times including mid-morning and mid-afternoon snacks for five days (Thursday to Monday). This is to include both food consumed at home at weekend as well as school meals consumed at school during weekdays. There was evidence of increase of consumption of healthy snack as well as the consumption of macro nutrients (carbohydrate, fat and protein) and micro nutrients (vitamin, mineral and fibre); all six classes of food that makes up a balanced diet [1] after the intervention compared to before the intervention, although the rate of increase in the consumption of micro nutrient was not statistically significant compared to the increased in the consumption of macro nutrient. This study revealed that though the teaching model was able to alter eating behaviour in the desired direction of healthy eating which is the consumption of micro nutrient. More has to be done to encourage adolescents to consume more vitamin, mineral and fibre rich food items.

Keyword: Balanced diet, healthy eating, nutrition education, food-diary, nutrients, healthy snacks, adolescent, macro-nutrient, micro-nutrient, United Kingdom.

INTRODUCTION

The ultimate goal of nutrition education is to inculcate in learners desirable dietary habits that will be beneficial in adulthood. One way of achieving this goal is teaching learners the principles underpinning healthy eating which is embedded in the concept of balanced diet and also teaching them how to apply these principles in their choice of food as it is been found that majority of students have well-established diet and health concepts [2] (7-16years old; [3] Post-16) but find it difficult translating the knowledge into making healthy food choices. Also, despite there being numerous behavioural-related dietary studies, there have been very few studies investigating the impact of formal school education and teaching strategies on health-related behaviour [4]. This study is specifically aimed at investigating students' choice of healthy eating as influenced by their knowledge of balanced diet taught in the classroom.

It is evident from research studies [5-7] that the dietary pattern of school children has not changed irrespective of the increased provision of nutritional information (e.g. 5 a Day). This delayed change might be due to the fact that several interrelated factors influence children's awareness and consumption of food not just the knowledge of balanced diet. Children tend to consume fewer classes of food in their choice combination and also tend to consume the 'same classes' of food most of the time. The macronutrient classes of food (carbohydrate, protein and fat), when consumed in excess, can be detrimental to health. The precursor of some chronic diseases starts in childhood and this is the time when dietary habits start to be formed.

Summarily, children's awareness of food and diet is influenced by a wide variety of interrelated factors including culture, socio-economic factors, parental influence, peer-group pressure, the media and nutritional education received at school. The literature on eating behaviour and its relation to nutrition knowledge is contradictory. Some researchers have shown that nutrition knowledge is highly and positively related to the behaviour towards nutrition [8, 9]. [8, p.131] further stated that:

'A positive relationship between nutrition knowledge and eating behaviour of students indicated that nutrition knowledge might have a positive impact on eating behaviour and concluded that a variety of student-centred activities focusing on relevant problems and developmentally appropriate, will result in increased knowledge of nutrition and may, in turn, improve eating behaviour.'

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E-ISSN: 1929-4247/12

Other researchers, however, found little correlation between nutrition knowledge and actual choices of healthy food [10, 11].

METHODS

The design of the study was a pre-post intervention design as participants filled-in the Food Diary for five days (Thursday to Monday) before the intervention (teaching on balanced diet) and after the intervention. The analysis of any effects of the intervention is focused on changes after the intervention. If the change (in the dependent variable i.e. healthy choice of food) is greater after the intervention than before the intervention then this difference is attributed to the impact of the treatment (independent variable – teaching model on balanced diet). Before the commencement of the teaching session that lasted for three weeks (a 45 minute teaching session once a week), the participants (124 Year 7 students from two secondary schools in rural Mid-Wales Local Education Authority) were given the research instrument employed in the study – Food Diary.

The food diary is a daily checklist of food consumed in five days – Thursday through Monday to include both school meals consumed at school during weekdays (Thursday, Friday and Monday) and food consumed at home at weekend (Saturday and Sunday) as food consumed might differ between weekdays and weekends. The diary was designed for five days for it not to be too long for boredom to set in nor too short as to not reveal a dietary pattern. Diaries have been used for different number of days by different researchers for various reasons. Some studies [12] used it as the main data-collecting instrument while some used [13] it amongst other instruments. The daily food checklist consisted of five columns: breakfast, mid-morning snack, lunch, mid-afternoon snack and dinner. In each column, the researcher listed several everyday food items consumed at various mealtimes and respondents were asked to put a tick against the food item consumed. A space was provided at the end of each column for 'others please specify' as the researcher cannot include every single food item that is consumable into the diary because of space constraints.

Diary as an instrument of data collection has its merits and demerits as well as its limitations. However, one limitation of diaries is that they require sustained cooperation and motivation from those who are asked to keep them, and are prone to distortion. It has been observed that diarists may become less diligent overtime about their data recording [14]. In order to overcome this limitation, sufficient instruction was given to the participants; the diary format was kept simple (daily food checklist) with just a tick in the box of the food consumed. Also 5-day diary duration as opposed to 7-day duration was adopted for this study. Another drawback of diaries as argued by [15] is that the quality of the data might be subject to participant conditioning,

Table 1: Percentages of Classes of Food Consumed at Each Mealtime Before and After the Intervention

Days/mealtimes	Before-intervention %						After-intervention %					
	Carb	Pro	Fat	Vit	Min	Fib	Carb	Pro	Fat	Vit	Min	Fib
Day 1 Breakfast	38.7	61.3	37.9	31.5	27.4	58.9	42.7	54.0	43.5	31.5	29.8	59.7
Lunch	95.2	60.5	83.1	65.3	55.6	38.7	91.1	62.1	85.5	34.7	30.6	25.0
Dinner	75.8	83.9	85.5	48.4	38.4	42.7	83.9	83.1	88.7	35.5	34.7	48.4
Day 2 Breakfast	42.7	60.5	38.7	25.0	25.0	51.6	42.7	61.3	44.4	25.8	26.6	58.9
Lunch	85.5	54.8	83.1	28.2	23.4	27.4	86.3	56.5	89.5	28.2	17.7	17.7
Dinner	82.3	74.2	87.1	30.6	24.2	26.6	76.6	80.6	85.5	41.9	35.5	42.7
Day 3 Breakfast	45.2	59.7	46.8	25.8	25.8	54.0	38.7	67.7	45.2	27.4	27.4	60.5
Lunch	87.1	49.2	74.2	38.7	32.3	25.0	81.5	59.7	83.1	32.3	25.8	22.6
Dinner	75.8	76.6	86.3	38.7	35.5	37.9	75.8	79.8	88.7	51.6	46.0	50.8
Day 4 Breakfast	47.6	65.3	48.4	13.7	11.3	57.3	44.4	62.9	53.2	26.6	25.8	57.3
Lunch	79.8	59.7	59.7	21.8	47.6	43.5	81.5	66.1	84.7	37.1	36.3	34.7
Dinner	66.9	75.0	81.5	47.6	37.1	41.1	76.6	77.4	88.7	49.2	45.2	49.2
Day 5 Breakfast	38.7	67.7	39.5	21.8	23.4	62.9	33.9	67.7	39.5	28.2	28.2	63.7
Lunch	82.1	58.9	83.1	46.8	34.7	27.4	77.4	58.1	75.8	33.1	23.4	20.2
Dinner	75.0	77.4	83.9	30.6	25.0	32.3	66.9	76.6	83.1	41.1	39.5	37.9

Carb means carbohydrate; Pro means protein; Vit means vitamins; Min means mineral; Fib means fibre.

poor recall, sample selection bias and fatigue. This was again taken care of by the simplicity of the daily food checklist that requires just a tick and also teachers and parents assisting where necessary. Respondent bias may also occur if the diarists record a detail that reflect positively on them, and leave out elements or events that reflect badly. There was an assertion by [16] that regular encouragement and feedback to the diarist about actions taken as a result of data collected may motivate them to sustain a high standard of record keeping. As such participants in this study were told the purpose of the research beforehand.

The diary was analysed based on the classes of food (nutrients: carbohydrate, fat, protein, vitamin, mineral and fibre) the respondent consumed at each mealtime and in a day both at school and at home – in order to determine whether the food consumed reflects a balanced healthy diet. After the intervention, participants were then asked to fill the diary again for the same five-day period. Responses from both diaries were then collated and analysed using simple percentages.

RESULTS

The student diary of food consumed in five days (Thursday through Monday) was collated and analysed on pre-test and post-test basis (before and after the intervention) in order to compare the pattern of consumption of the six classes of food (carbohydrate, protein, fat, vitamin, mineral and fibre). This was to certain if the intervention would influence behaviours in the desired direction of healthy eating. The results are presented in the following tables (Tables **1-3**):

Table **1** above shows the percentages of classes of food (carbohydrate, protein, fat, vitamin, mineral and fibre) consumed at the three mealtimes of breakfast, lunch and dinner; it was obvious that participants consumed more classes of food during lunch on weekdays than weekends. Fewer classes of food were consumed at the other two mealtimes (breakfast and dinner) but much fewer classes at breakfast than dinner. The more classes of food consumed at lunch on weekdays could be attributed to the school lunch provided by the participating schools during weekdays. There was no much difference (as the difference was not statistically significant) in the consumption pattern of the various classes of food (carbohydrate, protein, fat, vitamin, mineral and fibre) before and after the intervention.

Participants were also asked to tick or record snacks intake at mid-morning and mid-afternoon breaks during the five days periods. The mid-morning and mid-afternoon snacks were categorised into 'less healthy' and 'more healthy' snack. 'Less healthy' snacks are high sugary and high fat snack while 'more healthy' snacks are low sugary and low fat snack.

However, there was a comparative difference (statistically significant $p<0.05$) in the consumption of snack during mid-morning and mid-afternoon break

Table 2: Percentage Consumption of Less and More Healthy Snack at the Different Snack Periods

Days/snack periods	Before Intervention %			After Intervention %		
	No snack	Less healthy	More healthy	No snack	Less healthy	More healthy
Day 1						
Mid-morning	50.0	21.0	29.0	37.1	30.6	32.3
Mid-afternoon	26.6	38.7	34.7	31.5	37.1	31.5
Day 2						
Mid-morning	41.1	36.3	22.6	36.3	39.5	23.4
Mid-afternoon	37.1	44.4	18.5	33.9	35.5	30.6
Day 3						
Mid-morning *	41.9	37.9	20.2	29.8	37.1	33.1
Mid-afternoon	33.1	37.1	29.8	43.5	35.5	21.0
Day 4						
Mid-morning *	44.4	40.3	15.3	34.7	37.1	28.2
Mid-afternoon	37.9	40.3	21.8	36.3	45.2	18.5
Day 5						
Mid-morning *	58.1	18.0	23.4	40.3	31.5	28.2
Mid-afternoon	41.1	42.7	16.1	41.9	32.3	25.8

*Chi-square is significant at $p < 0.05$.

periods for the five days periods with an increase in the consumption of 'more healthy' snack after the intervention compared to before the intervention (Table **2**).

Table **3** compared the number of classes of food consumed at breakfast and dinner over the five days period. Lunch was excluded from the table because it was observed that participants consumed more classes of food during lunch mealtime implying that participants most likely have a balanced meal at lunch.

From Table **3**, the highest percentages of consumption of the different classes of food during breakfast are observed in the 'only 2 classes of food' column both before and after the intervention. The implication of this was that participants consume predominantly only two classes of food mostly, carbohydrate and fat or fibre and protein, while the least percentages are observed in the '6 classes of food' column. More participants consumed all six classes of food after the intervention compared to before the intervention particularly in the case of dinner (see column 6 before intervention and column 6 after intervention).

DISCUSSION

Table **1** shows that the six classes of food had a better representation in lunch mealtime than in breakfast and dinner. In breakfast and dinner, vitamin, mineral and fibre classes of food which are micro nutrient have least representation compared to carbohydrate, protein and fat which are macro nutrient meaning that the participants consumed a lot of carbohydrate, protein and fat rich food but less of vitamin, mineral and fibre rich foods. This finding corroborated with [17] report, [2] and [5] findings. It was reported in[1] that children were very aware of the health benefits of eating fruit and vegetables and that a balanced diet and regular exercise are important for health. Yet, dietary surveys consistently report that children's consumption of fruit and vegetables falls short of the recommended intake. Could participants' consumption of less vitamin, mineral and fibre classes of food be that they are not provided with or that they do not like or know food items rich in these classes of food? The former seems to be the case as results from a test of conceptual knowledge of the different classes of food revealed that participants have understanding of food items rich in vitamin, mineral and fibre especially after the intervention [18].

There was a comparative difference in the consumption of snacks during mid-morning and mid-afternoon breaks for the five-day period with an increase in the consumption of 'healthier' snacks after the intervention compared to before the intervention (Table **2**). This difference was statistically significant at

Table 3: Percentage of the Number of Classes of Food Consumed at Breakfast and Dinner Times in the Five Days Periods Before and After the Intervention

Days/mealtimes	Before-intervention %						After-intervention %					
	Classes of food						Classes of food					
	1	2	3	4	5	6	1	2	3	4	5	6
Day 1												
Breakfast	4.0	56.5	7.3	20.2	0.8	5.6	4.0	57.3	4.0	21	4.0	4.8
Dinner	3.2	9.7	41.1	11.3	6.5	25.8	2.4	7.3	38.7	18.5	6.5	22.6
Day 2												
Breakfast	3.2	64.5	7.3	14.5	3.2	2.4	2.4	58.1	4.0	23.4	3.2	3.2
Dinner *	2.4	15.3	43.5	12.1	6.5	13.7	0.8	4.0	38.7	17.7	7.3	21.8
Day 3												
Breakfast	-	61.3	9.7	19.4	0.8	4.0	1.6	54	11.3	14.5	6.5	5.6
Dinner	3.2	14.5	3.1	11.3	11.3	17.7	2.4	11.3	36.3	9.7	12.	26.6
Day 4												
Breakfast	1.6	58.9	8.1	21.0	1.6	1.6	-	54.0	11.3	20.2	6.5	2.4
Dinner	2.4	12.9	33.9	15.3	8.9	18.5	2.4	17.7	27.4	8.1	7.3	33.1
Day 5												
Breakfast	1.6	62.9	9.7	13.7	2.4	4.8	3.2	51.6	6.5	21.8	4.8	4.0
Dinner	2.4	12.1	46.0	16.9	4.0	12.1	0.8	18.5	27.4	6.5	8.9	25.8

*Chi-square is significant at $p < 0.05$.

p<0.05. This finding contradicted the report from Five-a-Day (developed by the Department of Health) and Food Dude (developed by the Bangor Food Research Unit [7] to promote fruit and vegetable intake at an early age. The young people surveyed in this study did reveal a better choice of healthy eating practices as compared to Tapper *et al.* study but might not be able to put them into practice since they will probably have to eat the meal they are presented with. Although, it has been demonstrated elsewhere that young consumers are aware of healthy food choices in theory, in practice they may still not select them [19]. On the contrary, participants in this study did put into practice the theory of healthy eating learnt from the concept of balanced diet that was taught them. The 'noticeable' difference in snack consumption between the pre-test and post-test in this study can be attributed to the fact that the participants (children aged 11-12years old) most likely chose their snacks, while the 'slight' difference in the consumption pattern of the classes of food at mealtimes could be due to the fact that parents plan the meal.

Participants consumed a relatively high percentage of classes of food at dinner times than breakfast (Table **3**). This is not supposed to be as each mealtime should contain all six classes of food in their right proportion to make it a balanced meal. Also 'only 2 classes of food' have the highest percentages of consumption both at breakfast and 'only 3 classes of food at dinner times. These two classes of food mostly are carbohydrate and fat and the three classes of food are mostly carbohydrate, fat and protein. Meaning that macro nutrient are consumed more often that micro nutrient. A balanced diet is the combination of the different classes of food in their right proportions. If these different food classes are not consumed during a meal then it is not balanced and will be lacking in some nutrients.

Participants' consumption of more classes of food during lunch on weekdays could be attributed to the school lunch provided by the participating schools. Also the participants' consumption of fewer classes of food during breakfast and dinner on weekdays and all mealtimes at weekends reveals the dietary pattern at home.

CONCLUSION

It could then be concluded that the six classes of food – carbohydrate, fat, protein, vitamin, mineral and fibre had a better representation in lunch mealtime than in breakfast and dinner. In breakfast and dinner, vitamin, mineral and fibre classes of food have least representation compared to carbohydrate, protein and fat meaning that the participants consumed a lot of carbohydrate, protein and fat rich food but less of vitamin, mineral and fibre rich foods. There was a change of dietary habit in the desired direction of healthy eating as more participants opt for healthier snacks after the intervention. The need for school nutritional education programmes to focus on understanding a balanced diet and healthy eating is an important goal. The challenge is then to design instructional sequences and learning environment conditions that help students become members of epistemic communities. The implication of this study for public health policy and practice is that the method of delivery of nutritional education should not just bring about conceptual understanding of healthy eating but also behavioural change. This is a valuable study for the UK, which has used the school setting in an innovative way to promote diet and healthy eating.

KEYPOINTS

- More classes of food were consumed at lunch than breakfast and dinner (meaning lunch had a better representation of the six classes of food than breakfast and dinner);
- Participants consumed more of carbohydrate, protein and fat rich foods but less of vitamin, mineral and fibre rich foods over the five days period;
- There was a substantive difference in the consumption of more healthy snacks after the intervention;
- More classes of food are consumed at lunch during weekdays than weekends.

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Received on 13-08-2012 Accepted on 30-09-2012 Published on 31-12-2012

http://dx.doi.org/10.6000/1929-4247.2012.01.02.1