Nutrient and Energy Intakes of School Children during the School Day

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This report was written in partial fulfilment of a UROS bursary scheme in which the analysis of school children's diets identified their energy and nutrient intake.

Abstract

  This research intended to explore the relationship of overall daily intake rather than that of specific meals, in order to provide a well-rounded conclusion with regards to the adequacy of nutrient intake of school children aged between 13-17 years. A total of 179 middle school students (85 girls and 94 boys) and 33 sixth form students (27 girls and 6 boys) took part in this study. In order to analyse the nutrient and energy intake of various school children, a questionnaire and food diary was compiled and distributed to two schools around Leicestershire. It was found that school children aged 13 to 14 years in the middle ability set are more likely to consume energy drinks compared to the higher and lower sets. Both the female and male middle school students aged 13 to 14 years old consume more calcium and iron than the upper school students aged 16 to 17 years old. All the male and female students, 13 to 14 years old, in the highest ability set consume more calcium, iron, thiamine, riboflavin, vitamin C and retinol equivalent compared to the other ability sets. However the female students in set 3 consume the most iron. The lower ability set female students from the middle school perceived their diet to be healthier compared to the other 2 sets. Whereas more male students in the higher set believed they had a healthy diet in comparison to the other 2 sets. The male and female students in set 1 of the middle school, on average, walk to school more often than the 2 ability sets. Male and female students in the highest ability set take part in organised sports more than the other 2 ability sets.

Introduction

  Various studies carried out concerning school childrens' diets, of which there have been many, have looked at the effects and potential effects of these specific meals in their individual context. The results of these studies have suggested that the performance, cognition, concentration and behaviour of pupils are linked to nutritional intake. As such, this research intends to explore these relationships in the context of overall daily intake rather than that of specific meals, in order to provide a well-rounded conclusion with regards to the adequacy of nutrient intake of school children aged between 13-17 years. This research will focus on Leicestershire school children.

  The diets of school children have, of late, been a great cause of concern. The main concerns being that young people are consuming too much or insufficient amounts and possibly the wrong foods which may increase the risk of obesity or insufficient energy intake or nutrient deficiency. Studies from Coppinger et al (2010), Grantham-McGregor and Ani (2001) and Bateson and Finch (2002) found males deficient in calcium and females deficient in iron. The age ranges from the studies varied from toddlers to young children to adolescents. The results of this research will be used to investigate the quality of the diets of school children (including, importantly, school meals) and moreover, the levels of specific nutrient intake of children within the age groups mentioned above, as well as the relative quality of the diets of the genders and different academic abilities within two schools.

  It is important to know if certain groups of people are not getting the correct nutritional requirements, whether it is too much or too little, in order to avoid the risk associated with deficiencies or diseases and the complications that arise as a result of these issues. Bateson and Finch (2002) found that the majority of year 8 boys' and girls' calcium intakes were below the Reference Nutrient Intake, which is important for the development of bone mass, therefore an inadequate intake of calcium can lead to low peak bone density. Coppinger et al. (2010) highlighted a cause for concern in relation to

males who were deficient in calcium and females who were deficient in iron (9-11 years old). Grantham-McGregor and Ani (2003) reviewed selected studies demonstrating the effects of iron deficiency on children's cognition and behaviour. Poor cognition, motor development and behavioural problems were found, in most studies, to be associated with iron-deficiency anaemia. The longitudinal studies provided a constant indication that children affected by anaemia in infancy have poorer cognition, school achievement and more behavioural problems into middle childhood (Grantham-McGregor and Ani, 2003).

School lunch is a major factor in how well a child will concentrate and perform in afternoon lessons. The Jamie Oliver campaign, as evaluated by Belot and James (2009) has provided evidence to support this. These researchers identified the positive effects of the "Jamie Oliver Feed Me Better" campaign concentrating on Key Stage 2 test scores which showed an increase in pupils reaching level 4 by 3 to 6 percentage points in English and 3 to 8 percentage points in Science. Changes of a smaller scale can provide a large impact on schoolchildren (Borja et al. 1996).

There is room for further research in this area as there is a shortage of studies with conclusive and well-rounded results, as such, our research aims to combat these issues and fill some of the gaps.

Process
In order to analyse the nutrient and energy intake of various school children, a questionnaire and food diary was compiled and distributed to two schools around Leicester, one of which was a middle school (ages 13 to 14 years) and the other was an upper school (ages 16 to 17 years). The school children were asked to complete the questionnaire and then complete the food diary on two separate school days. The school days were chosen at random and the children were asked to record all food and drink they consumed over a 24 hour period. All questionnaires and diet diaries were completed anomalously and only specific personal details were required, for example gender, age etc. As some of the participants were young, they were aided when completing their questionnaires and food diaries. Once the data was collected, it was analysed relative to current recommended intakes based on gender and academic ability. The diet diaries were analysed using Microdiet (Downlee System Ltd, 2005-2010) to provide the average daily intake, % LRNI, % EAR and % RNI. These results would then be used to determine calcium and iron content for boys and girls as well as conclude the number of students with an adequate diet.

Results
A total of 179 middle school students (85 girls and 94 boys) and 33 sixth form students (27 girls and 6 boys) took part in this study. The students completed questionnaires and diet diaries. Table 1 shows the response to question 3, refer to appendix A for the full questionnaire. Set 1 represents the higher ability set, set 2 represents the middle ability set and set 3 represents the lower ability set.

Table 1

Estimated number of school students aged 13-14 years that consume energy drinks

ABILITY SET	% of each set that consume energy drinks
1	58
2	67
3	66
MEAN %	64
MEDIAN %	66
STDEV %	4.92

   As the results in Table 1 show, on average, 64% of the high school students consumed energy drinks. A higher proportion of set 2 consumed more energy drinks than set 3 and 1. Set 1 consume less than energy drinks than set 3. Thus highlighting those in the higher ability set are less likely to drink energy than the other 2 sets. That said, those in the lower ability sets, consuming larger quantities of energy drinks, may find that their attention is distorted by the high energy and caffeine levels, causing disruptiveness rather than increased concentration. Energy drinks have been associated with serious adverse effects on, young adults and children with seizures, diabetes, cardiac abnormalities, or mood and behavioural disorders and sleep disturbances (Seifert et al. 2011).

Table 2

Estimated number of energy drinks consumed by students per week ages 13-14 years

ABILITY SET	Percentage of School Students			
	1 to 3 drinks consumed per week	4 to 7 drinks consumed per week	8+ drinks consumed per week	Unknown drinks consumed per week
1	75	15	4	6
2	67	23	8	0
3	58	32	10	0
MEAN %	67	23	8	2
MEDIAN %	69	23	8	0
STDEV %	8.60	8.71	3.01	3.61

   The respondents were able to indicate how many of these drinks they consumed per week by answering question 4. Out of the 64% of students that said yes, the higher set consumed fewer energy drinks per week than the lower set: 75% of the higher set consumed 1 to 3 energy drinks per week and only 4% claimed to drink more than 8 energy drinks per week. On the other hand, 10% of the lower set state that they get through 8 or more energy drinks per week and 58% of the same set drink 1 to 3 energy drinks per week. As such, more students in the higher ability sets consume energy drinks however; those that consume energy drinks in the lower set consume a greater quantity per week than their higher ability counterparts. Similarly, those students in set 2 who are more likely to consume 1 to 3 energy drinks per week consumed a lower quantity than those students from set 1 and set 3. This is highlighted in table 2.

Table 3
% of middle and upper school pupils that met the Dietary Reference Values for iron
intake combining ability and age sets for females and males

	Middle School (13to 14 years old)		Upper School (16 to 17 years old)	
	Females	Males	Females	Males
	Mean ± STDEV		Mean ± STDEV	
Average Daily Intake (mg)	7.6 ± 4.41	9.9 ± 9.54	6.7 ± 4.77	7.1 ± 5.91
Intake as average % of LRNI	94 ± 55.06	146 ± 62.37	83 ± 59.60	117 ± 96.86
Intake as average % of EAR	66 ± 38.64	102 ± 43.64	59 ± 41.86	82 ± 67.91
Intake as average % of RNI	51 ± 29.77	79 ± 34.15	45 ± 32.23	63 ± 52.29

Appendix B, expressed in table 3, shows females from the middle and upper school do not consume enough iron each day as they recommended intake dictates. Both female and male middle school students have a higher intake of iron compared to the female and male upper school students. These results are not statistically significant ($P > 0.05$) as demonstrated in appendix C. Language delay, poor coordination and delayed motor skills are just a few of the effects that iron deficiency can have. In addition children who are iron deficient have short attention spans, are unhappy, tend to be clingier and are tired (Harris, 2004). This undoubtedly will greatly affect their learning ability.

Table 4
% of middle and upper sixth school pupils that met the Dietary Reference Values for
calcium intake combining ability and age sets for females and males

	Middle School (13to 14 years old)		Upper School (16 to 17 years old)	
	Females	Males	Females	Males
	Mean ± STDEV		Mean ± STDEV	
Average Daily Intake (mg)	620.5 ± 378.65	624.2 ± 328.62	512.6 ± 293.2	618.9 ± 217.97
Intake as average % of LRNI	131 ± 77.86	139 ± 73.03	107 ± 61.08	138 ± 48.43
Intake as average % of EAR	100 ± 59.79	83 ± 43.75	82 ± 46.92	83 ± 29.07
Intake as average % of RNI	78 ± 46.72	63 ± 32.81	64 ± 36.65	62 ± 21.79

Appendix D, expressed in table 4, contains the average daily intake and the coma triplets of calcium intake between males and females. Both the high school data and sixth form data was used. The results shows the same pattern as appendix B indicating that middle school female and male students have a higher intake of calcium compared to the female and male upper school students. These results are not statistically significant (P>0.05) as demonstrated in appendix E. Calcium is the most important dietary factor for bone health. 90% of peak bone mass is obtained between the ages of 18 to 20 years as such it is important for adolescents to meet their daily recommended intakes of calcium. The development of strong bones and the achievement of reaching maximum potential bone mass will help prevent against bone loss and osteoporosis in later life (More, 2008).

Appendices F, G and H contain the number of students which reached the total LRNI, EAR and RNI for calcium, iron, thiamine, riboflavin, vitamin C and retinol equivalent.

Table 5
Intake of selected minerals and vitamins by males and females in set 1 aged
13 to 14 years

Set 1	LRNI		EAR		RNI	
	Females %	Males %	Females %	Males %	Females %	Males %
Calcium	68.18	87.1	50	38.71	31.82	22.58
Iron	36.36	87.1	18.18	64.52	4.55	32.26
Thiamine	100	100	100	100	90.91	93.55
Riboflavin	68.18	90.32	68.18	83.87	50	70.97
Vitamin C	100	96.77	95.45	83.87	77.27	77.42
Retinol Equiv	63.64	70.97	45.46	41.94	27.27	19.36

Appendix F is summarised in table 5 which shows the total percentage of students, in set 1, that reached either greater than or equal the DRVs.

Table 6
Intake of selected minerals and vitamins by males and females in set 2 aged
13 to 14 years

Set 2	LRNI		EAR		RNI	
	Females %	Males %	Females %	Males %	Females %	Males %
Calcium	58.33	45.16	44.44	32.26	30.56	3.23
Iron	38.89	54.84	13.89	41.94	0	22.58
Thiamine	97.22	96.77	97.22	96.77	88.89	87.1
Riboflavin	55.56	58.06	44.44	45.16	38.89	35.48
Vitamin C	75	83.87	63.89	67.74	55.56	51.61
Retinol Equiv	52.78	45.16	33.33	25.81	16.67	16.13

Table 6 represents appendix G showing the results for set 2.

Table 7
Intake of selected minerals and vitamins by males and females in set 3 aged
13 to 14 years

Set 3	LRNI		EAR		RNI	
	Females %	Males %	Females %	Males %	Females %	Males %
Calcium	55.56	71.88	48.15	18.75	33.33	18.75
Iron	44.44	65.63	18.52	40.63	7.41	21.88
Thiamine	100	100	88.89	100	81.48	96.88
Riboflavin	51.85	68.75	51.85	59.38	48.15	37.5
Vitamin C	88.89	90.63	77.78	81.25	44.44	71.88
Retinol Equiv	55.56	50	25.93	34.38	14.82	21.88

Table 7 summarises appendix H for set 3.

   The results show that, with regard to calcium, in set 2 only 3.23% of males reached the RNI whereas around 30% females, in all 3 sets, reached the RNI. 87.1% of males, in set 1, reached the LRNI in iron however no female students reached the RNI in iron. The majority of students in all 3 sets reached 100% of LRNI and EAR in thiamine. More students in set 1, on average, consumed 100% or more on all coma triplets than both the other 2 sets. More males in set 3 consumed higher amounts of riboflavin than set 2 as more male students in set 3 reached 100% or more in the coma triplets than the males in set 2. All female students in set 1 met the LRNI for vitamin C. In set 3 the male students consumed more vitamin C than the female students and this same pattern is evident in set 1. No more than 56% of students in set 2 and 3 reached the coma triplets of retinol equiv. Those that consumed the most retinol equiv were the male students in set 1. All the results for adequacy of diet show an uneven pattern highlighting that the adequacy of diet is not affected by academic ability or by gender.

Table 8
Middle school students both male and female aged 13 to 14 years on whether they feel
they have a healthy diet

Response	Set 1		Set 2		Set 3	
	Females %	Males %	Females %	Males %	Females %	Males %
Yes	64	73	68	63	77	63
No	36	27	32	37	23	37

   Table 8 shows the response to whether middle school students aged 13 to 14 years feel that they consume a healthy diet. The results show that majority of students in all 3 ability sets do feel that they have a healthy diet. The female students in the middle and lower sets believe they have a healthy diet compared to the male students however the more male students in the highest ability set believe they have a healthy diet (73%) compared to the female students (64%) in the same set.

Table 9
Number of times students both male and female aged 13 to 14 years walk to school

Times per week	Set 1		Set 2		Set 3	
	Females %	Males %	Females %	Males %	Females %	Males %
Not at all	44	58	68	71	64	65
1-2	7	8	5	4	18	12
3-4	7	6	5	4	3	7
5	42	28	22	21	15	16

   The same students were then asked how many times per week do they walk to school. The response, demonstrated in table 9 (refer to appendix A), indicates majority of students in all ability set and both genders do not walk to school at any point during the week. However, all female students, regardless of ability set, walk to school more often than the male students. 42% of female students in set 1 walk to school 5 days a week more than any other set. 28% of males in set 1 walk to school 5 days a week whereas only 21% in set 2 and 16% in set 3 walk to school 5 days per week. The results also demonstrate a pattern of which majority of students either do or do not walk to school, not split the week up for a mixture of walking and other modes of transport. Within the concept of a healthy lifestyle lies not only a healthy diet but also a certain amount of exercise (Yackobovitch-Gavan *et al*. 2009).

Table 10
Whether middle school students both male and female aged 13 to 14 years take part in organised sports.

Response	Set 1		Set 2		Set 3	
	Females %	Males %	Females %	Males %	Females %	Males %
Yes	53	64	45	47	30	40
No	47	36	55	53	70	60

   The middle school students were asked whether they took part in organised sports. The results shown in table 10 show more males than females take part in organised sports and the higher response of these was greater in set 1 compared to the other 2 sets. The figure indicate a trend, i.e. the higher the set the greater the participation in sport.

   The daily recommended calorie intake for boys 11 to 14 years is 2220kcal and for girls of the same age is 1845kcal (Department of Health, 1991). Appendix I show that girls are under eating, on average, by 430.44 kcal per day and that boys are under eating by, on average, 657.71kcal per day. Also this shows that girls are consuming less energy than boys however girls the gap between the average energy consumed and the recommended daily guideline is smaller for girls than it is for boys indicating, overall, that girls are closer to meeting the guidelines than boys.

Summary
   To summarise these results, the majority of school children, aged 13 to 17, have a less than adequate diet. This is shown in the data obtained in this research. To specify, the identification of energy drinks consumed among middle school children and the vast quantity of which occurs. Many students in the middle school are suffering from a lack of essential vitamins from their diet. These include; calcium, iron, thiamine, riboflavin,

vitamin C and retinol equivalent. In particular, no female, middle school students in set 2 reached the total RNI for iron, potentially leading to iron deficiency anaemia. The students' perception of their own diet is not a common question asked when assessing their actual diet. In this case, the lower ability set female students perceived their diet to be healthier compared to the other 2 sets. Whereas more male students in the higher set believed they had a healthy diet in comparison to the other 2 sets.

Conclusion
- School children aged 13 to 14 years in the middle ability set are more likely to consume energy sets compared to the higher and lower sets.
- The lower ability set, on average, are more likely to consume more than 8 cans/bottles of energy drinks per week in comparison to the higher ability set which are more likely to consume between 1 to 3 cans/bottles per week.
- Both the female and male middle school students aged 13 to 14 years old consume more calcium and iron than the upper school students aged 16 to 17 years old.
- All the male and female students, 13 to 14 years old, in the highest ability set consume more calcium, iron, thiamine, riboflavin, vitamin C and retinol equivalent compared to the other ability sets. However the female students in set 3 consume the most iron.
- The lower ability set female students from the middle school perceived their diet to be healthier compared to the other 2 sets. Whereas more male students in the higher set believed they had a healthy diet in comparison to the other 2 sets.
- The male and female students in set 1 of the middle school, on average, walk to school more often than the 2 ability sets.
- Male and female students in the highest ability set take part in organised sports more than the other 2 ability sets.

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