

1 **Abstract**

2 **Background:** Previous studies have reported on the associations between obesity and sedentary behavior  
3 (SB) or physical activity (PA) for children. The present study examined longitudinal and bidirectional  
4 associations between adiposity and SB and PA in children. Methods: Participants were 356 children in  
5 England. PA was measured at age 7 and 9 years using accelerometry. Outcome and exposures were time in  
6 SB and PAs and concurrent body mass index (BMI) Z-score and fat index (FI). Results: Adiposity at baseline  
7 was positively associated with change in SB ( $\beta=0.975$ , for FI) and negatively associated with changes in  
8 moderate-to-vigorous PA (MVPA) ( $\beta=-0.285$  for BMI Z-score,  $\beta=-0.607$  for FI), vigorous PA (VPA) ( $\beta$   
9  $=-0.095$  for FI) and total PA ( $\beta=-48.675$  for FI), but not vice versa. The changes in SB, MVPA and total PA  
10 for children with overweight/obesity were significantly more adverse than those of healthy weight children.  
11 **Conclusions:** A high BMI Z-score or high body fatness at baseline was associated with lower MVPA and  
12 VPA after 2 years, but not vice versa, which suggests that in this cohort adiposity influenced PA and SB, but  
13 the associations between adiposity and SB or PA were not bidirectional.

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## 1 **Introduction**

2 Childhood obesity is a widespread health and social problem which is still increasing in prevalence in  
3 many countries.<sup>1</sup> A previous review of prospective studies concluded that low levels of baseline physical  
4 activity (PA) were only weakly or not at all associated with body fat gain.<sup>2</sup> More recent reviews also suggest  
5 that the influence of changes in objectively measured sedentary behavior (SB) on change in adiposity in  
6 children and adolescents was unclear.<sup>3-5</sup>

7 Only a few previous longitudinal studies have reported on the associations between obesity as a predictor  
8 and SB or PA as an outcome by using an accelerometer as an objective measure of habitual physical activity  
9 and sedentary behavior for children and adolescents,<sup>6-10</sup> and these studies did not examine bidirectional  
10 associations. We have identified only four prospective studies that examined bidirectional associations  
11 between adiposity and objectively measured SB and/or PA in children and adolescents.<sup>11-14</sup> In two studies in  
12 children, increased adiposity or adiposity at baseline was negatively associated with change in moderate-  
13 vigorous PA (MVPA) but not vice versa.<sup>12,14</sup> On the other hand, one prospective study of preschool children  
14 demonstrated that adiposity did not influence change in total PA, MPA and VPA.<sup>11</sup> Moreover, one prospective  
15 study of adolescents showed that adiposity did not influence MVPA level or adiposity later in life.<sup>13</sup> One  
16 prospective study of adults also demonstrated that obesity as a predictor was negatively associated with  
17 subjective PA level later in life,<sup>15</sup> but that PA level did not influence fatness. Moreover, in regard to sedentary  
18 behavior, the other prospective adult cohort study showed that fatness led to objectively measured sedentary  
19 behavior but that sedentary behavior did not lead to fatness.<sup>16</sup> However, a number of recent childhood studies  
20 have found that reductions in objectively measured PA are associated with increased adiposity,<sup>17,18</sup> but did  
21 not examine bidirectional associations. It is possible that the associations between obesity and SB or PA may  
22 be bidirectional, and that increased adiposity may increase SB and/or decrease PA in children and  
23 adolescents.<sup>19</sup>

24 With an evidence base limited apparently to just four studies of bidirectionality in children and  
25 adolescents, one of which followed up for only 200 days,<sup>14</sup> and the others which simply considered baseline  
26 adiposity or PA and SB,<sup>11-13</sup> the reverse causation or ‘bidirectionality hypothesis’ needs to be tested by new

1 evidence. Thus, the main aim of the present study was to examine the longitudinal bidirectional associations  
2 between adiposity and daily SB and PA, measured objectively, in childhood.

#### 4 **Materials and Methods**

5 The Gateshead Millennium Study (GMS) is an observational cohort study which has been described in  
6 detail elsewhere.<sup>20,21</sup> The sample was socioeconomically representative of northeast England at the first SB  
7 and PA data collection in 2006/2007.<sup>20</sup> Baseline measures of PA and SB for the present study were collected  
8 between October 2006 and December 2007 when the children were aged 6–7 years, and follow-up data were  
9 collected 2 years later. Children aged 6–7 years (n=510 at baseline) were included in the study. The study  
10 was approved by the Gateshead and South Tyneside LREC (6-7y) and Newcastle University Ethics  
11 Committee (9y). Informed written consent was obtained from the parent/main caregiver of each child, and  
12 children provided assent to their participation.

#### 14 **Objective measurement of sedentary behavior and physical activity**

15 Overall SB and PA were measured with the Actigraph GT1M accelerometer as described previously.<sup>21</sup>  
16 The Actigraph has high validity, high reliability, and low reactivity in children.<sup>22</sup> In UK children, there are  
17 small but significant seasonal variations in objectively measured PA,<sup>23,24</sup> and so baseline and follow-up  
18 measurements were made during the same season. Children in the present study were asked to wear an  
19 accelerometer during waking hours for 7 days. Accelerometers were attached to an elastic belt and worn on  
20 the hip. Accelerometer counts were collected in 15 second intervals (epochs). Data were reduced manually,  
21 by juxtaposing accelerometry output and log-sheets in order to delete occasional periods of nonwear time.<sup>22,24</sup>  
22 Children were included only if they recorded complete wear time diaries. Non-wear time and sleep data were  
23 removed manually based on the wear time diaries and visual inspection by a trained researcher. It was decided  
24 not to define non-wear time using consecutive zeros as previous research has shown this affects the outcomes  
25 significantly especially in longitudinal studies where changes in their behavioral patterns are very likely.<sup>25</sup> In  
26 this cohort, 3 days of accelerometry with a minimum of 6 hours recording per day provides acceptable

1 reliability,<sup>26</sup> so measures were included in the present study if at least 3 days of accelerometry of at least 6  
2 hours were obtained at both baseline and follow-up measures, but in practice the actual accelerometry  
3 monitoring periods were typically much longer than these minimum values and are reported below.

4 Five constructs were measured: SB (expressed as minutes/day and %); light PA (LPA) (expressed  
5 minutes/day and %); moderate PA (MPA) (expressed as minutes/day and %), MVPA (expressed as  
6 minutes/day and %); total volume of physical activity (TPA, expressed as counts per minute; cpm). Evidence-  
7 based “cutoff points” were used to measure SB and the intensity of PA : <25 counts per 15 seconds to quantify  
8 SB,<sup>28,29</sup> 25-799 counts per 15 seconds to quantify LPA,<sup>27,28</sup> 800-2049 counts per 15 seconds or more to  
9 quantify MPA,<sup>28</sup> 2050 counts per 15 seconds or more to quantify vigorous PA.<sup>28</sup> MVPA was calculated as a  
10 sum of MPA and vigorous PA.

## 12 **Anthropometric measurements**

13 Height was measured to 0.1 cm with a Leicester Portable height measure and weight measured to 0.1  
14 kg in light indoor clothing. Body mass index (BMI=weight [kg]/height [m]<sup>2</sup>) was calculated for each child  
15 and Z-scores expressed relative to UK 1990 population reference data.<sup>31</sup> Definitions of obesity as a BMI of  
16 more than the 95<sup>th</sup> centile (z score > 1.645) and overweight as a BMI greater than the 85<sup>th</sup> centile (z score  
17 >1.036) compared to 1990 BMI UK reference data were used. Body fat was estimated with a TANITA TBF  
18 300MA. Fat mass was estimated from TANITA bioelectric impedance (TBF-300MA) by applying constants  
19 for the hydration of fat-free mass having first estimated total body water using validated sex and age-specific  
20 prediction equations.<sup>32, 33</sup> Then fatness was estimated from total body water using sex- and age-specific  
21 prediction equations from Haroun et al.<sup>33</sup> Fat index (FI) was calculated as a Z score relative to age and sex  
22 specific reference data from the UK ALSPAC (Avon Longitudinal Study of Parents and Children) cohort  
23 (born in 1991/92), as described in Wright et al..<sup>34</sup>

## 25 **Statistical analysis**

26 Descriptive characteristics of the study sample were presented as a mean and standard deviation (SD).

1 Change variables were calculated as follow-up values minus baseline values. An independent samples t-test  
2 was used to compare between boys and girls. There were no significant interactions between gender and  
3 variation of each variable. Partial correlations were analyzed between BMI Z-score and FI, changes in BMI  
4 Z-score and changes in FI, SB and each PA intensity at baseline and changes in SB and each PA intensity  
5 while adjusting for gender.

6 The associations between change of BMI Z-score or FI and SB or each PA variable at baseline variables  
7 were analyzed by analysis of covariance (ANCOVA) adjusted for gender and BMI Z-score or FI at baseline.  
8 Moreover, if the association was found to be significantly associated with SB or MVPA or MPA variable,  
9 extra analysis was conducted adjusting for the other variable (MVPA or SB). The associations between  
10 change of SB or each PA variable and BMI Z-score or FI at baseline variables were analyzed by ANCOVA  
11 adjusted for sex and SB or each PA variable at baseline. Moreover, the associations between change in BMI  
12 Z-score or FI and change in SB or each PA variable were analyzed using ANCOVA adjusted for gender and  
13 BMI Z-score or FI at baseline and SB or each PA variable at baseline. The associations between weight status  
14 at baseline (children with overweight/obesity versus healthy weight children) and change of SB or PA were  
15 analyzed by ANCOVA, adjusted for sex and the SB or each PA variable at baseline. Moreover, if weight  
16 status was found to be significantly associated with SB or each PA variable extra analysis was conducted  
17 adjusting for SB or MVPA. Analyses were performed with the entire sample and for boys and girls separately,  
18 because our previous study found a possible gender difference in the relationship between SB or MVPA on  
19 adiposity in childhood using the longitudinal GMS data.<sup>17</sup> Statistical analysis was performed with IBM SPSS  
20 statistics 20.0 for Windows (IBM Co., Tokyo, Japan). All statistical tests were regarded as significant when  
21 p-values were less than 0.05.

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## 23 **Results**

24 Due to missing data (no consent to take part/unable to trace for follow-up measures [n=55], no  
25 accelerometer data at follow-up [n=59], no height/weight data at follow-up [n=4] and no body composition  
26 data at follow-up [n=36]), our longitudinal sample for the present study comprised data from 356 children.

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**2 Characteristics of study participants**

3 The characteristics of study participants are presented in Table 1. Ninety (25%) of the sample was  
4 categorized as having overweight/obesity at baseline. The duration of accelerometry was much greater than  
5 the minimum criteria specified (at least 3 days and 6 hours), with an average of 6.4 days and 11.2 hours at  
6 baseline and 6.1 days and 11.4 hours at follow-up, respectively. Boys had lower SB and VPA and higher  
7 MVPA, MPA and TPA (only at follow-up) than girls at each time point. The partial correlations between  
8 baseline values of BMI Z-score and FI and change in BMI Z-score and FI were  $r=0.705$  ( $p<0.001$ ) and  
9  $r=0.603$  ( $p<0.001$ ), respectively.

10 The partial correlations at baseline and the change between SB (%) and LPA (%) were strong ( $r=-0.937$   
11 and  $r=-0.939$ , respectively;  $p<0.001$ ). However, the relationship between absolute SB (min/day) and LPA  
12 (min/day) was weak at baseline ( $r=-0.217$ ,  $p<0.001$ ) and the relationship between the change in SB and LPA  
13 was not significantly correlated ( $r=-0.053$ ,  $p=0.318$ ). The partial correlations between SB (% or min/day) and  
14 MVPA (%), MPA (%) or TPA (cpm) were moderate. The partial correlation between SB (%) and VPA (%)  
15 was weak. The details of partial correlations are shown in the Supplementary Table1.

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**17 Baseline adiposity as a predictor of change in sedentary behavior, physical activity, and vice versa**

18 Changes in BMI Z-score or FI were not associated with SB or the different intensities of PA at baseline.  
19 On the other hand, changes in MVPA (min/day and %), MPA (min/day and %) were associated with both  
20 BMI Z-score and FI at baseline (Table 2a). The change in SB (%), VPA (min/day and %) and TPA (cpm)  
21 were also associated with FI at baseline. These associations remained after adjusting for change in MVPA  
22 (%) or SB (min/day, %) as covariates. The change in LPA was not associated with both BMI Z-score and FI  
23 at baseline.

24 For boys, the changes in MVPA (min/day and %) and MPA (min/day and %) were associated with BMI  
25 Z-score and FI at baseline (Table 2b). The change in SB (%) and TPA (cpm) were also associated with FI at  
26 baseline. On the other hand, for girls, the associations were only significant between FI at baseline and

1 changes in MVPA (min/day and %), MPA (min/day and %) and VPA (min/day and %) (Table 2c). All these  
2 significant associations remained significant after addition of MVPA (%) or SB (min/day and %) as the  
3 further covariates in both genders. On the other hand, changes in BMI Z-score or FI were not associated with  
4 SB or the different intensities of PA at baseline in both genders.

5 The results of associations between change in adiposity and change in SB or PA are shown in the  
6 Supplementary Table 2a, Table 2b and Table 2c. Change in FI was negatively associated with change in  
7 MVPA and MPA in both genders.

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### 9 **Influence of baseline overweight and obesity on changes in sedentary behavior and physical activity**

10 Children with overweight/obesity at baseline had a significantly bigger increase in SB (%;  $p=0.022$ )  
11 and significantly bigger reductions in MVPA (min/day;  $p=0.001$ , %;  $p<0.001$ ), MPA (min/day;  $p=0.002$ , %;  
12  $p=0.001$ ) and TPA (cpm;  $p=0.002$ ) than those of healthy weight children, with all associations remaining  
13 significant after adjusting for change in MVPA (%) or SB (min/day, %) as covariates. The table is shown in  
14 the Supplementary Table 3a.

15 For boys, children with overweight/obesity at baseline had a significantly bigger increase in SB (%;  
16  $p=0.043$ ) and a significantly bigger reduction in MVPA (min/day;  $p=0.004$ , %;  $p=0.001$ ), MPA (min/day;  
17  $p=0.004$ , %;  $p=0.001$ ) and TPA (cpm;  $p=0.009$ ) than those of normal weight children. All of these associations  
18 remained significant after adjusting for change in MVPA (%) and SB (min/day or %). However, there were  
19 no significant differences in SB or PA between weight status categories for girls. The tables are shown in the  
20 Supplementary Table 3b and Table 3c.

21

### 22 **Discussion**

23 This study examined whether adiposity was associated with subsequent SB or PA level in childhood  
24 and vice versa. To our knowledge, no previous study has addressed both habitual SB and the different  
25 intensities of PA in the ‘bidirectionality hypothesis’ in children. Previously, we reported the  
26 unidirectional associations between of accelerometer-measured SB or MVPA on adiposity in childhood

1 using longitudinal GMS data.<sup>17,21</sup> Using the same cohort study, we herein examined the bidirectional  
2 associations between baseline and subsequent changes of adiposity and habitual SB or the different  
3 intensities of PA during childhood. Adiposity at baseline was associated with subsequent changes in SB (%)  
4 or PA, independent of changes in MVPA or SB, but not vice versa. Moreover, higher baseline adiposity  
5 predicted greater increases in SB and declines in PA.

6 We identified only four prospective studies that examined bidirectional associations between adiposity  
7 and objectively measured SB and/or PA in children and adolescents.<sup>12,14</sup> Hjorth et al.<sup>14</sup> demonstrated that  
8 changes over time in MVPA were negatively associated with changes in adiposity. However, none of the  
9 movement behaviors (SB, MVPA and total PA) at baseline predicted changes in adiposity, but higher  
10 adiposity at baseline predicted a decrease in MVPA and total PA, and an increase in sedentary time.<sup>14</sup>  
11 Metcalf et al.<sup>12</sup> reported that there were no significant associations between baseline total PA and  
12 subsequent change in adiposity, yet for the reverse analysis, baseline adiposity versus changes in total PA  
13 from age 7 to 8 years and 9 to 10 years were found to be significantly associated. In addition, adiposity at  
14 baseline predicted change in MVPA from 7 to 10 years, but MVPA at 7 years did not predict change in  
15 adiposity from 7 to 10 years.<sup>12</sup> On the other hand, Burgi et al.<sup>11</sup> demonstrated that adiposity or total PA,  
16 MPA and VPA as a predictor did not influence change in total PA, MPA and VPA level in age 4-6 year  
17 children. Moreover, Hallal et al.<sup>13</sup> reported that adiposity at 11.3 years or MVPA at 13.3 years as a predictor  
18 did not influence MVPA level at 13.3 years or adiposity at 14.7 years. The present study findings are  
19 consistent with the two studies in primary school children on the relation between adiposity and MVPA at  
20 baseline or change in MVPA that respects the temporal sequence of possible cause and effect.<sup>12,14</sup>

21 Two previous studies in children or adolescents reported significant associations between adiposity at  
22 baseline and MVPA at follow-up, or the change on total PA.<sup>7,8</sup> However, six previous studies among  
23 children and adolescents reported no associations between adiposity at baseline and change in SB, MVPA,  
24 MPA and VPA, or MVPA and total PA at follow-up.<sup>6, 7, 9, 10, 11, 13</sup> Potential confounding factors may partially  
25 explain the inconsistency across studies. Some previous studies did not take into account LPA or SB, which  
26 were found to be significant confounding factors in the present study. Moreover, it may be inappropriate to



1 directly compare results across studies, even where studies have used the same hardware and software,  
2 because of the use of different of accelerometer cut points and decisions about issues such as epoch length  
3 and non-wear time for the assessment of habitual SB or PA. However, in the current study and our previous  
4 studies in this cohort the use of two distinct SB accelerometer cut-points (>100 cpm/min vs >1100  
5 cpm/min) and epoch length (15 sec vs 60 sec) and this did not influence the association between SB and  
6 adiposity.<sup>17,21</sup>

7 In the present study, the percentages of MVPA, MPA and total PA (only at follow-up) were  
8 significantly higher in boys than girls, and the percentages of time in SB and VPA were significantly lower  
9 in boys than girls. However, the differences between the sexes were small, and it is not clear if these small  
10 differences could explain the different associations between adiposity and SB or PA between boys and girls  
11 found in the present study. In addition, the numbers of boys and girls in the present study were similar and  
12 2-year changes in SB and PA were actually more marked in girls than boys.<sup>21,35</sup> Therefore, we compared the  
13 coefficients of variation for SB and PA in boys versus girls. In general, the CV values were comparable  
14 between boys and girls. A systematic review concluded that PA was associated more consistently with  
15 adiposity in boys than girls, and the present study was consistent with this finding.<sup>36</sup> It is not clear why  
16 adiposity might be more sensitive to variation in SB (%) and total PA in boys than in girls, but it is possible  
17 that influences on the energy-intake side of the energy-balance equation may be more important in girls  
18 than boys. One additional possible reason might be the gender difference in the level of maturation.<sup>37</sup>

19 In the present study higher baseline adiposity, and overweight/obesity at baseline, predicted a greater  
20 increase in SB (%) and decline in PA (most marked for MVPA). This indicates that overweight or obese  
21 children at age 7 may be a high risk group for becoming inactive and may benefit from PA interventions  
22 more than normal weight children. The present study supports Kwon's study showing that the odds of being  
23 in the lowest quartile relative to the highest quartile of intensity-weighted MVPA at age 11 for boys and  
24 girls with high BF% at age 8 were approximately four times higher than the odds for those with low BF%  
25 at age 8.<sup>8</sup> Weight status-specific intervention strategies for PA promotion or SB reduction may be important  
26 in boys. Furthermore, our recent review showed that school-aged boys spent more time in sedentary

1 behavior compared to adolescent boys.<sup>5</sup> However, time spent in SB was similar for school-aged and  
2 adolescent girls.<sup>5</sup> Therefore, if further studies support the findings of the present study, future intervention  
3 studies aiming to decrease SB should possibly focus on primary (elementary) school-aged boys with  
4 overweight/obesity.

5       There were several limitations to the present study. Sleep is an important predictor of overweight and  
6 obesity.<sup>38</sup> However, the present study focused on habitual SB or PA in waking time only, and so any  
7 influence of adiposity on sleep cannot be considered by the present study. Moreover, although adiposity  
8 may impact PA levels by influencing cognition such as the intention to be active and perceived behavioral  
9 control over factors which influence PA,<sup>39,40</sup> those potentially mediating variables, and indeed other  
10 mediators, were not assessed in the present study. Moreover, total sedentary time is not the same as breaks  
11 in sedentary time (e.g. number of breaks in sedentary time)<sup>41</sup>, and this is another limitation of the present  
12 study. Nonetheless, to our knowledge, this study is the first prospective cohort study in a fairly large  
13 childhood sample to explicitly examine the bidirectionality hypothesis. The use of objective and  
14 accurate measures for both SB and PA and adiposity helped reduce measurement error. Future studies  
15 should prospectively examine the bidirectional association between adiposity and patterns of SB to obtain  
16 more evidence on this important issue.

17       In conclusion, the present study suggested that the children with lowest adiposity at baseline showed  
18 smallest declines in PA at two-year follow-up than those with highest adiposity at baseline, but not vice  
19 versa. The present study also suggests that adiposity might be particularly influential on MVPA, and that it  
20 also influences time spent sedentary, a behavioral risk factor which increases across childhood and  
21 adolescence.<sup>5</sup> Regarding future research, more evidence should be accumulated to test the reverse causation  
22 hypothesis in childhood and adolescence, and in different populations.

23

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- 18

1 Table 1 Physical characteristics and sedentary behavior and physical activity for participants at baseline and  
 2 follow-up

	All (n=356)		Boys (n=174)		Girls (n=182)	
	Baseline Mean (SD)	Follow-up Mean (SD)	Baseline Mean (SD)	Follow-up Mean (SD)	Baseline Mean (SD)	Follow-up Mean (SD)
Age (years)	7.5 (0.4)	9.3 (0.4)	7.4 (0.4)	9.3 (0.4)	7.5 (0.4)	9.3 (0.4)
Height (cm)	124.9 (5.7)	135.7 (6.2)	125.2 (6.0)	135.9 (6.5)	124.6 (5.4)	135.4 (6.0)
Body weight (kg)	26.3 (5.2)	33.5 (7.2)	26.4 (5.3)	33.2 (7.2)	26.3 (5.1)	33.6 (7.2)
BMI (kg/m <sup>2</sup> )	16.7 (2.2)	18.0 (2.8)	16.7 (2.3)	17.9 (2.8)	16.8 (2.2)	18.2 (2.7)
BMI_Z score	0.40 (1.07)	0.58 (1.07)	0.44 (1.13)	0.61 (1.13)	0.36 (1.01)	0.53 (1.03)
Fat index	0.46 (0.71)	0.55 (0.81)	0.52 (0.73)	0.54 (0.83)	0.40 (0.69)	0.56 (0.80)
Obese (n)	46	59	19	26	19	26
Overweight (n)	44	60	27	34	27	34
Normal weight (n)	266	237	136	122	136	122
Wearing time (min/day)	669 (68)	681(69)	675 (68)	683 (70)	664 (66)	680 (69)
Valid days (days)	6.4 (1.0)	6.1 (1.1)	6.4 (0.9)	6.1 (1.1)	6.3 (1.0)	6.1 (1.1)
CPM	758.0 (225.4)	676.8 (207.6)	774.3 (225.2)	712.6 (189.9)	742.4 (225.1)	642.6 (218.2)
Sedentary behavior (min/day)	337.8 (56.3)	377.4 (60.5)	334.4 (57.8)	369.3 (59.0)	341.1 (54.7)	385.1 (61.1)
Light physical activity (min/day)	290.3 (49.2)	266.0 (47.5)	295.5 (50.4)	270.2 (50.8)	285.4 (47.6)	262.0 (44.0)
MVPA (min/day)	41.0 (17.0)	37.9 (17.4)	45.1 (18.6)	43.5 (18.3)	37.0 (14.3)	32.4 (14.5)
Moderate physical activity (min/day)	38.0 (15.4)	35.2 (16.2)	42.9 (16.9)	41.4 (17.4)	33.3 (12.2)	29.2 (12.3)
Vigorous physical activity (min/day)	3.0 (4.3)	2.7 (3.9)	2.2 (3.8)	2.1 (3.0)	3.7 (4.7)	3.2 (4.5)
Sedentary behavior (%)	50.5 (6.9)	55.4 (6.9)	49.6 (7.2)	54.1 (7.0)	51.4 (6.4)	56.6 (6.6)
Light physical activity (%)	43.4 (5.8)	39.0 (5.8)	43.7 (6.0)	39.5 (6.0)	43.0 (5.5)	38.6 (5.7)
MVPA (%)	6.1 (2.5)	5.5 (2.4)	6.7 (2.8)	6.0 (2.4)	5.6 (2.2)	4.8 (2.0)
Moderate physical activity (%)	5.7 (2.3)	5.1 (2.3)	6.4 (2.5)	6.0 (2.4)	5.0 (1.8)	4.3 (1.7)
Vigorous physical activity (%)	0.4 (0.7)	0.4 (0.6)	0.3 (0.6)	0.3 (0.4)	0.6 (0.7)	0.5 (0.6)

4 BMI: body mass index, MVPA: moderate-to-vigorous physical activity.

5



1 Table 2a Baseline sedentary behavior and physical activity as predictors of change in adiposity and vice versa

2

	Outcome: $\Delta$ BMI Z-score				Outcome: $\Delta$ fat index				Exposure: BMI Z-score at baseline				Exposure: fat index at baseline				
	$\beta$ -Coefficient	95% CI	p value		$\beta$ -Coefficient	95% CI	p value		$\beta$ -Coefficient	95% CI	p value		$\beta$ -Coefficient	95% CI	p value		
Sedentary behaviour at baseline (min/day)	0.000	-0.001	0.001	0.643	0.000	-0.001	0.000	0.299	$\Delta$ sedentary behaviour (min/day)	1.243	-3.936	6.422	0.637	4.602	-3.189	12.392	0.246
Light physical activity at baseline (min/day)	0.000	-0.001	0.001	0.850	0.000	-0.001	0.001	0.362	$\Delta$ light physical activity (min/day)	0.548	-3.334	4.429	0.782	-3.109	-8.949	2.730	0.296
MVPA at baseline (min/day)	-0.001	-0.004	0.002	0.368	0.000	-0.003	0.003	0.989	$\Delta$ MVPA (min/day)	-1.913	-3.214	-0.611	0.004	-4.004	-5.993	-2.014	<0.001
									$\Delta$ MVPA (min/day)*	-1.928	-3.228	-0.627	0.004	-4.051	-6.040	-2.063	<0.001
Moderate physical activity at baseline (min/day)	-0.001	-0.005	0.002	0.359	0.001	-0.003	0.004	0.766	$\Delta$ moderate physical activity (min/day)	-1.692	-2.878	-0.506	0.005	-3.334	-5.157	-1.510	<0.001
									$\Delta$ moderate physical activity (min/day)*	-1.713	-2.896	-0.530	0.005	-3.390	-5.210	-1.569	<0.001
Vigorous physical activity at baseline (min/day)	-0.002	-0.013	0.009	0.738	-0.005	-0.016	0.006	0.348	$\Delta$ vigorous physical activity (min/day)	-0.179	-0.548	0.190	0.341	-0.710	-1.262	-0.158	0.012
									$\Delta$ vigorous physical activity (min/day)*					-0.703	-1.256	-0.150	0.013
Total physical activity at baseline (cpm)	0.000	0.000	0.000	0.862	0.000	0.000	0.000	0.943	$\Delta$ total physical activity (cpm)	-16.271	-33.782	1.239	0.068	-48.675	-74.950	-22.401	<0.001
Sedentary behaviour at baseline at baseline (%)	0.000	-0.006	0.007	0.936	-0.004	-0.011	0.003	0.296	$\Delta$ sedentary behaviour (%)	0.201	-0.341	0.743	0.466	0.911	0.096	1.725	0.029
									$\Delta$ sedentary behaviour (%)*					0.975	0.144	1.806	0.022
Light physical activity at baseline (%)	0.001	-0.007	0.009	0.866	0.005	-0.003	0.013	0.213	$\Delta$ light physical activity (%)	0.069	-0.398	0.535	0.772	-0.360	-1.061	0.340	0.312
MVPA at baseline (%)	-0.006	-0.025	0.013	0.537	0.000	-0.020	0.019	0.976	$\Delta$ MVPA (%)	-0.280	-0.463	-0.097	0.003	-0.603	-0.881	-0.326	<0.001
									$\Delta$ MVPA (%)*	-0.285	-0.469	-0.102	0.002	-0.607	-0.885	-0.330	<0.001
Moderate physical activity at baseline (%)	-0.008	-0.029	0.014	0.491	0.003	-0.020	0.026	0.795	$\Delta$ moderate physical activity (%)	-0.244	-0.410	-0.079	0.004	-0.497	-0.750	-0.244	<0.001
									$\Delta$ moderate physical activity (%)*	-0.250	-0.416	-0.083	0.003	-0.095	-0.175	-0.016	0.019
Vigorous physical activity at baseline (%)	-0.002	-0.013	0.009	0.738	-0.033	-0.104	0.037	0.354	$\Delta$ vigorous physical activity (%)	-0.026	-0.079	0.027	0.329	-0.100	-0.179	-0.021	0.013
									$\Delta$ vigorous physical activity (%)*					-0.095	-0.175	-0.016	0.019

3 BMI: body mass index, MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$  variables were calculated as follow-up values minus baseline values, adjusted for gender, sedentary behaviour or physical activity and BMI Z-score or fat index at baseline,  
4 \*: adjusted for gender, sedentary behaviour and MVPA or moderate physical activity and BMI Z-score or fat index at baseline.

4

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1 Table 2b Baseline sedentary behavior and physical activity as predictors of change in adiposity and vice versa for boys

2

	Outcome: ΔBMI Z-score				Outcome: Δfat index				Exposure: BMI Z-score at baseline				Exposure: fat index at baseline				
	β-Coefficient	95% CI	p value		β-Coefficient	95% CI	p value		β-Coefficient	95% CI	p value		β-Coefficient	95% CI	p value		
Sedentary behaviour at baseline (min/day)	0.000	-0.001	0.002	0.519	0.000	-0.001	0.001	0.782	Δsedentary behaviour (min/day)	2.179	-4.919	9.277	0.545	8.673	-2.230	19.575	0.118
Light physical activity at baseline (min/day)	0.000	-0.002	0.001	0.473	0.000	-0.001	0.002	0.481	Δlight physical activity (min/day)	-1.956	-7.436	3.524	0.482	-5.139	-13.563	3.284	0.230
MVPA at baseline (min/day)	-0.001	-0.004	0.003	0.721	0.002	-0.002	0.005	0.394	ΔMVPA (min/day)	-2.216	-4.095	-0.338	0.021	-3.566	-6.595	-0.538	0.021
									ΔMVPA (min/day)*	-2.184	-4.051	-0.318	0.022	-3.673	-6.681	-0.666	0.017
Moderate physical activity at baseline (min/day)	-0.001	-0.005	0.003	0.652	0.002	-0.002	0.006	0.391	Δmoderate physical activity (min/day)	-2.000	-3.778	-0.223	0.028	-3.118	-5.997	-0.239	0.034
									Δmoderate physical activity (min/day)*	-1.972	-3.735	-0.209	0.029	-3.220	-6.073	-0.367	0.027
Vigorous physical activity at baseline (min/day)	0.002	-0.015	0.020	0.800	0.003	-0.013	0.019	0.720	Δvigorous physical activity (min/day)	-0.129	-0.525	0.267	0.521	-0.400	-1.011	0.210	0.197
Total physical activity at baseline (cpm)	0.000	0.000	0.000	0.760	0.000	0.000	0.000	0.593	Δtotal physical activity (cpm)	-19.405	-40.442	1.633	0.070	-44.602	-77.390	-11.814	0.008
Sedentary behaviour at baseline at baseline (%)	0.004	-0.005	0.014	0.366	-0.001	-0.010	0.008	0.819	Δsedentary behaviour (%)	0.414	-0.323	1.150	0.269	1.257	0.123	2.391	0.030
									Δsedentary behaviour (%)*					1.491	0.592	2.518	0.013
Light physical activity at baseline (%)	-0.006	-0.017	0.006	0.333	0.000	-0.010	0.010	0.967	Δlight physical activity (%)	-0.118	-0.755	0.518	0.714	-0.734	-1.709	0.241	0.139
MVPA at baseline (%)	-0.003	-0.028	0.022	0.793	0.006	-0.017	0.030	0.598	ΔMVPA (%)	-0.306	-0.572	-0.041	0.024	-0.306	-0.572	-0.041	0.024
									ΔMVPA (%)*	-0.318	-0.585	-0.052	0.020	-0.570	0.214	-2.668	0.008
Moderate physical activity at baseline (%)	-0.005	-0.033	0.022	0.706	0.007	-0.019	0.033	0.605	Δmoderate physical activity (%)	-0.269	-0.519	-0.019	0.035	-0.485	-0.883	-0.087	0.017
									Δmoderate physical activity (%)*	-0.278	-0.530	-0.027	0.030	-0.493	-0.893	-0.093	0.016
Vigorous physical activity at baseline (%)	0.021	-0.096	0.138	0.722	0.016	-0.091	0.122	0.770	Δvigorous physical activity (%)	-0.021	-0.078	0.035	0.462	-0.056	-0.143	0.031	0.209

BMI: body mass index, MVPA: moderate-to-vigorous physical activity, Δ: change, Δ variables were calculated as follow-up values minus baseline values, CI: 95% confidence interval, adjusted for sedentary behavior or physical activity and BMI Z-score or fat index at baseline, \*: adjusted for sedentary behavior and MVPA or moderate physical activity and BMI Z-score or fat index at baseline.

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1 Table 2c Baseline sedentary behavior and physical activity as predictors of change in adiposity and vice versa for girls

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	Outcome: $\Delta$ BMI Z-score				Outcome: $\Delta$ fat index				Exposure: BMI Z-score at baseline				Exposure: fat index at baseline				
	$\beta$ -Coefficient	95% CI	p value		$\beta$ -Coefficient	95% CI	p value		$\beta$ -Coefficient	95% CI	p value		$\beta$ -Coefficient	95% CI	p value		
Sedentary behaviour at baseline (min/day)	-0.001	-0.002	0.000	0.171	-0.001	-0.002	0.000	0.098	$\Delta$ sedentary behaviour (min/day)	0.455	-7.209	8.119	0.907	0.529	-10.677	11.736	0.926
Light physical activity at baseline (min/day)	0.000	-0.001	0.002	0.614	0.000	-0.001	0.002	0.534	$\Delta$ light physical activity (min/day)	3.096	-2.435	8.627	0.271	-0.830	-8.957	7.298	0.841
MVPA at baseline (min/day)	-0.002	-0.007	0.002	0.310	-0.002	-0.007	0.003	0.496	$\Delta$ MVPA (min/day)	-1.515	-3.330	0.300	0.101	-4.307	-6.935	-1.679	0.001
									$\Delta$ MVPA (min/day)*					-4.300	-6.936	-1.663	0.002
Moderate physical activity at baseline (min/day)	-0.002	-0.008	0.003	0.346	-0.001	-0.007	0.005	0.777	$\Delta$ moderate physical activity (min/day)	-1.281	-2.846	0.283	0.108	-3.396	-5.675	-1.118	0.004
									$\Delta$ moderate physical activity (min/day)*					-3.404	-5.690	-1.118	0.004
Vigorous physical activity at baseline (min/day)	-0.004	-0.018	0.009	0.518	-0.010	-0.026	0.005	0.183	$\Delta$ vigorous physical activity (min/day)	-0.236	-0.877	0.406	0.470	-1.047	-1.975	-0.120	0.027
									$\Delta$ vigorous physical activity (min/day)*					-1.046	-1.976	-0.116	0.028
Total physical activity at baseline (cpm)	0.000	0.000	0.000	0.952	0.000	0.000	0.000	0.661	$\Delta$ total physical activity (cpm)	-12.267	-40.957	16.423	0.400	-52.099	-93.619	-10.579	0.014
Sedentary behaviour at baseline at baseline (%)	-0.005	-0.014	0.005	0.362	-0.007	-0.018	0.004	0.205	$\Delta$ sedentary behaviour (%)	-0.052	-0.860	0.755	0.898	0.540	-0.642	1.722	0.369
Light physical activity at baseline (%)	0.008	-0.004	0.019	0.184	0.011	-0.002	0.024	0.101	$\Delta$ light physical activity (%)	0.285	-0.408	0.978	0.418	0.034	-0.981	1.050	0.947
MVPA at baseline (%)	-0.010	-0.039	0.019	0.503	-0.007	-0.040	0.026	0.674	$\Delta$ MVPA (%)	-0.237	-0.491	0.016	0.067	-0.628	-0.995	-0.261	0.001
									$\Delta$ MVPA (%)*					-0.628	-0.996	-0.260	0.001
Moderate physical activity at baseline (%)	-0.012	-0.047	0.023	0.512	0.000	-0.040	0.040	0.995	$\Delta$ moderate physical activity (%)	-0.202	-0.419	0.015	0.068	-0.489	-0.806	-0.173	0.003
									$\Delta$ moderate physical activity (%)*					-0.492	-0.809	-0.175	0.003
Vigorous physical activity at baseline (%)	-0.016	-0.102	0.070	0.708	-0.061	-0.158	0.035	0.214	$\Delta$ vigorous physical activity (%)	-0.032	-0.124	0.060	0.488	-0.149	-0.282	-0.016	0.029
									$\Delta$ vigorous physical activity (%)*					-0.146	-0.280	-0.012	0.032

BMI: body mass index, MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$  variables were calculated as follow-up values minus baseline values, CI: 95% confidence interval, adjusted for sedentary behavior or physical activity and BMI Z-score or fat index at baseline, \*: adjusted for sedentary behavior and MVPA or moderate physical activity and BMI Z-score or fat index at baseline.

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Table S1 Partial correlations between at baseline or the change in sedentary behavior or physical activity

		Light physical activity at baseline (min/day)	MVPA at baseline (min/day)	Moderate physical activity at baseline (min/day)	Vigorous physical activity at baseline (min/day)	Total physical activity at baseline (cpm)
Sedentary behaviour at baseline (min/day)	r	-.217	-.332	-.313	-.210	-.591
	p value	<0.001	<0.001	<0.001	<0.001	<0.001
Light physical activity at baseline (min/day)	r		.308	.338	.028	.277
	p value		<0.001	<0.001	.600	<0.001
MVPA at baseline (min/day)	r			.969	.541	.851
	p value			<0.001	<0.001	<0.001
Moderate physical activity at baseline (min/day)	r				.318	.735
	p value				<0.001	<0.001
Vigorous physical activity at baseline (min/day)	r					.767
	p value					<0.001
		Light physical activity at baseline (%)	MVPA at baseline (%)	Moderate physical activity at baseline (%)	Vigorous physical activity at baseline (%)	
Sedentary behaviour at baseline (%)	r	-.937	-.576	-.581	-.260	
	p value	<0.001	<0.001	<0.001	<0.001	
Light physical activity at baseline (%)	r		.254	.273	.059	
	p value		<0.001	<0.001	.269	
MVPA at baseline (%)	r			.273	.581	
	p value			<0.001	<0.001	
Moderate physical activity at baseline (%)	r				.358	
	p value				<0.001	
		$\Delta$ light physical activity (min/day)	$\Delta$ MVPA (min/day)	$\Delta$ moderate physical activity (min/day)	$\Delta$ vigorous physical activity (min/day)	$\Delta$ total physical activity (cpm)
$\Delta$ sedentary behaviour (min/day)	r	-.053	-.132	-.113	-.089	-.427
	p value	.318	.013	.034	.093	<0.001
$\Delta$ light physical activity (min/day)	r		.346	.393	-.019	.211
	p value		<0.001	<0.001	.724	<0.001
$\Delta$ MVPA (min/day)	r			.939	.451	.758
	p value			<0.001	<0.001	<0.001
$\Delta$ moderate physical activity (min/day)	r				.117	.538
	p value				.027	<0.001
$\Delta$ vigorous physical activity (min/day)	r					.793
	p value					<0.001
		$\Delta$ light physical activity (%)	$\Delta$ MVPA (%)	$\Delta$ moderate physical activity (%)	$\Delta$ vigorous physical activity (%)	
$\Delta$ sedentary behaviour (%)	r	-.939	-.552	-.557	-.172	
	p value	<0.001	<0.001	<0.001	.001	
$\Delta$ light physical activity (%)	r		.231	.264	-.003	
	p value		<0.001	<0.001	.950	
$\Delta$ MVPA (%)	r			.936	.495	
	p value			<0.001	<0.001	
$\Delta$ moderate physical activity (%)	r				.158	
	p value				.003	

MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$ variables were calculated as follow-up values minus baseline values, adjusted for gender.

Table S2a Associations between change in adiposity and change in sedentary behavior or physical activity

	Exposure: $\Delta$ BMI Z-score				Exposure: $\Delta$ fat index			
	$\beta$ -Coefficient	95% CI		p value	$\beta$ -Coefficient	95% CI		p value
$\Delta$ sedentary behaviour (min/day)	-0.353	-12.963	12.256	0.956	4.597	-7.697	16.892	0.463
$\Delta$ light physical activity (min/day)	5.024	-4.402	14.449	0.295	-7.270	-16.450	1.911	0.120
$\Delta$ MVPA (min/day)	-4.351	-7.480	-1.222	0.007	-8.335	-11.259	-5.412	<0.001
$\Delta$ MVPA (min/day)*	-4.313	-7.434	-1.192	0.007	-8.221	-11.147	-5.294	<0.001
$\Delta$ moderate physical activity (min/day)	-3.966	-6.814	-1.119	0.006	-8.563	-11.201	-5.925	<0.001
$\Delta$ moderate physical activity (min/day)*	-3.938	-6.781	-1.095	0.007	-8.479	-11.121	-5.837	<0.001
$\Delta$ vigorous physical activity (min/day)	-0.442	-1.344	0.460	0.336	0.162	-0.703	1.027	0.713
$\Delta$ total physical activity (cpm)	-33.566	-76.029	8.897	0.121	-51.142	-91.809	-10.474	0.014
$\Delta$ sedentary behaviour (%)	0.059	-1.259	1.378	0.929	1.618	0.348	2.888	0.013
$\Delta$ sedentary behaviour (%)*					0.328	-0.815	1.470	0.573
$\Delta$ light physical activity (%)	0.620	-0.513	1.752	0.283	-0.530	-1.637	0.577	0.347
$\Delta$ MVPA (%)	-0.690	-1.128	-0.252	0.002	-1.092	-1.504	-0.680	<0.001
$\Delta$ MVPA (%)*	-0.665	-1.045	-0.285	0.001	-0.813	-1.182	-0.444	<0.001
$\Delta$ moderate physical activity (%)	-0.617	-1.014	-0.221	0.002	-1.136	-1.506	-0.766	<0.001
$\Delta$ moderate physical activity (%)*	-0.592	-0.935	-0.250	0.001	-0.890	-1.219	-0.561	<0.001
$\Delta$ vigorous physical activity (%)	-0.070	-0.200	0.059	0.284	0.034	-0.090	0.158	0.585

BMI: body mass index, MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$ variables were calculated as follow-up values minus baseline values, CI: 95% confidence interval, adjusted for gender, sedentary behavior or physical activity and BMI Z-score or fat index at baseline, \*: adjusted for gender, sedentary behavior or physical activity and BMI Z-score or fat index at baseline and change on sedentary behavior or MVPA.

Table S2b Associations between change in adiposity and change in sedentary behavior or physical activity for boys

	Exposure: $\Delta$ BMI Z-score				Exposure: $\Delta$ fat index			
	$\beta$ -Coefficient	95% CI		p value	$\beta$ -Coefficient	95% CI		p value
$\Delta$ sedentary behaviour (min/day)	7.029	-10.768	24.827	0.437	5.639	-13.838	25.116	0.568
$\Delta$ light physical activity (min/day)	9.685	-3.964	23.334	0.163	-6.181	-21.226	8.865	0.419
$\Delta$ MVPA (min/day)	-5.850	-10.463	-1.237	0.013	-0.010	-0.014	-0.005	<0.001
$\Delta$ MVPA (min/day)*	-5.836	-10.464	-1.208	0.014	-11.317	-16.223	-6.411	<0.001
$\Delta$ moderate physical activity (min/day)	-4.768	-9.148	-0.388	0.033	-11.267	-15.861	-6.672	<0.001
$\Delta$ moderate physical activity (min/day)*	-4.760	-9.154	-0.365	0.034	-11.270	-15.879	-6.660	<0.001
$\Delta$ vigorous physical activity (min/day)	-0.966	-1.949	0.018	0.054	-0.008	-1.100	1.083	0.988
$\Delta$ total physical activity (cpm)	-59.465	-111.483	-7.447	0.025	-71.303	-127.810	-14.796	0.014
$\Delta$ sedentary behaviour (%)	0.187	-1.667	2.042	0.842	1.785	-0.214	3.784	0.080
$\Delta$ light physical activity (%)	0.798	-0.797	2.394	0.325	-0.324	-2.070	1.422	0.715
$\Delta$ MVPA (%)	-0.977	-1.622	-0.332	0.003	-1.454	-2.145	-0.763	<0.001
$\Delta$ MVPA (%)*	-1.003	-1.567	-0.438	0.001	-1.206	-1.829	-0.583	<0.001
$\Delta$ moderate physical activity (%)	-0.797	-1.408	-0.187	0.011	-1.455	-2.101	-0.808	<0.001
$\Delta$ moderate physical activity (%)*	-0.817	-1.351	-0.283	0.003	-1.219	-1.799	-0.638	<0.001
$\Delta$ vigorous physical activity (%)	-0.157	-0.297	-0.017	0.028	0.005	-0.151	0.161	0.954
$\Delta$ vigorous physical activity (%)*	-0.157	-0.298	-0.017	0.028				

BMI: body mass index, MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$ variables were calculated as follow-up values minus baseline values, CI: 95% confidence interval, adjusted for sedentary behavior or physical activity and BMI Z-score or fat index at baseline, \*: adjusted for sedentary behavior or physical activity and BMI Z-score or fat index at baseline and change on sedentary behavior or MVPA.

Table S2c Associations between change in adiposity and change in sedentary behavior or physical activity for girls

	Exposure: $\Delta$ BMI Z-score				Exposure: $\Delta$ fat index			
	$\beta$ -Coefficient	95% CI		p value	$\beta$ -Coefficient	95% CI		p value
$\Delta$ sedentary behaviour (min/day)	-6.891	-25.014	11.231	0.454	4.330	-11.770	20.429	0.596
$\Delta$ light physical activity (min/day)	0.893	-12.157	13.942	0.893	-7.620	-19.163	3.923	0.194
$\Delta$ MVPA (min/day)	-2.932	-7.198	1.334	0.177	-6.629	-10.210	-3.048	<0.001
$\Delta$ MVPA (min/day)*					-6.733	-10.364	-3.102	<0.001
$\Delta$ moderate physical activity (min/day)	-3.288	-6.948	0.372	0.078	-6.952	-9.992	-3.912	<0.001
$\Delta$ moderate physical activity (min/day)*					-7.131	-10.203	-4.059	<0.001
$\Delta$ vigorous physical activity (min/day)	0.137	-1.376	1.651	0.858	0.040	-1.289	1.369	0.953
$\Delta$ total physical activity (cpm)	-6.413	-74.057	61.231	0.852	-39.083	-97.852	19.685	0.191
$\Delta$ sedentary behaviour (%)	-0.108	-2.017	1.800	0.911	1.442	-0.234	3.119	0.091
$\Delta$ light physical activity (%)	0.503	-1.136	2.142	0.546	-0.576	-2.033	0.882	0.437
$\Delta$ MVPA (%)	-0.404	-1.000	0.192	0.183	-0.874	-1.376	-0.371	0.001
$\Delta$ MVPA (%)*					-0.708	-1.068	-0.348	<0.001
$\Delta$ moderate physical activity (%)	-0.444	-0.952	0.064	0.086	-0.931	-1.355	-0.507	<0.001
$\Delta$ moderate physical activity (%)*					-0.960	-1.387	-0.533	<0.001
$\Delta$ vigorous physical activity (%)	0.024	-0.193	0.242	0.824	0.020	-0.171	0.210	0.838

BMI: body mass index, MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$ variables were calculated as follow-up values minus baseline values, CI: 95% confidence interval, adjusted for sedentary behavior or physical activity and BMI Z-score or fat index at baseline, \*: adjusted for sedentary behavior or physical activity and BMI Z-score or fat index at baseline and change on sedentary behavior or MVPA.

Table S3a Associations between change of sedentary behavior or physical activity and weight status

Dependent variables		Estimated				Estimated				
		mean	SE	B	p-value	mean	SE	B	p-value	
$\Delta$ sedentary behavior (min/day)	Obese or overweight	46.6	5.6	9.7	0.134	$\Delta$ sedentary behavior (%)	6.0	0.6	1.6	0.021
	Normal weight	36.8	3.3	0.0			4.5	0.3	0.0	
						$\Delta$ sedentary behavior (%)*	6.1	0.6	1.6	0.017
							4.5	0.3	0.0	
$\Delta$ light physical activity (min/day)	Obese or overweight	-27.8	4.2	-4.5	0.354	$\Delta$ light physical activity (%)	-4.9	0.5	-0.8	0.185
	Normal weight	-23.3	2.4	0.0			-4.1	0.3	0.0	
$\Delta$ MVPA (min/day)	Obese or overweight	-7.0	1.4	-5.4	0.001	$\Delta$ MVPA (%)	-1.2	0.2	-0.8	p<0.001
	Normal weight	-1.7	0.8	0.0			-0.4	0.1	0.0	
$\Delta$ MVPA (min/day)*	Obese or overweight	-7.0	1.4	-5.4	0.001	$\Delta$ MVPA (%)*	-1.2	0.2	-0.9	p<0.001
	Normal weight	-1.6	0.8	0.0			-0.4	0.1	0.0	
$\Delta$ moderate physical activity (min/day)	Obese or overweight	-6.3	1.3	-4.7	0.002	$\Delta$ moderate physical activity (%)	-1.1	0.2	-0.7	0.001
	Normal weight	-1.6	0.7	0.0			-0.3	0.1	0.0	
$\Delta$ moderate physical activity (min/day)*	Obese or overweight	-6.3	1.3	-4.7	0.001	$\Delta$ moderate physical activity (%)*	-1.1	0.2	-0.7	p<0.001
	Normal weight	-1.6	0.7	0.0			-0.3	0.1	0.0	
$\Delta$ vigorous physical activity (min/day)	Obese or overweight	-0.8	0.4	-0.7	0.121	$\Delta$ vigorous physical activity (%)	-0.1	0.1	-0.1	0.106
	Normal weight	-0.1	0.2	0.0			0.0	0.0	0.0	
$\Delta$ total physical activity (cpm)	Obese or overweight	-131.4	18.8	-67.7	0.002					
	Normal weight	-63.7	11.0	0.0						

MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$ variables were calculated as follow-up values minus baseline values, dependent variables:  $\Delta$ sedentary behavior or physical activity, adjusted for gender, sedentary behavior or physical activity and weight status at baseline, \*: adjusted for sedentary behavior and MVPA or moderate physical activity and weight status at baseline. Estimated means mean the changes over follow-up in sedentary behavior or physical activity adjusted for gender, sedentary behavior or physical activity and weight status at baseline.



Table S3b Associations between change of sedentary behavior or physical activity and weight status for boys

Dependent variables		Estimated				Estimated				
		mean	SE	B	p-value	mean	SE	B	p-value	
$\Delta$ sedentary behavior (min/day)	Obese or overweight	45.3	8.0	13.7	0.143	$\Delta$ sedentary behavior (%)	6.0	0.8	1.9	0.046
	Normal weight	31.6	4.7	0.0			4.1	0.5	0.0	
						$\Delta$ sedentary behavior (%)*	6.2	0.8	2.2	0.027
							4.0	0.5	0.0	
$\Delta$ light physical activity (min/day)	Obese or overweight	-30.6	6.2	-6.9	0.337	$\Delta$ light physical activity (%)	-4.9	0.7	-0.8	0.313
	Normal weight	-23.7	3.6	0.0			-4.0	0.4	0.0	
$\Delta$ MVPA (min/day)	Obese or overweight	-7.0	2.1	-7.1	0.004	$\Delta$ MVPA (%)	-1.2	0.3	-1.1	0.001
	Normal weight	0.2	1.2	0.0			-0.1	0.2	0.0	
$\Delta$ MVPA (min/day)*	Obese or overweight	-6.8	2.1	-7.1	0.004	$\Delta$ MVPA (%)*	-1.2	0.3	-1.2	0.001
	Normal weight	0.3	1.2	0.0			0.0	0.2	0.0	
$\Delta$ moderate physical activity (min/day)	Obese or overweight	-6.6	2.0	-6.7	0.004	$\Delta$ moderate physical activity (%)	-1.1	0.3	-1.1	0.001
	Normal weight	0.1	1.2	0.0			-0.1	0.2	0.0	
$\Delta$ moderate physical activity (min/day)*	Obese or overweight	-6.5	2.0	-6.6	0.004	$\Delta$ moderate physical activity (%)*	-1.1	0.3	-1.1	0.001
	Normal weight	0.2	1.1	0.0			0.0	0.2	0.0	
$\Delta$ vigorous physical activity (min/day)	Obese or overweight	-0.1	0.4	-0.1	0.858	$\Delta$ vigorous physical activity (%)	0.0	0.1	0.0	0.804
	Normal weight	0.0	0.3	0.0			0.0	0.0	0.0	
$\Delta$ total physical activity (cpm)	Obese or overweight	-116.0	23.6	-70.3	0.011					
	Normal weight	-45.7	13.8	0.0						

MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$ variables were calculated as follow-up values minus baseline values, dependent variables:  $\Delta$ sedentary behavior or physical activity, adjusted for sedentary behavior or physical activity and weight statuses at baseline, \*: adjusted for sedentary behavior and MVPA or moderate physical activity and weight status at baseline. Estimated means mean the changes over follow-up in sedentary behavior or physical activity adjusted for gender, sedentary behavior or physical activity and weight status at baseline.

Table S3c Associations between change of sedentary behavior or physical activity and weight status for girls

Dependent variables		Estimated				Estimated				
		mean	SE	B	p-value	mean	SE	B	p-value	
$\Delta$ sedentary behavior (min/day)	Obese or overweight	48.9	7.8	6.4	0.477	$\Delta$ sedentary behavior (%)	6.1	0.8	1.2	0.223
	Normal weight	42.4	4.5	0.0			4.9	0.5	0.0	
$\Delta$ light physical activity (min/day)	Obese or overweight	-25.5	5.7	-2.7	0.678	$\Delta$ light physical activity (%)	-4.9	0.7	-0.7	0.405
	Normal weight	-22.7	3.3	0.0			-4.2	0.4	0.0	
$\Delta$ MVPA (min/day)	Obese or overweight	-7.3	1.9	-3.7	0.091	$\Delta$ MVPA (%)	-1.2	0.3	-0.5	0.082
	Normal weight	-3.6	1.1	0.0			-0.7	0.2	0.0	
$\Delta$ moderate physical activity (min/day)	Obese or overweight	-6.1	1.6	-2.7	0.143	$\Delta$ moderate physical activity (%)	-1.0	0.2	-0.4	0.147
	Normal weight	-3.4	0.9	0.0			-0.7	0.1	0.0	
$\Delta$ vigorous physical activity (min/day)	Obese or overweight	-1.4	0.7	-1.3	0.091	$\Delta$ vigorous physical activity (%)	-0.2	0.1	-0.2	0.084
	Normal weight	-0.1	0.4	0.0			0.0	0.1	0.0	
$\Delta$ total physical activity (cpm)	Obese or overweight	-147.5	29.1	-63.8	0.059					
	Normal weight	-83.7	16.9	0.0						

MVPA: moderate-to-vigorous physical activity,  $\Delta$ : change,  $\Delta$ variables were calculated as follow-up values minus baseline values, dependent variables:  $\Delta$ sedentary behavior or physical activity, adjusted for sedentary behavior or physical activity and weight status at baseline. Estimated means mean the changes over follow-up in sedentary behavior or physical activity adjusted for gender, sedentary behavior or physical activity and weight status at baseline.