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Lifestyle Behaviors Associated With Body Fat Percent in 9- to 11-Year-Old Children

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Article

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Swindell, N, Berridge, D, McNarry, MA, Mackintosh, KA, Boddy, LM, Fairclough, SJ and Stratton, G (2021) Lifestyle Behaviors Associated With Body Fat Percent in 9- to 11-Year-Old Children. Pediatric Exercise Science. ISSN 0899-8493

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1 **Lifestyle behaviours associated with body fat percent in 9-11-year-** 2 **old children**

3 **Abstract**

4 *Purpose*

5 To examine [1] associations between body fat percent (BF) and lifestyle behaviours in
6 children aged 9-11 years, and [2] the consistency of these associations over a 10-year period.

7 *Methods*

8 In this repeat, cross-sectional study, 15,977 children aged 9-11 years completed an
9 anthropometric assessment and the SportsLinx Lifestyle survey between 2004 and 2013. Body
10 fat was estimated according to the sum of the tricep and subscapular skinfold measurements.
11 Multilevel models were utilized to examine associations between BF and responses to the
12 lifestyle survey, while controlling for known covariates.

13 *Results*

14 Lifestyle behaviours explained 8.6% of the total variance in body fat. Specifically, negative
15 associations were found between BF and active transport to school ($\beta=-0.99\pm0.19$ $p<0.001$),
16 full-fat milk (-0.07 ± 0.15 $p<0.001$) and sweetened beverage consumption (-0.40 ± 0.15
17 $p=0.007$). Relative to the reference group of $\leq 8:00$ pm, later bedtime was positively associated
18 with BF; 8:00-8:59pm ($\beta=1.60\pm0.26$ $p<0.001$); 9:00-10:00pm ($\beta=1.04\pm0.24$ $p<0.001$);
19 $\geq 10:00$ pm ($\beta=1.18\pm0.30$ $p<0.001$). Two-way interactions revealed opposing associations
20 between BF and the consumption of low-calorie beverages for boys ($\beta=0.95 \pm 0.25 = p<0.001$)
21 and girls ($\beta=-0.85\pm0.37$ $p=0.021$). There was no significant change in these associations over
22 a 10-year period.

23 *Conclusions*

24 In this population-level study covering a decade of data collection, lifestyle behaviours were
25 associated with BF. Policies and interventions targeting population-level behaviours change,

26 such as active transport to school, sleep time and consumption of full-fat milk, may offer an
27 opportunity for improvements in BF.

28

29 **Key Words:** Body fat, child, lifestyle behaviour, skinfold, obesity, active transport, bedtime.

30

31 **Introduction**

32 Childhood obesity is a significant public health concern, with a third of children in the UK
33 being affected by overweight or obesity (1). Excess body weight increases the risk of
34 developing type 2 diabetes, cardiovascular disease, hypertension, and sleep apnoea (2).
35 Childhood obesity is also related to emotional problems and reduces quality of life (3).
36 Moreover, excess weigh at this age and during adolescents tends to persist into adulthood (4).
37 Given that excess BF result from long-term energy imbalance, efforts to prevent obesity must
38 promote lifestyle behaviours that reduce energy intake and promote energy expenditure.

39 In 2009, data from the SportsLinx study showed the increase in prevalence of overweight and
40 obesity had slowed among children across Liverpool (5). These changes may reflect a
41 combined impact of the initiatives delivered in Liverpool at the time including interventions
42 delivered by the SportsLinx programme such as after school clubs and taster sessions, and
43 Liverpool City Council's campaigns such as Active City and A Taste for Health, part of the
44 city's obesity agenda that aimed to halt the rise in obesity by targeting physical activity and
45 healthy eating (6). In the same period, the SportsLinx study reported an improvement in
46 children's food intake with an increase in fruit, vegetable and salad intake over a 10-year period
47 (7). Despite these changes, it is unclear how specific behaviours relate to adiposity and whether
48 this has changed over time. Diet, physical activity and sedentary behaviours such as skipping
49 breakfast, screen time, and the consumption of sugar sweetened beverages, have been
50 implicated in the development of obesity in children (8,9). Conversely, increased fruit and

51 vegetable consumption and physical activity are linked with reduced risk of overweight and
52 obesity in children (10). However, associations are inconsistent, for example, in a large
53 international study of 10–16 year olds, obesity was associated with low physical activity levels
54 and television viewing but not with the fruit and vegetable intake, soft drink consumption or
55 the time spent using computers, yet a negative association was found between the frequency of
56 the consumption of sweets (candy in the USA) and obesity (11,12). Furthermore, the ISCOLE
57 study including 6,025 children (9-12 years) from 12 countries, failed to find an association
58 between dietary patterns and obesity (11), in accord with population-level studies in the UK
59 (13,14). It is therefore unclear which behaviours are related to obesity and should be the target
60 of interventions. Associations between specific foods and obesity are not always intuitive. For
61 example, the intake of fat from dairy is negatively associated with obesity during childhood
62 (15,16) despite its energy content. Similarly, the relationship between sugar sweetened
63 beverages and BF is not straightforward as might be assumed. Data from the SportsLinx study
64 has demonstrated that children with the greatest intake of sugar sweetened beverages had a
65 significantly lower BMI than non-consumers (17). Methodological limitations to population-
66 level studies such as the pooling of responses to a food frequency questionnaire to produce a
67 “healthy” and “unhealthy” score (13,14), may mask associations between specific foods and
68 obesity and precludes further interpretation of these findings.

69 Over the past decade there has been a year-on-year shift from full-fat to skimmed milk varieties
70 and an increase of wholemeal bread (18). Moreover, between 2004 and 2008, the percentage
71 soft drinks consumed by children with no added sugar increased by 9 percent (19).

72 Likewise, over the past 15 years screen behaviour has changed, TV viewing has decreased,
73 while computer use has sharply increased (20). Despite these changes, it is unclear whether
74 lifestyle behaviours and food choices positively impact on adiposity over time.

75 Exploring the lifestyle behaviours that influence childhood overweight and obesity and how
76 these have altered among changing technology use, food composition and public health policy
77 and campaigns is essential for the development of effective interventions. To our knowledge,
78 no studies have reported long-term changes to cross-sectional associations between lifestyle
79 behaviours and BF.

80 The aim of this study was to examine the associations between BF and dietary and physical
81 activity behaviours in primary school children over a 10-year period.

82

83 **Methods**

84 *Participants and Settings*

85 Participants included children aged 9-11 years that took part in the SportLinx program between
86 2004 and 2013. The SportsLinx program has been described in more detail elsewhere (7,21).
87 Briefly, SportsLinx was a repeat, cross-sectional physical activity, nutrition and health program
88 conducted in primary schools within the Liverpool Local Education Authority (UK). All year
89 5 pupils (9-10 years) were invited to take part annually resulting in 15,977 children who
90 completed an anthropometric assessment and lifestyle survey (7). On average, 105 primary
91 schools took part every year, representing 90% of all primary schools in the area.

92

93 *Measures and Procedures*

94 The SportsLinx Lifestyle Survey was used to assess sport participation, screen time, diet and
95 sleep. Participants specified, on a 5-point Likert scale, how much time during week and
96 weekend days they typically spent watching TV/DVDs/videos, playing video games, using the
97 internet, and participating in sport. Given that spending ≥ 2 hours in sedentary pursuits, is
98 unfavourable associated with body composition (22), data were categorized into dichotomous
99 levels for each variable to reflect participation in each sedentary activity for above or below 2

100 hour per day. Children were asked to select what time they went to bed (1: Before 8pm; 2: 8-
101 8:59pm; 3: -9:59pm; 4: After 10pm). The food intake questionnaire was designed to measure
102 eating habits at the population level based on the recall of foods consumed on the previous day.
103 A series of 'yes/no' questions indicated which foods were consumed from a list of 44 items.
104 The survey has acceptable validity (23) and reliability (24), in children of a similar age. For
105 this study, all foods, dietary patterns or behaviours that may have affected energy balanced
106 were considered in the analysis (List in supplementary material).

107 Socioeconomic status (SES) was calculated using the 2007 Indices of Multiple Deprivation
108 (IMD) (25) based on participants home postcode.

109 Skinfold thicknesses at the triceps and subscapular were measured by the same ISAK qualified
110 anthropometrist using standardised procedures (26). The Slaughter equations (27) which have
111 been validated in this age group (28) were used to estimate BF from the skinfold thicknesses.

112 Height was measured to the nearest 0.1 cm using a Leicester Height Measure (Seca,
113 Birmingham, UK), and weight was measured using calibrated analogue scales (model 873,
114 Seca, Birmingham, UK) to the nearest 0.1 kg.

115 The 20 meter multi-stage fitness test (MSFT) which has previously been validated in this age
116 group (29), was used to estimate the children's aerobic fitness. Given cardio-respiratory fitness
117 is negatively associated with BF (30), BMI (31) and sedentary time (32) and positively
118 associated with physically active (33) it was controlled for in the analysis.

119 The study was conducted according to the guidelines laid down in the Declaration of Helsinki
120 and all procedures involving human subjects/patients were approved by xxxxx University
121 ethics committee [xxxxx]. All participating children and their parents provided informed
122 written assent and consent.

123 *Statistical analyses*

124 Descriptive statistics, independent samples t-test, and Pearson's chi-squared tests were used to
125 examine differences in the basic characteristics and questionnaire responses between sexes.
126 The proportion of children reporting each behaviour was also compared between years using
127 chi-square tests followed by pairwise comparisons using the z-test of two proportions with a
128 Bonferroni correction, to determine which years were different. The statistical package IBM
129 SPSS statistics, version 22.0 (IBM Corp., Armonk, NY, USA) was used for these analyses.

130 As data were collected from schools across Liverpool, a two-level multi-level model
131 (participant, school) was constructed using MLwiN v.3.01 software (Centre for Multilevel
132 Modelling, University of Bristol, UK) to examine associations between lifestyle survey
133 responses and BF. The model was constructed in three stages. Firstly, a backwards stepwise
134 deletion approach was used to identify all predictor variables that were significantly associated
135 with the outcome variable. Regression coefficients were assessed for significance using the
136 Wald statistic and a Chi-square distribution (34). All significant predictor variables were
137 entered into a crude model (model 1). Secondly, to control for confounders, sex, year, MSFT
138 and SES were entered into the model (model 2). Finally, two-way interactions were explored
139 to establish whether predictors differed by sex or year of data collection (model 3). Alpha was
140 set at $p < .05$ for main effects and $p < 0.1$ for interaction terms (34). The explained variance
141 was calculated by comparing the variance in each model to the variance in the null model
142 containing no independent variables.

143 Multiple imputation was used to address the potential bias and loss of precision that can result
144 from complete-case analysis. REALCOM-IMPUTE software with MLwiN (35) was used to
145 generate 10 imputed datasets with missing values replaced by plausible values based on known
146 covariates and distributional information. After a total of 6,500 iterations the model of interest
147 was fitted to each imputed dataset and the results were combined using Rubin's rule (36).

148

149 **Results**

150 Participant characteristics are presented in Table 1. Girls (n=7,949) had a greater prevalence of
151 overweight and obesity than boys (n=7,955; $p < 0.001$) and a higher percent BF ($p < 0.001$).

152 Responses to the lifestyle survey are presented in the supplementary materials.

153 Results of the multilevel models are presented in Table 2. The estimated variance at the school
154 level, indicated by the null model, suggests a significant inter-individual difference across
155 schools in BF ($\chi^2 = 2,141$ $p < 0.001$). The interclass correlation coefficient revealed that 16.4%
156 of the variability in BF was explained by the school-level and 83.6% was explained by
157 individual level factors.

158 The crude model which contained all lifestyle behaviours that were significantly associated
159 with BF explained approximately 8.6% of the variance in BF. The adjusted model, which
160 adjusted for relevant covariates, accounted for 15.3% of the variance. Associations, between
161 bedtime, active transport, sugar sweetened cereals, sugar sweetened beverage, low calorie
162 beverage and full-fat milk were not attenuated by covariates. The final model with interaction
163 terms explained 15.5% of the total variation in BF.

164 After adjusting confounders, significant positive associations were observed between bedtime
165 and BF (Table 2). All bedtimes later than 8pm were positively associated with BF. The use of
166 an active mode of transport to get to school was negatively associated with BF. Intake of full-
167 fat milk was negatively associated BF as were sugar sweetened cereal and sugar sweetened
168 beverage intake. Low calorie beverages were positively associated with BF. Two-way
169 interactions indicated that the positive association between low calorie beverages and BF was
170 moderated by sex, with a negative association for girls. The main effects of year indicate that
171 BF in 2010 and 2011 was significantly lower than 2004. However, two-way interactions
172 between year and lifestyle behaviours were not significant. Some significant differences in

173 lifestyle behaviours were found between years (supplementary material). However, these
174 differences did not coincide with differences in BF.

175 **Discussion**

176

177 The aim of this study was to investigate the associations between BF, and lifestyle behaviours
178 in a large population of children in one city and to test the consistence of these associations
179 over a 10 -year period. Lifestyle behaviours explained 8.6% of the variation in BF and remained
180 significant after adjustment for confounding variables. Despite alterations in behaviour, the
181 composition of foods, nutritional policies and obesity prevention strategies, associations with
182 childhood adiposity have not significantly changed over a 10-year period.

183 Retiring to bed later than 8pm was positively associated with adiposity. This is consistent with
184 literature that has shown short sleep and late bedtimes are associated with an unhealthy body
185 weight (37,38). Insufficient sleep has been shown to effect dietary patterns, resulting in food
186 cravings and a greater consumption of energy dense foods (39). Further explanations for this
187 association may be that sleep is negatively impacted by sedentary pursuits, such as television
188 watching (40), and positively affected by exercise (41). However, no association was found
189 between television watching and BF in the present study. Current sleep guidelines suggest
190 children should achieve between 9-11 hours of sleep every 24-hours (42). In the present study,
191 the bedtimes associated with BF were relatively early; guidelines could be achieved while
192 going to bed beyond 8pm. This may reflect a discrepancy between bedtime and sleep onset
193 which are not always synonymous and may be influenced by media use (43). None the less,
194 bedtime and sleep duration are important considerations when planning lifestyle interventions
195 for the prevention of obesity.

196 Active transport to school was negatively associated with BF, likely because active commuters
197 expend more energy than children who use motorised transport (44). This finding is consistent
198 with results from a study of children of the same age from 12 counties (45) which also found

199 that active transport increases daily physical activity levels (46). These findings suggest that
200 commuting to school may offer an effective approach to reducing BF by increasing daily
201 physical activity and energy expenditure.

202 The consumption of free sugars is a determinant of body weight. Consequently, guidelines
203 recommend an intake of below 5% of total energy intake (47). In the present study, no
204 association was found between reporting the intake of biscuits, cakes, chocolate bars, fizzy
205 drinks or added sugar, but a negative association was found between BF and sugar-sweetened
206 cereals and sweetened beverages, similar to the findings of Janssen et al (12). As we could not
207 establish portion size from our data, it is possible that overweight children consumed greater
208 quantity of sugar-sweetened cereals and sweetened soft drinks. Another possible explanation
209 is that overweight children are more likely to under-report unhealthy food intake than their
210 normal weight counterparts (48). We found that the consumption of low-calorie soft drinks was
211 positively and negatively associated with BF in boys and girls respectively. The result for boys
212 was unexpected but are in agreement with previous findings that diet soft drinks are positively
213 associated with body weight, suggesting that calorie content is not solely responsible for this
214 association (49). It may be that soft drinks, regardless of their sugar content, are regularly
215 consumed alongside high-energy snacks or during sedentary behaviours, such as television
216 watching. Conversely, soft drinks, including sports drinks, are frequently sold at sports centres
217 and may be consumed while also participating in exercise (50). It is also possible that following
218 weight gain, children consume diet soft drinks in an attempt to reduce their calorie intake (51).
219 However, prospective studies have shown that these associations remain significant after
220 controlling for BMI at baseline or when studying normal weight adults separately (52).
221 Repeatedly consuming sweet tasting foods with no energy content may lead to the failure to
222 anticipate calories from sugar when they are consumed, disrupting the signals that lead to
223 satiety (53). Independent of underlying mechanisms, we found that the association between

224 low-calorie beverages and BF differs between boys and girls. Very few studies have
225 distinguished between regular and sugar-free or diet drinks when investigating association with
226 BF or obesity; this is the first study to show a sex difference in the associations with BF in a
227 large population over time. Further research is required to establish the wider context in which
228 diet and low-calorie soft drinks relate to BF. Based on our findings, future studies should
229 analyse data dependent on sex.

230 Breakfast cereals are a major contributor to free sugar intake among children in the UK, which
231 are in-turn associated with over-eating and weight gain (47). Despite this link, a negative
232 association was found between BF and sugar-sweetened cereals. This finding agrees with
233 outcomes from the NHANES study which found children who ate cereal, regardless of sugar
234 content, had significantly lower BMI compared with children who did not. Furthermore, cereal
235 consumption was associated with lower fat intake, a higher intake of carbohydrates, whole
236 grains, and a range of vitamins (54). Similarly, a recent Australian study found no association
237 between anthropometric measures and the choice of non-sweetened or sweetened breakfast
238 cereal. Furthermore, added and free sugar intake was similar between cereal and no-cereal
239 consumers (55). These findings might be explained by a lower Glycaemic index (GI) diet in
240 participants who consumed breakfast cereals. Although no association was found between high
241 fibre cereals and BF, the energy density and GI of breakfast cereals is not solely dependent on
242 sugar content but also processing techniques and the quantity and type of fibre (56,57).
243 Research has shown higher dietary fibre intake in participants consuming breakfast cereals
244 regardless of sugar content (54,55).

245 Full-fat milk was negatively associated with BF, no association was found between low fat
246 milk varieties. Previous studies have provided inconsistent reports of the relationship between
247 milk/dairy intake in children and adiposity with studies reporting negative association (58), no
248 association (9) or positive associations (15). Several studies have shown that soft drink

249 consumption displaces milk consumption in children and adolescents (59), however, the
250 associations between soft drink consumption and BF were inconclusive and could not explain
251 the lack of association for low fat milk in this study. Few studies have distinguished between
252 low and full-fat dairy products in children in relation to BF; However while the consumption
253 skimmed milk was associated with weight gain, dairy fat was not (15). In a cohort of children
254 up to 3-years of age, a higher milk fat consumption was associated with lower odds of obesity
255 (16). Mechanisms for the adverse association between dairy fat and obesity are unclear but
256 may include bioactive effects of the fatty acids contained in milk which have been shown to
257 have an effect on low grade inflammation, oxidative stress (60) and insulin resistance (61)
258 particularly in adults. Existing evidence from prospective studies reported that full-fat milk
259 may be protective of weight gain and obesity (61,62). The findings of the present study add to
260 this evidence by showing that at a population level, the consumption of full-fat milk is
261 negatively associated with BF in 9-11 years old children.

262
263 Despite alterations in behaviour, the composition of foods, nutritional policies and obesity
264 prevention strategies, associations between lifestyle behaviours and BF have not significantly
265 changed over a 10-year period. This may reflect the fact that very few programmes and policies
266 have successfully influenced childhood obesity and that any positive effects have been modest
267 in relation to population trends (63). This may in turn be due to the lack of clarity about the
268 relative importance of possible causative factors such as changes in dietary patterns, increases
269 in soft drink consumption, portion size, screen time, physical activity and sedentary behaviours
270 or most likely, a combination of all these factors. It is important to acknowledge that although
271 significant associations between lifestyle behaviours and BF were found, combined, they
272 explained only a small proportion of the variance in BF indicating the potential for other
273 important contributing factors.

274 This study has several strengths. First, the large sample size and the duration of study spanning
275 10 years has allowed us to test consistency of associations between BF and lifestyle behaviours
276 over time. To our knowledge, this is the first study to examine a near complete cross-section
277 of children (aged 9-11 years) from a UK city. Secondly, the pathogenic processes associated
278 with obesity are related to BF. BMI is a composite measure using height and weight and is not
279 a measure of body composition. Skinfold measures on the other hand are a 2-compartment
280 model and allow fat mass and fat free mass to be estimated. Finally, the use of multilevel
281 analyses and multiple imputation techniques add to the rigour of our methodology by
282 accounting for clustering between schools and by handling missing data respectively.

283 Limitations of this study include the cross-sectional design which precluded the inference of
284 causality. Further, the lifestyle behaviours were captured with a self-report questionnaire that
285 may be susceptible to social desirability and recall bias. Furthermore, some items on the survey
286 had not been previously validated. However, single-item measures to measure screen time are
287 common in large pollution studies and show high levels of validity among available
288 methodologies (64). Similarly, comparable items on frequency of sports participation and club
289 membership have shown good validity in this age group (65).

290 Previous studies investigating associations between lifestyle behaviours and BF or BMI have
291 shown negative associations between physical activity and markers of obesity (11,13,14). In
292 the present study, we did not have a direct measure for physical activity, instead we reported
293 aerobic fitness. Although we recognize that aerobic fitness is partially genetic in origin, it can
294 also be a reflection of recent physical activity levels (33,66). Finally, we were unable to control
295 for maturation, given the age range of the participants it is possible that some, particularly girls,
296 were going through puberty which may have affected their behaviour and BF.

297
298 **Conclusions**

299 In a large population of children, lifestyle behaviours were associated with adiposity but no
300 significant change in these associations were found over a 10-year period. Policies and
301 interventions targeting population shifts in behaviours, such as active transport to school, sleep
302 time and consumption of full-fat milk may offer an opportunity for public health improvement.
303 Further research is required to establish the wider context in which low calorie soft drink are
304 linked with BF, future studies should consider different mechanisms for boys and girls.

305

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Table 1

Participant characteristics

	Boys (n=7,955)		Girls (n=7,949)		P-value
Age (years)	9.7	(0.4)	9.7	(0.4)	0.84
Height (cm)	137.8	(6.2)	137.5	(7.8)	0.001
Weight (kg)	39.2	(13.9)	39.4	(13.7)	0.223
BMI (kg·m ⁻²)	20.4	(6.9)	20.7	(6.8)	0.024
BMI z-score ^a	0.8	(1.5)	0.9	(1.4)	0.004
Fat percent	23.8	(8.9)	27.2	(8.6)	<0.0005
Prevalence of overweight ^b (%)	17.7		21.0		<0.0005
Prevalence of obese ^b (%)	11.4		13.5		<0.0005

Data are means and standard deviations unless stated otherwise. ^aBMI Z-score denotes the standard deviation score calculated from International Obesity Task Force values. ^bOverweight and obesity were defined by using the International Obesity Task Force criteria.

Table 2

Associations between lifestyle behaviours and body fat percentage

	Crude model (model 1)				Adjusted model (model 2)				Model 2 plus two-way interactions			
	Beta	95% CI		p-value	Beta	95% CI		p-value	Beta	95% CI		p-value
		Low	High			Low	High			Low	High	
Constant	27.025	26.44	27.61	<0.0005	25.96	24.87	27.05	<0.0005	25.88	24.79	26.96	<0.0005
Sugar sweetened cereals	-0.70	-1.02	-0.37	<0.0005	-0.62	-0.94	-0.29	<0.0005	-0.62	-0.95	-0.29	<0.0005
High fibre cereals	-0.31	-0.66	0.03	0.071	-0.19	-0.52	0.15	0.285	-0.19	-0.53	0.15	0.272
Ordinary sausages	-0.52	-0.90	-0.14	0.007	-0.28	-0.66	0.11	0.157	-0.27	-0.65	0.11	0.163
Full fat milk	-1.10	-1.41	-0.79	<0.0005	-0.97	-1.27	-0.67	<0.0005	-0.97	-1.27	-0.67	<0.0005
Sugar sweetened beverages	-0.37	-0.66	-0.08	0.013	-0.39	-0.68	-0.10	0.009	-0.40	-0.70	-0.11	0.007
Low calorie beverages	0.54	0.16	0.91	0.005	0.54	0.19	0.89	0.003	0.95	0.46	1.44	<0.0005
Active Transport	-1.34	-1.71	-0.97	<0.0005	-1.00	-1.37	-0.62	<0.0005	-0.99	-1.37	-0.61	<0.0005
Week Sport	-0.50	-0.78	-0.22	<0.0005	-0.13	-0.41	0.14	0.339	-0.14	-0.41	0.14	0.331
Usual bed time during the week $\leq 8:00pm$ (Ref)												
8:00-8:59pm	1.66	1.15	2.18	<0.0005	1.59	1.08	2.10	<0.0005	1.59	1.09	2.10	<0.0005
9:00-10:00pm	1.09	0.62	1.56	<0.0005	1.04	0.57	1.50	<0.0005	1.03	0.57	1.49	<0.0005
$\geq 10:00pm$	0.92	0.33	1.50	0.002	1.18	0.60	1.76	<0.0005	1.18	0.60	1.76	<0.0005
Computer on the weekend	-0.74	-1.02	-0.46	<0.0005	0.18	-0.12	0.47	0.241	0.18	-0.11	0.47	0.232
IMD Score					0.01	0.00	0.02	0.003	0.01	0.00	0.02	0.003
MSFT					-0.04	-0.04	-0.03	<0.0005	-0.04	-0.04	-0.03	<0.0005
Sex (girl)					3.06	2.78	3.35	<0.0005	3.25	2.94	3.56	<0.0005
Year 2004 (ref)												
2005					-0.40	-1.45	0.66	0.461	-0.39	-1.44	0.66	0.467
2006					0.05	-1.03	1.12	0.932	0.05	-1.03	1.12	0.930
2007					0.45	-0.62	1.51	0.410	0.45	-0.62	1.51	0.412
2008					0.42	-0.69	1.53	0.456	0.42	-0.69	1.53	0.455
2009					-0.15	-1.21	0.91	0.783	-0.15	-1.21	0.91	0.783

<i>2010</i>				-6.89	-8.22	-5.55	<0.0005	-6.90	-8.23	-5.56	<0.0005
<i>2011</i>				-3.13	-4.25	-2.01	<0.0005	-3.13	-4.26	-2.01	<0.0005
<i>2012</i>				0.39	-0.80	1.57	0.522	0.40	-0.79	1.58	0.514
<i>2013</i>				-0.35	-3.48	2.79	0.829	-0.36	-3.49	2.78	0.823
Two-way interactions											
<i>Sex * low calorie beverages (girl)</i>								-0.84	-1.57	-0.12	0.023
Random	Null model	Crude model		Adjusted model (model 2)				Model 2 plus two-way interactions			
Total variance	78.42	68.62		65.09				65.06			
ICC	16.4	5.8		4.9				4.8			
Deviance	101592.084	60334.059		47145.847				47138.582			
Variance explained											
<i>Total</i>		8.6%		15.3%				15.5%			
<i>School level</i>		7.4%		10.7%				10.8%			
<i>Individual level</i>		1.2%		4.6%				4.7%			
IMD, Indices of Multiple Deprivation; MSFT, Multi Stage Fitness Test; ICC Intraclass Correlation Coefficient. Beta values are unstandardized beta coefficients.											
Model 1 Contained all lifestyle behaviours associated with body fat percentage											
Model 2 Contained all variables in model 1 plus confounding variables: IMD, MSFT, sex and year											
Model 3 Contained all variables in model 2 plus 2-way interactions between sex and the consumption of low calories beverages											

