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Obesogenic diet and physical activity behaviors: independent or associated behaviors in adolescents?

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Abstract

Objective—Associations between diet and physical activity may identify behaviors that could be changed together to prevent childhood obesity. This study examines associations between physical activity and obesogenic dietary behaviors in a large UK youth cohort.

Design—Cross-sectional analysis of UK cohort.

Subjects and methods—10–11 year old UK youths completed 3, one-day diet diaries. Average daily energy consumption, percent energy from fat, carbohydrate, energy density and grams of fruit and vegetables were estimated. To assess physical activity participants wore an accelerometer for 3 or more days. Regression models were run by sex to examine the extent to which dietary variables predicted physical activity before and after controlling for pubertal status, maternal education and adiposity.

Results—Among boys percent energy from fat was consistently negatively associated with accelerometer determined indicators of physical activity (Std. Beta −.055 to −.101, p<.05) while total energy (Std. Beta = .066 to .091. p<.05) and percent energy from carbohydrate (.054 to .106, p<.05) were positively associated before and after adjustment for confounders. For girls fruit and vegetable intake was consistently positively associated with physical activity (Std. Beta = .056 to .074, p<.005). However all associations were weak. Associations were broadly comparable when participants with non-plausible dietary reports were included or excluded from the analyses.

Conclusions—Obesogenic diet and physical activity behaviors were weakly associated, suggesting that interventions should focus on implementing strategies that are independently successful at changing diet or physical activity behaviors either separately or in combination.

Keywords

ALSPAC; under-report; physical activity; childhood obesity

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INTRODUCTION

Children who are overweight are more likely to become overweight adults (1). Obesity is the result of an imbalance between the energy consumed and the energy expended (2). Dietary behaviors that have been positively associated with increased body mass among children include energy intake (3), percent energy from fat (3) and energy density (4,5) while fruit and vegetable intake has been negatively associated (6). Ensuring that youth are physically active and consume a healthy diet is essential in preventing childhood obesity (7).

Previous research among 8–10 year old, African-American girls showed that physical activity was negatively associated with percent energy consumed from fat and positively associated with percent energy from carbohydrate (8). These associations implied that interventions which attempt to change both behaviors by changing some underlying common construct may hold greater utility. It is not clear what such a construct may be, but it could be a personality trait, a desire to be healthy, living in a healthy environment, higher socio-economic status or an increased awareness of the importance of healthy eating and engaging in regular physical activity. Interventions designed to change both behaviors would be more effective if they attempted to manipulate the underlying construct but before searching for the construct it is important to confirm if there are strong associations between adolescent diet and physical activity behaviors. While associations between diet and physical activity have been reported among adults (9) there is a shortage of findings among youth. Although previous research has shown a substantial percentage of participants are liable to misreport their dietary intake (10) and it is not clear if including these in analyses will affect associations between diet and physical activity. The aim of this paper was to examine, in a large cohort of UK children, associations between the obesogenic aspects of diet and physical activity behaviors before and after accounting for mis-reporting of dietary intake. Furthermore, to examine if the accuracy of dietary reports affected the detected associations all analyses were run for all participants and separately for just participants who provided “normal” or “valid” reports of dietary intake.

METHODS

Participants were 10–11 year old youths from the Avon Longitudinal Study of Parents and Children (ALSPAC). As described elsewhere (11), ALSPAC is a birth cohort study that recruited participants in the former British county of Avon in Southwest England. A total of 14,541 pregnant women were recruited into the original study, which resulted in 13,988 children alive at one year. Data are presented here for children who provided diet data at age 10 and physical activity data at 11. Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees.

Participants provided three, one-day un-weighed diet diaries using methods that have been described in detail elsewhere and included an additional parent questionnaire and a brief interview which were used to clarify any issues that might have arisen (10,12). Diet data were processed using methods similar to those previously described when the participants were aged seven (10) and to maximize the sample size all participants with at least one day of data were included in the analysis. As the focus of this paper is on dietary behaviors that have been associated with obesity, the following dietary variables were utilized: average energy consumed per day (kcal), percent energy from fat, percent energy from carbohydrate and mean grams of fruit and vegetables per day (excluding all juice, potatoes and baked beans). In addition, energy density (excluding drinks) was computed by dividing total food energy by total food weight.

Participants wore a MTI actigraph model 7164 (Manufacturing Technology Inc, Fort Walton Beach Florida) for 7 consecutive days (13). The MTI actigraph has been shown to provide accurate and reliable assessments of physical activity in both children and adolescents (14,15). Previous analysis of the data from this study has shown that the reliability coefficient for 3 days of accelerometer monitoring was 0.7 within this cohort. Further analysis also indicated that there was a very small tendency for accelerometer counts to be higher on the first day of measurement when compared to the remaining days due to the novelty of the measurement but this effect was very small (17 counts/min) and was less than 0.1 standard deviation of usual monitoring days. Thus, including the first day of monitoring in analysis is unlikely to introduce bias into any analyses (16). In light of this previous work participants were included in the analyses if they provided 3 or more days of data with at least 600 minutes of data per day (17). Mean counts per minute (CPM), an indication of the volume of physical activity was calculated. To provide an indication of time spent engaged in moderate to vigorous physical activity (MVPA) the mean minutes per day in which there were more than 3600 accelerometer counts per minute was also calculated (Mean MVPA) and averaged (18). To assess if associations with dietary behaviors differed by week or weekend day, the mean minutes of MVPA per weekday (Weekday MVPA) and per weekend day (Weekend MVPA) were calculated with participants included in the analysis if they had at least 1 day of each assessment.

Maternal education was self-reported. Pubertal status was self-reported at age 10 and 11. Height was measured using a Harpenden stadiometer (Holtain UK) and weight was measured using a Tanita TBF 305 body fat scale and body mass index (BMI - kg/m^2) at age 10 was calculated. To facilitate international comparisons of the descriptive data the International Obesity Taskforce (IOTF) criteria were used to classify participants as normal weight or overweight/obese (19). As height has been associated with accelerometer energy expenditure (20) and pedometer step counts among youth (21) all of the regression models were adjusted for height. Fat mass was measured using a Lunar prodigy DXA scanner (GE Medical systems) at age 11. As total levels of fatmass increase with height it is important to account for stature when expressing an individuals levels of adiposity and therefore fatmass index (fat mass/height squared in metres) was calculated for all participants (22–24).

Analysis

Age estimated Basal Metabolic Rate (BMR) was calculated using the Schofield criteria (25). Using the same methods that have previously been applied to the diet data when the participants were seven years of age (10), the Torun criteria (26) were then used to identify likely misreporting of dietary intake and two samples, the full and restricted samples were created. The full sample included participants with any diet data and at least 3 days of valid accelerometer data while the restricted sample included participants who had “plausible” dietary reports and at least 3 days of accelerometer data. χ^2 tests were used to examine sex differences in the pubertal status and IOTF categories of obesity (at age 10 and 11) for both samples. χ^2 were then used to examine if there were differences in the pubertal status or IOTF groups between the samples (i.e. comparing normal dietary reporters vs. all other participant groups). For the full sample one-way analysis of variance (ANOVA) tests were performed with sex as a factor investigating the following variables: BMI, fatmass index, CPM, Mean MVPA, Weekday MVPA, Weekend MVPA, energy, percent energy from fat, percent energy from carbohydrate, height, energy density and grams of fruit and vegetable per day. This process was then repeated using the restricted sample.

As the diet and physical activity assessments were made a year apart the month of each assessment was coded as Spring (March, April, May), Summer (June, July, August), Autumn (September, October, November) or Winter (December, January or February). The two assessments were then compared and a dummy variable created to take account of the

59.9% of physical activity assessments conducted in a different season to the dietary assessments. Linear regression models were used to examine the extent to which dietary variables (energy; percent energy from carbohydrate; percent energy from fat; energy density and fruit and vegetable consumption) predicted each of the four physical activity outcome variables. Models were run in five steps for each outcome: Model 1) exposure variable only; Model 2) Model 1 plus maternal education, fatmass index, height and season change; Model 3) Model 2 plus pubertal status at age 11 (when the outcome was assessed); Model 4) As Model 2 but with IOTF category at age 11 (overweight/obese with normal as the reference group), instead of fatmass index ; Model 5) Model 4 plus pubertal status. All fruit and vegetable models also controlled for total energy consumed. As preliminary analyses indicated there was strong evidence (p<.001) of sex differences in outcome and exposure variables all models were run separately by sex. Analyses were performed separately for the full and restricted samples in the Statistical Package for the Social Sciences (Version 14.0) and alpha was set at 0.05.

RESULTS

There were 5134 participants in the full sample and 3684 in the restricted sample. For the full sample 20.1% of the participants were overweight or obese based on the IOTF criteria at age 10. χ^2 tests indicated sex differences in the pubertal status at both age 10 and 11 with more girls being classified with higher Tanner stage scores than the boys using both the full and restricted samples. For the full sample, Tanner stage data was missing for 46.8% of males and 43.9% of females at age 10 and 45.8% of males and 24.7% females at age 11 with similar proportions in the restricted sample(Table 1).

In the full sample, girls' fatmass index was higher than that of the boys (5.6 vs. 4.5 kg/m^2, p<.001) with a similar pattern in the restricted sample (5.1 vs. 4.0, p<.001). Participants in the full sample were slightly taller than participants in the restricted sample at age 10 (144.7 vs. 143.5cm) and at age 11 (151.5 vs. 150.4cm). Fatmass index was lower in the restricted sample than the full sample (4.6 vs. 6.2 kg/m^2). For the full sample CPM were higher among the boys than the girls (664.3 vs. 552.2) as were Mean MVPA minutes/day (28.5 vs. 18.2), Weekday MVPA minutes/day (30.0 vs. 19.05) and Weekend MVPA minutes/day (23.5 vs. 15.0), with similar results for the restricted sample (all p<.005). All physical activity variables were higher in the restricted sample (p<.005).

There was a sex difference in the energy consumption of participants in the full sample with higher consumption among the boys (1952.3 vs. 1769.3 kcals/day). Girls in the full sample consumed a greater percentage of their energy from fat than the girls (36.7% vs. 36.2%), with comparable finings in the restricted sample. Boys in the restricted sample consumed a greater percentage of their energy from carbohydrates than girls (53.8% vs. 53.4%). Girls in the full sample consumed a greater weight of fruit and vegetables per day than boys (147.1 vs. 136.0 g/day) with a similar result in the restricted sample (152.5 vs. 141.0 g/day).

Regression models in which each of the dietary variables predicted CPM are shown by sex in the restricted sample in Table 2. Total energy was associated with CPM among boys in models that adjusted for confounders, however the associations were weak (Std. Beta .071 to .091). Percent energy from carbohydrate was positively associated with CPM in boys in the unadjusted model (Beta = 2.269 (95% CI = .637 to 3.901), p=.006) and this pattern was still evident after adjustment for confounders but not when the model was also adjusted for pubertal status (models 3 and 5). Percent energy from fat was negatively associated with CPM among boys in an unadjusted model (Beta = −2.198 (95% CI = −4.048 to −.348), p=.020) but only remained associated in the model that adjusted for IOTF thresholds instead of fatmass index (model 4). For girls fruit and vegetable consumption was associated with

CPM after adjusting for all confounders and pubertal status (Beta = .080 (95% CI = .001to .160), p=.047) with a similar pattern evident when the IOTF cut-point was used instead of fatmass index (Table 2).

Among boys percent energy from carbohydrate was positively associated with Mean MVPA in all of the models (Std Beta = .056 to .106) while percent energy from fat was negatively associated in all of the models (Std beta = −.065 to −.098). Among girls fruit and vegetable consumption was positively associated with Mean MVPA in all of the models (Std. Beta .041 to .074) (Table 3). A similar pattern was evident for both genders when Weekday MVPA was the outcome (Table 4). When Weekend MVPA was the outcome fruit and vegetable intake was associated with physical activity among the girls but only in the models that controlled for all confounders and pubertal status (Models 3 and 5).

In the full sample, total energy consumption was associated with CPM among girls in the two models (3 and 5) that adjusted for pubertal status (Std. Beta = .065 and .069) with fruit and vegetable consumption also associated with physical activity but only after adjusting for pubertal status (Std beta = .047 and .046). For boys total energy was associated with CPM in all of the models but was only associated with percent energy from carbohydrate in the unadjusted model (Beta = 1.394 (95% CI = .046 to .2.739), Std, beta = .040, p = .042) and Model 4 which used IOTF cut points (Std beta = .046, p=.001) but did not adjust for pubertal status. When Mean MVPA was the outcome patterns in the full sample were similar to the restricted sample with all total energy and percent energy from carbohydrate positively associated in all of the models, but percent energy from fat was not associated in any of the models. For girls, fruit and vegetable consumption was associated with Mean MVPA in the unadjusted (Std. Beta = .041, p = .029) and model 3 which included all possible confounders and pubertal status (Std. Beta = .053, p = .024.) Similar findings were evident when Weekday MVPA was the outcome. When Weekend MVPA was the outcome fruit and vegetable intake was associated with physical activity for the full sample of girls in the unadjusted (Std. Beta = .042, p = .028) model and the two models that adjusted for pubertal status (Model 3 Std Beta = .049, p =.036 , and Model 5 Std Beta = .050, p = .033). (Data not in Tabular form).

DISCUSSION

In this study we found that total energy, percent energy from fat and percent energy from carbohydrate were associated with physical activity among boys while fruit and vegetable consumption was associated with physical activity among girls. However all the associations were weak (Std Beta’s <0.11). Moreover, although patterns were broadly similar when CPM, Mean MVPA and Weekday MVPA were the outcomes there were no associations between diet and physical activity behaviors for boys when Weekend MVPA was the outcome. Analyses therefore show that there were weak, sex and week/weekend day specific associations between an obesogenic diet and physical activity behaviors of a large sample of UK youths.

The associations between diet and physical activity reported in this paper are weaker than those reported for a small sample of 8–10 year old African-American girls (8) young adults in the Bogalusa sample (9) and US adults (27–29). However, the participants diet was around 53% carbohydrate and 36% fat which is broadly comparable to UK and US findings that have used food frequency questionnaires (30) (31) and multiple 24 hour dietary recalls) (8,32). Similarly, the mean minutes of MVPA obtained in this sample are broadly comparable to UK and US studies that have included children of a comparable age (33,34). Collectively these findings may therefore suggest that the presence or absence of associations between diet and physical activity behaviors are unlikely to be a function of measurement and are more likely to be sample dependent, differing by participant age, gender or perhaps country of study.

The weak associations between diet and physical activity behaviors suggest that while targeting change in both behaviors may be beneficial for obesity prevention the benefit is likely to be a function of an accumulation of small changes rather than the product of a shared underlying construct. We found that associations between behaviors were consistent before and after adjustment for maternal education, a surrogate measure of socio-economic status suggesting that socioeconomic position is not a key underlying construct in understanding associations. Moreover, although associations differ by gender the overall associations remained weak suggesting that if diet and physical activity behaviors are influenced by an underlying construct the effect is only very small. Thus, intervention effectiveness could be improved by findings ways to obtain small but achievable, increases in physical activity as well as small but achievable changes in dietary consumption so that overall there is a change in energy balance and reduction in obesity. Obesity prevention interventions that include both diet and physical activity elements should therefore focus on the most effective method of changing each behavior separately.

Over twenty percent of participants under-reported their dietary intake with girls providing more inaccurate reports than boys. These findings are slightly higher than the 21% of boys and 11% of girls in the same sample that provided under-reports at age seven (10), suggesting that under-reporting may become a greater issue as girls grow up. Interestingly, mean minutes of MVPA per day and mean counts per minute were higher in the restricted sample than the full sample indicating that “plausible” dietary reporters were more active than the mis-reporters. Identifying participants who provide implausible dietary records may be useful in delineating the factors that contribute to obesogenic dietary behaviors. Associations between diet and physical activity behaviors were comparable whether mis-reporters of diet were included or not in the analyses. Results therefore suggest that the associations between diet and physical activity behaviors are not related to dietary reporting status.

Strengths and limitations

This study has used relatively robust measures to assess whether associations between diet and physical activity behaviors are evident before and after controlling for potential confounders. However, the study is limited by the gap between the two assessments, pubertal change between assessments and the fact that 59% of the diet and physical activity assessments were conducted in different seasons which could have adversely affected the sensitivity of our assessments as physical activity has been shown to differ by time of year (35). It is also important to recognize that physical activity patterns are not the same every day with previous analysis of a sub-set of these participants indicating that the intraindividual intra-class correlation for accelerometer counts was 0.53 (35). To address potential limitation participants were only included in the analyses if they provided 3 or more days of accelerometer data and thus it is reasonable to assume that the accelerometer data provides a reasonable indication of habitual physical activity. It is also important to recognize that both the diet and physical activity measures were designed to capture patterns of behavior that are representative of usual life and we controlled for pubertal development and seasonal change in our analyses. It therefore seems reasonable to assume that if there were associations between diet and physical activity behaviors we should have been able to detect them despite the measures being collected 12 months apart. It is also important to recognize that a number of possible associations were examined in both boys and girls and therefore results need to be interpreted with caution as it is possible that associations are a function of chance.

Conclusions

We found weak associations between the percent energy from fat in the diet and physical activity behaviors of UK boys and between the fruit and vegetable intake and physical activity of UK girls. Moreover, we found that these associations were largely unchanged after excluding participants likely to have misreported dietary intake. Strategies that attempt to prevent obesity by small changes in both behaviors should focus on the most effective means of changing diet and the most effective means of changing physical activity separately.

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Table 1

Participant characteristics by gender for full (Diet and 3 days of accelerometer data) and restricted samples (Plausible diet data and at least 3 days of accelerometer data)

	Full sample (n=5134)				Restricted sample (n=3684)				
	Boys		Girls		Boys		Girls		Tests
Pubertal stage (10)	N	%	N	%	N	%	N	%	
1	875	35.6	512	19.1	651	36.2	380	20.6	
2	370	15.0	579	21.6	269	14.9	401	21.7	
3	53	2.2	301	11.2	34	1.9	204	11.1	
4	6	0.2	93	3.5	4	0.2	46	2.5	
5	1	0.0	18	0.7	1	0.1	12	0.7	A,B,C
Missing	1149	46.8	1177	43.9	841	46.7	841	45.6	
Pubertal stage (11)									
1	510	20.8	195	7.3	375	20.8	148	8.0	
2	563	22.9	624	23.3	426	23.7	443	24.0	
3	200	8.1	713	26.6	132	7.3	499	27.1	
4	54	2.2	380	14.2	41	2.3	547	29.7	
5	2	0.0	107	4.0	2	0.1	65	3.5	A,B,C
Missing	1125	45.8	661	24.7	824	45.8	182	9.9	
IOTF (10)									
Normal	2000	81.9%	2079	78.0%	1580	87.8%	1569	83.2%	
Overweight / Obese	443	18.1%	586	22.0%	213	11.8%	304	16.1%	A,B,C
IOTF (11)									
Normal	1960	80.7%	2056	77.7%	1543	85.7%	1534	81.4%	
Overweight / Obese	469	19.3%	591	22.3%	240	13.3%	330	17.6%	A.B,C
Under-report of diet	541	22.0%	728	27.2%	NA	NA	NA	NA	
Normal diet report	1800	73.3%	1884	70.3%	NA	NA	NA	NA	
Over-report of diet	113	4.6%	68	2.5%	NA	NA	NA	NA	A
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Height (10) cm	143.8	6.4	143.9	6.9	143.4	6.3	143.5	6.7	C
Height (11) cm	150.6	7.0	151.3	7.2	149.6	7.0	151.6	7.2	A,B,C
BMI (10) kg/m^2	18.0	3.0	18.4	3.2	17.4	2.3	17.8	2.7	A,B,C

	Full sample (n=5134)				Restricted sample (n=3684)				
	Boys		Girls		Boys		Girls		Tests
BMI (11) kg/m^2	18.7	3.2	19.3	3.5	18.1	2.6	18.7	3.0	A,B,C
Fatmass Index kg/m^2	4.5	2.7	5.6	2.7	4.0	2.1	5.1	2.4	A,B,C
CPM	664.3	190.8	552.2	156.0	670.4	186.6	555.1	151.7	A,B,C
Mean MVPA (mins/day)	28.5	17.0	18.2	11.8	29.3	17.0	18.5	11.8	A,B,C
Weekday MVPA (mins/day)	30.0	18.6	19.05	12.8	30.7	18.7	19.4	12.8	A,B,C
Weekend MVPA (mins/day)	23.5	20.3	15.0	14.9	24.4	20.9	15.4	15.3	A,B,C
Energy (kcals)	1952.3	392.0	1769.3	348.4	2033.6	279.1	1881.1	246.9	A,B,C
% Fat	36.2	4.9	36.7	4.8	36.4	4.7	36.9	4.5	A,B,C
% Carbohydrates	53.6	5.4	53.4	5.4	53.8	5.3	53.4	5.1	B,C
Energy density kj/gram	8.8	1.6	8.6	1.6	8.9	1.5	8.7	1.5	A,B,C
Fruit & Veg (grams per day)	136.0	109.7	147.1	106.7	141.0	108.9	152.5	109.2	A,B,C

10 = assessment at age 10 11 = assessment at age 11

A = sex difference ($p<0.05$) in full sample B = sex differences ($p<0.05$) in restricted sample C = difference ($p<.05$) for participants in restricted and full sample

Table 2

The association between mean CPM per day and dietary variables in 11 year old children from ALSPAC (restricted to plausible reporters of dietary intake only)

		Boys				Girls			
Exposure	**#**	**Beta**	**95% CI**	**Std. Beta**	**P**	**Beta**	**95% CI**	**Std. Beta**	**P**
Total energy (kcal)	1	.015	−.016 to .046	.022	.345	−.028	−.055 to .000	−.045	.052
	2	.061	.027 to .095	.091	**<.001**	.017	−.014 to .049	.029	.276
	3	.060	.014 to .105	.090	**.010**	.044	.008 to .080	.072	**.017**
	4	.047	.013 to .082	.071	**.007**	.002	−.029 to .034	.004	.893
	5	.045	−.001 to .091	.068	.055	.032	−.004 to .068	.052	.084
% Energy from carbohydrate	1	2.269	.637 to 3.901	.064	**.006**	.151	−1.187 to 1.489	.005	.825
	2	1.871	.231 to 3.512	.054	**.025**	.367	−.995 to 1.729	.013	.597
	3	1.904	−.381 to 4.189	.053	.102	.367	−1.200 to 1.933	.013	.646
	4	2.257	.605 to 3.909	.064	**.007**	.562	−.818 to 1.941	.019	.424
	5	2.313	.003 to 4.624	.065	.050	.612	−.972 to 2.197	.021	.448
% Energy from Fat	1	−2.198	−4.048 to −.348	−.055	**.020**	.492	−1.017 to 2.000	.015	.523
	2	−1.724	−3.593 to .144	−.043	.070	.454	−1.086 to 1.993	.014	.563
	3	−1.505	−4.100 to 1.090	−.037	.255	.216	−1.558 to 1.989	.007	.811
	4	−2.215	−4.0494 to −.355	−.056	**.021**	.291	−1.267 to 1.849	.009	.714
	5	−1.955	−4.617 to .627	−.049	.136	−.006	−1.797 to 1.785	.000	.995
Energy density	1	−.828	−6.423 to 4.767	−.007	.772	1.087	−3.470 to 5.644	.011	.640
	2	.438	−5.292 to 6.168	.004	.881	1.222	−3.535 to 5.980	.012	.614
	3	3.800	−3.981 to 11.581	.031	.338	.278	−5.227 to 5.783	.003	.921
	4	−.559	−6.335 to 5.218	−.005	.850	.414	−4.396 to 5.224	.004	.866
	5	3.710	−4.163 to 11.584	.031	.355	−.439	6.003 to 5.124	−.004	.877
Fruit & Vegetable*	1	−.008	−.088 to .072	−.005	.842	.043	−.020 to .106	.031	.183
	2	−.018	−.101 to .064	−.011	.663	.043	−.025 to .111	.030	.217
	3	−.031	−.146 to .083	−.018	.591	.080	.001 to .160	.056	**.047**
	4	−.022	−.086 to .081	−.001	.961	.055	−.014 to .124	.039	.116
	5	−.028	−.144 to .088	−.016	.635	.091	.010 to .171	.062	**.027**

Model 2 = Model 1plus maternal education, fatmass index, height & season change

Model 3 = Model 2 plus pubertal status

Model 4 = Model 1 plus maternal education, IOTF group (ref normal), length height & season change

Model 5 = Model 4 plus pubertal status

* All fruit and vegetable models are also adjusted for total energy consumption

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Table 3

The association between mean Mean MVPA minutes per day and dietary variables in 11 year old children from ALSPAC (restricted to plausible reporters of dietary intake only)

		Boys				Girls			
Exposure	**#**	**Beta**	**95% CI**	**Std. Beta**	**P**	**Beta**	**95% CI**	**Std. Beta**	**P**
Total energy (kcal)	1	.001	−.002 to .004	.013	.577	−.002	−.004 to .001	−.035	.132
	2	.004	.001 to .007	.066	**.011**	.000	−.002 to .003	.006	.830
	3	.004	.000 to .008	.068	.052	.003	.000 to .005	.054	.074
	4	.003	.000 to .006	.044	.097	−.001	−.003 to .002	−.019	.464
	5	.003	.002 to .007	.044	.216	.002	−.001 to .004	.033	.271
% Energy from carbohydrate	1	.219	.071 to .368	.068	**.004**	.021	−.083 to .125	.009	.692
	2	.180	.029 to .330	.056	**.020**	.033	−.073 to .139	.015	.541
	3	.313	.102 to .524	.095	**.004**	.037	−.084 to .159	.017	.547
	4	.221	.069 to .373	.069	**.004**	.050	−.058 to .158	.022	.361
	5	.349	.135 to .563	.106	**.001**	.060	−.063 to .184	.026	.338
% Energy from Fat	1	−.232	−.401 to −.064	−.064	**.007**	.023	−.095 to .140	.009	.707
	2	−.179	−.350 to −.007	−.088	**.041**	.020	−.100 to .139	.008	.750
	3	−.321	−.561 to −.082	−.086	**.009**	−.011	−.149 to .126	−.004	.873
	4	−.235	−.408 to −.061	−.065	**.008**	.005	−.117 to .127	.002	.940
	5	−.366	−.609 to −.124	−.098	**.003**	−.033	−.172 to .107	−.013	.646
Energy density	1	−.180	−.691 to .330	−.016	.489	−.127	.482 to .228	−.016	.482
	2	.044	−.483 to .570	.004	.871	−.044	−.414 to .327	−.006	.817
	3	.125	−.595 to .846	.011	.733	−.134	−.580 to .293	−.017	.538
	4	−.048	−.581 to .484	−.004	.858	−.107	−.484 to .270	−.014	.578
	5	.160	−.572 to .891	.014	.669	−.191	−.624 to .243	−.024	.389
Fruit & Vegetable*	1	.002	−.006 to .009	.011	.639	.006	.001 to .011	.057	**.015**
	2	−.001	−.009 to .006	−.008	.737	.005	−001 to .010	.041	**.090**
	3	−.001	−.012 to .010	−.006	.865	.008	.001 to .014	.068	**.016**
	4	.000	−.007 to .008	.002	.920	.006	.000 to .011	.050	**.044**
	5	−.001	−.012 to .010	−.005	.875	.008	.002 to .015	.074	**.009**

Model 2 = Model 1plus maternal education, fatmass index, height & season change

Model 3 = Model 2 plus pubertal status

Model 4 = Model 1 plus maternal education, IOTF group (ref normal), height & season change

Model 5 = Model 4 plus pubertal status

*All fruit and vegetable models are also adjusted for total energy consumption

Table 4

The association between Weekday MVPA minutes and dietary variables in 11 year old children from ALSPAC (restricted to plausible reporters of dietary intake only)

		Boys				Girls			
Exposure	**#**	**Beta**	**95% CI**	**Std. Beta**	**P**	**Beta**	**95% CI**	**Std. Beta**	**P**
Total energy (kcal)	1	.001	−.022 to .005	.022	.344	−.022	−.044 to .000	−.036	.118
	2	.005	.001 to .008	.073	**.006**	.000	−.002 to .003	.003	.896
	3	.005	.001 to .010	.079	**.024**	.002	−.001 to .005	.048	.114
	4	.003	.000 to .007	.049	.063	−.001	−.004 to .002	−.020	.448
	5	.004	−.001 to .008	.057	.108	.001	−.002 to .004	.028	.346
% Energy from carbohydrate	1	.235	.071 to .398	.066	**.005**	.018	−.095 to .131	.007	.752
	2	.190	.024 to .357	.054	**.025**	.027	−.087 to .142	.011	.639
	3	.340	.109 to .570	.094	**.004**	.040	−.090 to .171	.017	.545
	4	.231	.063 to .399	.066	**.007**	.044	−.072 to .160	.018	.458
	5	.372	.139 to .605	.103	**.002**	.064	−.068 to .197	.026	.340
% Energy from Fat	1	−.244	−.429 to −.059	−.061	**.010**	.023	−.105 to .150	.008	.725
	2	−.195	−.385 to −.006	−.049	**.044**	.024	−.105 to .154	.009	.716
	3	−.371	−.633 to −.109	−.091	**.005**	−.020	−.168 to .126	−.007	.792
	4	−.250	−.441 to −.060	−.063	**.010**	.009	−.122 to .140	.003	.893
	5	−.412	−.676 to −.148	−.101	**.002**	−.043	−.193 to .106	−.016	.570
Energy density	1	−.029	−.589 to .532	−.002	.920	−.155	−.540 to .230	−.018	.430
	2	.219	−.362 to .801	.018	.459	−.066	−.467 to .334	−.008	.745
	3	.183	−.605 to .970	.015	.649	−.151	−.610 to .308	−.018	.518
	4	.129	−.457 to .716	.011	.666	−.127	−.532 to .279	−.015	.540
	5	.227	−.570 to 1.024	.019	.576	−.214	−.678 to .251	−.025	.368
Fruit & Vegetable*	1	.000	−.008 to .008	−.050	.960	.006	.001 to .001	.051	**.028**
	2	−.004	−.012 to .004	−.022	.361	.005	−.001 to .010	.038	.118
	3	−.002	−.014 to .010	−.012	.725	.007	.000 to .014	.058	**.041**
	4	−.002	−.011 to .006	−.012	.620	.005	.000 to .011	.045	.067
	5	−.002	−.014 to .010	−.011	.734	.008	.001 to .014	.064	**.025**

Model 2 = Model 1plus maternal education, fatmass index, height & season change

Model 3 = Model 2 plus pubertal status

Model 4 = Model 1 plus maternal education, IOTF group (ref normal), length & season change

Model 5 = Model 4 plus pubertal status

*All fruit and vegetable models are also adjusted for total energy consumption

Table 5

The association between Weekend MVPA minutes and dietary variables in 11 year old children from ALSPAC (restricted to plausible reporters of dietary intake only)

		Boys				Girls			
Exposure	**#**	**Beta**	**95% CI**	**Std. Beta**	**P**	**Beta**	**95% CI**	**Std. Beta**	**P**
Total energy (calories)	1	−.003	−.006 to .001	−.037	.134	−.001	−.004 to .002	−.016	.509
	2	.000	−.004 to .005	.006	.838	.001	−.002 to .005	.019	.502
	3	.000	−.005 to .006	.004	.904	.003	−.001 to .007	.055	.087
	4	−.001	−.005 to .003	−.014	.626	.000	−.004 to .003	−.001	.981
	5	−.001	−.007 to .004	−.015	.688	.002	−.002 to .006	.038	.231
% Energy from carbohydrate	1	.166	−.026 to .358	.042	.089	.049	−.096 to .195	.016	.507
	2	.137	−.059 to .332	.035	.170	.069	−.082 to .219	.023	.370
	3	.142	−.130 to .414	.035	.306	.072	−.101 to .245	.024	.411
	4	.183	−.013 to .380	.047	.067	.088	−.065 to .241	.029	.257
	5	.186	−.088 to .459	.046	.183	.097	−.079 to .273	.032	.282
% Energy from Fat	1	−.167	−.385 to .050	−.037	.131	.010	−.153 to .173	.003	.907
	2	−.096	−.319 to .127	−.022	.398	.001	−.168 to .170	.000	.989
	3	−.052	−.363 to .259	−.011	.741	−.025	−.220 to .171	−.007	.805
	4	−.159	−.383 to .065	−.036	.164	−.016	−.188 to .156	−.005	.855
	5	−.111	−.423 to .202	.024	.486	−.047	−.245 to .151	−.014	.643
Energy density	1	−.604	−1.263 to .054	−.045	.072	−.004	−.494 to .486	−.017	.986
	2	−.505	−1.190 to .180	.037	.149	−.083	−.439 to .605	.008	.754
	3	−.212	−1.135 to .711	−.015	.652	−.073	−.687 to .541	−.007	.816
	4	−.604	−1.292 to .085	.044	.086	.010	−.520 to .539	.001	.971
	5	−.202	−1.132 to .727	−.015	.670	−.132	−.756 to .492	−.012	.678
Fruit & Vegetable*	1	.006	−.003 to .015	.031	.218	.006	−.001 to .012	.040	.107
	2	.005	−.004 to .015	.028	.285	.004	.004 to .011	.026	.310
	3	.005	−.009 to .018	.024	.491	.010	.002 to .019	.069	**.021**
	4	.007	−.003 to .017	.036	.164	.005	−.002 to .013	.034	.188
	5	.005	−.009 to .019	.026	.460	.011	.002 to .020	.074	**.014**

Model 2 = Model 1plus maternal education, fatmass index, height & season change

Model 3 = Model 2 plus pubertal status

Model 4 = Model 1 plus maternal education, IOTF group (ref normal), height & season change

Model 5 = Model 4 plus pubertal status

* All fruit and vegetable models are also adjusted for total energy consumption