

1 PAPER AS ACCEPTED FOR PUBLICATION BY PEDIATRIC EXERCISE SCIENCE

2 **The CHANGE! Project: Changes in body composition and cardiorespiratory fitness in 10-11**
3 **year old children after completing the CHANGE! Intervention**

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30 **Title: The CHANGE! Project: Changes in body composition and cardiorespiratory fitness in**
31 **10-11 year old after completing the CHANGE! Intervention**

32 **Running Head:** Changes in body composition

33 **Abstract**

34 *Purpose:* To assess the effects of the Children's Health, Activity and Nutrition: Get Educated!
35 intervention on body size, body composition and VO₂peak in a sub-sample of 10-11 year old
36 children.

37 *Method:* Sixty children were recruited from 12 schools (N= 6 intervention) to take part in the
38 CHANGE! sub-sample study. Baseline, post intervention and follow measures were
39 completed in October 2010, March-April 2011, and June-July 2011 respectively. Outcome
40 measures were BMI z-score, waist circumference, body composition assessed using DEXA
41 (baseline and follow up only), and VO₂peak.

42 *Results:* Significant differences in mean trunk fat mass (control 4.72 kg, intervention 3.11 kg,
43 p = 0.041) and trunk fat % (control 23.08%, intervention 17.75 %, p = 0.022) between groups
44 were observed at follow up. Significant differences in waist circumference change scores
45 from baseline to follow up were observed between groups (control 1.3 cm, intervention -0.2
46 cm, p = 0.023). Favourable changes in body composition were observed in the intervention
47 group; however, none of these changes reached statistical significance. No significant
48 differences in VO₂peak were observed.

49 *Conclusion:* The results of the present study suggest the multicomponent curriculum
50 intervention had small to medium beneficial effects on body size and composition health
51 outcomes.

52

53 Introduction

54 Childhood obesity, poor nutritional intake, low cardiorespiratory fitness (CRF) and
55 insufficient physical activity increase the risk of developing cardiometabolic disease (2, 3,
56 16). Over the last decade childhood obesity has increased (UK) (8, 40). Concurrently CRF, an
57 independent risk factor for cardiometabolic (CM) disease, has decreased independent of
58 changes in body size and other confounders such as maturation and deprivation (7, 8, 40).

59 Current UK guidelines recommend children participate daily in at least 60 minutes of
60 moderate to vigorous intensity PA (MVPA) whilst engaging in vigorous PA (VPA) at least 3
61 times per week (12). However, few children report meeting these guidelines (34, 36).
62 Schools provide an ideal opportunity to implement an intervention designed to improve PA
63 since children spend approximately half of their waking hours in school (15). Health
64 promoting curriculum based interventions have been found to be successful in children,
65 especially when utilising a multi-disciplinary approach, which combines PA and diet, and
66 uses established behaviour change and social support processes (21, 43). Several
67 intervention studies have aimed to increase PA, reduce sedentary time and improve
68 nutritional intake in children in order to reduce CM disease risk, often reporting mixed levels
69 of success (18, 30, 37, 38). These studies typically include measures of body size such as
70 body mass index, skin fold thicknesses and waist circumference rather than composition.
71 Furthermore the majority of studies assessed CRF in the field using the 20m multi-stage
72 shuttle runs test, which although valid and reliable does not provide a direct assessment of
73 peak oxygen uptake (VO_{2peak}). The Children's Health, Activity and Nutrition: Get Educated!
74 (CHANGE!) intervention was designed to improve PA levels and healthy eating behaviours of
75 10-11 year old children using a school-based curriculum intervention delivered by in-service

76 teachers (14). The main intervention outcomes have been reported elsewhere (14). Briefly,
77 significant differences between the control and intervention group were observed in waist
78 circumference at post intervention and BMI z-scores and light intensity physical activity at
79 follow up. As part of the CHANGE! study a sub-sample of children were invited to take part
80 in some additional laboratory based measures, including treadmill assessed peak oxygen
81 uptake (VO_{2peak}) and DEXA scans to provide detailed information on body composition.
82 This study reports outcomes from the sub-sample group who participated in these
83 additional measures rather than the full CHANGE! pragmatic evaluation group. The aim of
84 this analysis was to assess changes in measures of body size and VO_{2peak} between baseline
85 and post intervention and baseline and 10 week follow between the control and
86 intervention group in the CHANGE! sub-sample. In addition, differences in pre-follow up
87 DEXA assessed body composition between the control and intervention groups were also
88 examined. This study extends the previous CHANGE! pragmatic evaluation study by
89 examining changes on reference standard measures of body composition and
90 cardiorespiratory fitness in the sub-sample participants.

91

92 **Materials and Methods**

93 **Participants and Study Design**

94 After receiving institutional ethical approval 12 primary schools from the Wigan Borough in
95 North West England were recruited to participate within the clustered randomized
96 controlled pilot trial, registered with Current Controlled Trials (ISRCTN03863885). All
97 children within Year 6 (10 - 11.9 y) were invited to take part in the CHANGE! study from
98 each school (N = 420). At baseline informed parental consent and participant assent was

99 received from 318 participants (75.7% participation rate), the results of the whole sample
100 are reported elsewhere (14). A stratified random sub-sample of sixty participants (5
101 participants from each participating school), were invited to take part in these additional
102 study measures, and are reported here. The sample size was based on feasibility of data
103 collection and the resources available to the research team. If the selected children did not
104 wish to participate in the sub-sample measures another participant was randomly selected
105 from the volunteers in the school using the random number generator function in SPSS V.17
106 (SPSS Inc., Chicago, IL.) This sampling approach was completed until parental consent and
107 participant assent was received for 60 participants to take part in the subsample measures.
108 The number of children invited to take part in the subsample vs the number agreeing to
109 participate were not recorded. Approximately 95% of the children were of white British
110 ethnicity, which is representative of the school age population in Wigan (45). Schools were
111 randomised to an intervention (N = 6 schools) or control condition (N = 6 schools) prior to
112 baseline measures being completed in October 2010. Randomisation occurred prior to
113 baseline measures to allow enough time for the teacher training sessions to take place, and
114 was completed using the random number generator function in SPSS v17 (SPSS Inc., Chicago
115 IL). Post intervention measures were completed after the 20 week intervention period in
116 March and April 2011 for all measures with the exception of DEXA assessed body
117 composition, which was assessed at baseline and follow up only. Follow up laboratory
118 measures were taken 8 to 10 weeks after the intervention ended, prior to the school
119 summer holidays in June-July 2011. One intervention school withdrew from the CHANGE!
120 project shortly after baseline measurements leaving a subsample of 30 children in the
121 control group, and 25 in the intervention group (total N = 55, N = 24 boys, 31 girls).

122 **Intervention Design**

123 The CHANGE! Intervention including details on lesson topics has been described elsewhere
124 (14). Briefly the CHANGE! Intervention was designed and adapted from the Planet Health
125 resources that have been used in the USA (19). The adaptations were made following
126 formative work which has been described elsewhere (9, 29). The CHANGE! topics were
127 aligned with the UK Healthy Schools programme and were cross-referenced to English
128 National Curriculum objectives in Personal Social Health and Economic Education (PSHE) PE,
129 Maths, Science, ICT, English, Geography and History (35). In total the CHANGE! Intervention
130 consisted of 20 lesson plans which included worksheets, and other resources, and were also
131 supported by homework tasks which involved the whole family, since the formative work
132 emphasised the importance of family support. The CHANGE! lesson themes, titles and
133 content summary have been published previously (14). Briefly themes such as energy
134 balance, reducing sedentary time, what physical activity is and where children are active
135 were amongst the topics covered.

136

137 **Outcome Measures**

138 **Anthropometrics**

139 Stature and sitting stature were measured to the nearest 0.1 cm and body mass to the
140 nearest 0.1 kg using a stadiometer (Seca, Bodycare, Birmingham, UK) and calibrated
141 electronic scales (Seca, Bodycare, Birmingham, UK) using standard techniques (28). Body
142 Mass Index (BMI) was calculated using the equation $\text{body mass (kg)} \div \text{height (m)}^2$. Waist
143 Circumference (WC) was measured using a non-elastic anthropometric tape. Measurements

144 were taken at the narrowest point between the bottom of the ribs and the iliac crest by one
145 researcher.

146 **Body Composition**

147 Body composition was assessed at baseline and follow up using fan beam dual energy x-ray
148 absorptiometry (DEXA) (Hologic QDR series, Delphi A, Bedford, Massachusetts, USA) in the
149 whole body scan mode. Participants were scanned in a supine position in lightweight
150 clothing and without shoes. All scans were carried out by the same qualified researcher and
151 were analysed using Hologic QDR software for Windows version 11.2. All scans were
152 completed in accordance with standard operating procedures and after completing the
153 necessary quality control checks including daily calibration. Key variables assessed from the
154 whole body scan were absolute (kg) fat mass and lean tissue mass, and relative (%) body fat.
155 Segmental analysis was also carried out to assess the distribution of body fat and the key
156 variables of interest were trunk fat mass, and relative (%) trunk fat, peripheral (arms and
157 legs) fat mass (PFM), and relative (%) peripheral fat.

158

159 **Somatic Maturation**

160 Somatic maturation was estimated using the sex specific regression equations (32) by
161 determining years from peak height velocity. This method has been used previously in
162 similar paediatric populations (20, 25) and shows acceptable agreement with skeletal age
163 (32).

164

165 **Estimation of Deprivation**

166 To account for the known associations between deprivation and health outcomes,
167 postcodes for the primary address of each participant were collected and indices of multiple
168 deprivation score (IMD) were calculated using Geoconvert (<http://geoconvert.mimas.ac.uk/>)
169 which uses data from the National Statistics Postcode Database November 2010. The IMD
170 score was then retained for analysis.

171

172 **Cardiorespiratory Fitness (VO₂peak)**

173 Peak oxygen uptake (VO₂peak) was assessed using an individually calibrated continuous
174 incremental treadmill (H P Cosmos, Traunstein, Germany) test to volitional exhaustion,
175 under ambient conditions, using an online gas analysis system (Jaeger Oxycon Pro, Viasys
176 Health Care, Warwick, UK). All participants wore an accelerometer (Actigraph GT1M,
177 ActiGraph LLC, Pensacola, FL, USA) on the right hip and a heart rate monitor (Polar,
178 Kempele, Finland) throughout the test. In order to account for individual variation in limb
179 length, the VO₂peak test speeds were calibrated individually by setting treadmill speeds to
180 set Froude (Fr) numbers. Dynamic similarity theory suggests that geometrically, individuals
181 will have similar gait dynamics if the Fr number is kept constant (1). According to this theory
182 optimum walking speed will be at Fr 0.25, with the transition between walking and running
183 occurring close to Fr 0.5 regardless of variations in body size (31). Therefore treadmill
184 speeds were calculated individually using the equation:

$$185 \quad Fr = v^2 / (g \times l)$$

186 [Where v is speed of movement (m/sec), g is gravity, l is leg length (m)]

187 The protocol involved 2 minute incremental stages; stage 1 was programmed to individual
188 walking speed equivalent to Fr 0.25; stage 2 was programmed to a speed equivalent of Fr

189 0.5; subsequent stage increments were based on researcher judgement using respiratory
190 exchange ratio (RER) and heart rate (HR) of participant as a guide and either involved an
191 increase in speed, determined by the difference in speed for stages one and two
192 (approximately 1 to 2 km/h), or by an increase in gradient. VO_{2peak} was determined as the
193 highest 15-s averaged oxygen uptake achieved during the test when participants exhibited
194 subjective indicators of peak effort that were confirmed by a $RER \geq 1.05$ and/or $HR \geq 195$
195 $beats \cdot min^{-1}$. This protocol has been used previously in similar paediatric studies (10, 24).

196

197 **Statistical Analysis**

198 All analyses were conducted using SPSS V.17 (SPSS Inc., Chicago, IL.). Participant
199 characteristics were compared at baseline using multivariate analysis of covariance
200 (MANCOVA) controlling for sex and IMD. Differences in mean waist circumference, BMI Z-
201 scores, body composition measures and VO_{2peak} between participants in the intervention
202 and control groups at each time point were assessed using MANCOVA with somatic
203 maturation, IMD and sex as covariates. Change scores between baseline and post
204 intervention and baseline and follow up were calculated for waist circumference, BMI Z-
205 scores, body composition measures (baseline and follow up only) and VO_{2peak} . Group
206 differences between mean change scores were assessed using MANCOVA with sex, somatic
207 maturity at baseline, IMD, and baseline measure value as covariates. This method has been
208 recommended for use in randomised control trials (RCTs), and generally has greater
209 statistical power than other methods when analysing the effects of RCTs (44). Partial eta
210 squared (η^2) values provide estimates of effect sizes for the main analyses where partial $\eta^2 \geq$
211 0.01, 0.09 and 0.25 classified as small, medium and large effect sizes respectively (33).

212

213 Results

214 Participant characteristics are presented for the control and intervention groups in Table 1.
215 Groups were well matched at baseline. Table 2 shows adjusted means (SD) for measures at
216 baseline, post intervention and follow up. For the comparison of mean values between
217 groups, there were no significant differences for any values at post intervention. There were
218 also no significant differences for any values with the exception of significantly lower trunk
219 fat mass (control group 4.7 kg, intervention group 3.1 kg, $p = 0.041$, partial $\eta^2 = 0.098$,
220 medium effect size) and trunk fat mass % in the intervention group in comparison to the
221 control group at follow up (control group 23.08%, intervention group 17.75%, $p = 0.022$,
222 partial $\eta^2 = 0.122$, medium effect size). Table 3 displays adjusted mean change scores
223 between baseline and post intervention, and between baseline and follow up, when
224 controlling for baseline values, sex, maturity, and IMD. For the change score analysis there
225 were no significant differences between groups for baseline to post intervention change
226 scores. A significant difference between groups for waist circumference change between
227 baseline and follow up was observed after controlling for sex, maturity, baseline values, and
228 IMD (control waist circumference change: 0.013 cm, intervention change score: -0.002cm,
229 $p=0.023$, partial $\eta^2 = 0.166$, medium effect size) (Table 3). There were no other statistically
230 significant differences between groups for changes between baseline and follow up for any
231 of the other measures.

232

233 The adjusted body composition (DEXA) measures showed favourable improvements in the
234 intervention group in comparison to the control group in a range of measures (Tables 2 and
235 3); however, none of these changes with the exception of mean trunk fat and trunk fat%
236 reached statistical significance ($p > 0.05$). Whole body fat mass decreased by 0.31 kg in the

237 intervention group and increased by 1.84 kg in the control group (partial $\eta^2 = 0.096$ medium
238 effect size), and whole body fat % reduced in the intervention group by 0.68 %, whereas the
239 control group increased by 2.04 % (partial $\eta^2 = 0.095$, medium effect). There was a slight
240 decrease in trunk fat mass of 0.26 kg in the intervention group, and an increase of 1.02 kg in
241 the control group (partial $\eta^2 = 0.024$, small effect). Trunk fat % reduced in the intervention
242 group by 1.32 % and increased by 2.6 % in the control group, however this change score
243 trend did not reach statistical significance ($p = 0.091$, partial $\eta^2 = 0.022$, small effect).
244 Peripheral fat mass also decreased slightly in the intervention group (0.04 kg) and a small
245 increase was observed in the control group (0.80 kg, partial $\eta^2 = 0.008$, negligible effect).
246 Peripheral fat mass % decreased by 0.33% in the intervention group and increased by 2.22%
247 in the control group (partial $\eta^2 = 0.042$, small effect). Whole body lean mass % increased in
248 the intervention group slightly (0.68%) in comparison to a small decline in the control group
249 (-2.04%), however this trend was not statistically significant ($p = 0.268$, partial $\eta^2 = 0.012$,
250 small effect). Between baseline and post intervention the control group exhibited greater
251 changes in VO_{2peak} (4.1 ml/kg/min) than the intervention group (2.37 ml/kg/min). Despite
252 this, the intervention group exhibited a greater increase in VO_{2peak} between baseline and
253 follow up (5.25 ml/kg/min) in comparison to the control group (2.87 ml/kg/min) however
254 this difference did not reach statistical significance ($p=0.410$, partial $\eta^2 = 0.042$, small effect).

255

256 **Discussion**

257 This cluster randomised study aimed to assess the effects of the school-based CHANGE! PA
258 and healthy eating intervention on body composition and cardiorespiratory fitness in a sub-
259 sample of 10 to 11 year old children. A significant intervention effect was detected at follow
260 up for adjusted mean waist circumference change scores, mean trunk fat mass and trunk

261 fat %. Furthermore, there were also favourable improvements in body composition (DEXA)
262 measures in the intervention group in comparison to the control group (Tables 2 and 3);
263 however, none of these changes reached statistical significance ($p > 0.05$), which may be
264 due to the small sample size involved in the sub-sample cohort. Despite the lack of
265 statistically significant findings, medium and small effect sizes were observed that suggested
266 the intervention may have been beneficial.

267

268 The results of the present study add a degree of support to the existing evidence of the
269 effectiveness of combined curriculum based PA and nutrition interventions on lifestyle-
270 related health outcomes. The changes observed in mean trunk fat (mass and %) and waist
271 circumference suggest reductions in central adiposity in the intervention group. Waist
272 circumference and DEXA assessed trunk fat predict visceral fat (11, 41) and are positively
273 associated with cardiometabolic risk factors in children (5, 39). The small to medium
274 improvements in central adiposity observed, equating to a change score difference of 1.5cm
275 between the control and intervention group at follow up, may be associated with reduced
276 disease risk therefore representing an important intervention effect. Significant differences
277 in waist circumference were also observed between the intervention and control groups in
278 the main CHANGE! trial, however these improvements were statistically significant at post
279 intervention only. Other physical activity and dietary intervention studies have reported
280 improvements in waist circumference, for example the Lekker Fit! (26) study conducted
281 with 9-12 year old children reported significant improvements in waist circumference in the
282 intervention group, however their reported decrease in waist circumference was greater at
283 0.71 cm (26). Unlike the main CHANGE! study, no significant changes in BMI Z-scores were
284 observed between the intervention and control groups either at post intervention or follow

285 up, though the intervention group exhibited smaller Z-score changes between baseline and
286 follow up (0.01 Z-score units) than the control group (0.48 Z-score units, partial $\eta^2= 0.056$,
287 small effect), suggesting favourable changes in the intervention group in overall body size,
288 though these did not reach statistical significance. Other intervention studies have
289 demonstrated significant improvements in BMI z-scores, with significant decreases in
290 intervention children's BMI z-scores (0.2 units) observed after two years follow-up in the
291 APPLE Project (42), and in the Planet Health intervention study obesity prevalence
292 significantly reduced in girls (19). Any reduction in BMI z-scores is thought to be clinically
293 meaningful (6), reducing the risk of cardiometabolic disease (22, 23), therefore despite the
294 lack of statistical significance the medium effects observed for BMI z-scores may have been
295 meaningful in our study.

296

297 Despite differences in other measures of body size and body composition failing to reach
298 statistical significance small and medium effect sizes demonstrate potentially beneficial
299 changes in total body fat and peripheral fat mass between groups at follow up. These
300 findings suggest that the CHANGE! intervention may have improved body composition, but
301 that the sub-sample study was not suitably powered to detect changes. Future studies
302 should aim to include larger sample sizes in all key outcome measures to better examine the
303 effect of the intervention on body composition. Despite this recommendation, the use of
304 DEXA in children's studies on a large scale is not always feasible, due to a lack of facilities
305 and resources available.

306

307 When assessing change in VO_2 peak from baseline to follow up the control group slightly
308 increased VO_2 peak (adjusted mean (SE) change = 2.87 (1.7) [95% CI -2.8, 4.2] ml/kg/min),

309 whereas the intervention group increased VO₂peak by over 5 ml/kg/min. The difference in
310 VO₂peak between groups did not reach statistical significance ($p = 0.410$). Other studies
311 have demonstrated greater increases in fitness immediately following multi-disciplinary
312 curriculum based interventions (27, 30, 38), however, fitness was assessed using different
313 methods to CHANGE!. The small improvement in VO₂peak in the intervention group
314 between baseline and follow up equates to an increase of 2.8%, representing a small effect
315 size. In a review of 22 aerobic training studies, there was an average improvement in
316 VO₂peak of 5-6%, and greatest improvements were evident where training intensity
317 exceeded 80% HR max (4). In light of this, the improvement in the present study is low, and
318 suggests that any changes in physical activity were not of sufficient intensity or duration to
319 stimulate significantly improved fitness. Despite the minor intervention effects observed,
320 cross sectional studies have demonstrated the negative relationship between clustered
321 cardiometabolic risk and VO₂peak (3, 10, 17) and therefore the small improvement in
322 VO₂peak observed in the current study, if sustained, may be physiologically beneficial.

323

324 The CHANGE! intervention was underpinned by a programme of formative work (9, 29) as
325 well as reviews of empirical evidence related to school-based physical activity and nutrition
326 interventions. Empirical evidence consistently reported that multi-component studies stood
327 the best chance of success and formative work highlighted key issues of importance to the
328 target population. The theoretically underpinned curriculum intervention that was adjusted
329 to the needs of the population involved (9, 29) in combination with homework tasks to
330 promote family engagement (13) may have created an environment conducive to behaviour
331 change, thus accounting for the changes observed in body composition and body size
332 observed. In the absence of a thorough process evaluation it is difficult to establish which

333 components of the CHANGE! intervention were successful or unsuccessful, therefore future
334 studies should build-in thorough process evaluation measures to provide this important
335 information going forwards.

336

337 *Strengths and Limitations*

338 Over 75% of children invited to take part in the main CHANGE! study consented to take part,
339 and the subsample was randomly invited to participate from this group, therefore reducing
340 the risk of sampling bias. Despite this, records were not kept to examine how many
341 participants declined to participate in the subsample groups, so recruitment rates cannot be
342 calculated. Randomisation into treatment groups was by school therefore reducing risk of
343 intervention contamination to control group children, however randomization occurred
344 prior to baseline measures. The intervention content was informed by opinions and beliefs
345 of the participants and stakeholders and was relevant to the local context. Furthermore, the
346 intervention was a sustainable approach since existing class teachers delivered the lessons,
347 which were able to be integrated into the existing curriculum. Randomisation into
348 treatment group was limited to clusters (by school) and therefore allows for the possibility
349 of clustering of outcome observations within schools. However, at baseline control and
350 intervention participants were well matched and analysis of the main CHANGE! intervention
351 study found no significant influence of clustering on outcomes. Statistical analysis presented
352 within the present study controlled for baseline results, as well as sex, deprivation (IMD),
353 and maturation therefore accounting for the influence of these covariates within analyses.

354

355 Teachers received training on how to deliver the intervention lessons; however, there were
356 no on-going procedures in place to monitor progress or to evaluate delivery of lessons,

357 therefore intervention fidelity is unknown. The study used reference standard measurement
358 techniques to assess body composition (DEXA), and CRF (individually calibrated treadmill
359 based VO₂peak protocol). In larger scale studies the combination of such high quality
360 measures are rarely utilised. However, the sample size for the subsample was relatively
361 small. This would have therefore reduced statistical power and may account for some
362 between group and time-point differences failing to reach statistical significance;
363 furthermore, due to the small sample size and narrow age range of participants, the results
364 may not be generalised to a wider population. This study demonstrates that conducting
365 reference standard measures in children is possible and feasible, however a larger sample
366 size is needed in future to obtain the necessary statistical power to detect any changes in
367 health outcomes. A strength of the study was that it included a follow up investigation
368 period. However, this was relatively short (8 to 10 weeks) and a longer term follow up is
369 required to determine whether any intervention effects were maintained long-term.

370

371 *Conclusions*

372 The present study demonstrated short-term positive intervention effects with statistically
373 significant improvements in waist circumference, mean trunk fat mass and mean trunk fat
374 mass % at follow up. Given the association between central adiposity and disease risk, these
375 changes are likely to be beneficial. The study also demonstrated some small to medium
376 improvements in other markers including whole body fat %, lean mass % and VO₂peak at
377 follow up. Since the CHANGE! intervention focused mainly on behaviour change, it is
378 possible that any behavioural changes may not have clinical influence immediately after
379 intervention. Therefore a similar study involving a greater number of participants and longer

380 term follow up is required in order to establish if behaviour can transition into clinical health

381 benefits using the CHANGE! intervention approach.

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521 **Tables**

522 Table 1. Participant characteristics at baseline adjusted for sex and IMD

	Control N= 27		Intervention N= 26	
	mean	(SE)	mean	(SE)
Age	10.62	(0.06)	10.64	(0.06)
Somatic Maturation (Years)	-1.99	(0.08)	-1.99	(0.08)
Stature (m)	1.46	(0.01)	1.45	(0.01)
Sitting Stature (m)	0.72	(0.007)	0.73	(0.007)
Mass (kg)	39.9	(1.5)	37.5	(1.5)
BMI (kg/m ²)	18.5	(0.53)	17.82	(0.54)
BMI z-scores	0.43	(0.2)	0.24	(0.2)
Waist circumference (cm)	63	(0.01)	62	(0.01)

523

524 BMI = Body mass index

525 Table 2 Adjusted mean (SE) and partial η^2 for waist circumference, BMI Z-score, and VO₂peak at
 526 baseline, post intervention and follow up (where available), controlling for somatic maturation, IMD
 527 and sex

Variable	Time point	Control N= 24		Intervention N= 22		P Value	Partial η^2
		mean	(SE)	mean	(SE)		
Waist Circumference (CM)	Baseline	63.8	0.01	61.5	0.02	.286	0.028
	Post intervention	65	0.01	61.3	0.01	.074	0.076
	Follow Up	64.7	0.01	62.1	0.01	.212	0.038
BMI Z-score	Baseline	0.44	0.21	0.27	0.22	.581	0.008
	Post intervention	0.49	0.22	0.26	0.22	.459	0.013
	Follow Up	0.48	0.2	0.01	0.21	.128	0.056
VO ₂ peak (ml/kg/min)	Baseline	41.41	1.96	44.4	2.06	.320	0.024
	Post Intervention	46.49	1.12	45.66	1.17	.620	0.006
	Follow Up	44.61	1.7	49.26	1.78	.076	0.075
Whole Body Fat Mass (kg)	Baseline	11.34	0.88	9.62	0.93	.202	0.039
	Follow Up	12.69	1.11	9.84	1.16	.093	0.067
Whole Body Fat %	Baseline	26.34	1.29	24.3	1.35	.30	0.026
	Follow Up	27.98	1.42	24.05	1.49	.073	0.076
Trunk Fat Mass (kg)	Baseline	4.02	0.42	3.02	0.44	.117	0.059
	Follow Up	4.72	0.51	3.11	0.53	0.041*	0.098
Trunk Fat %	Baseline	21.04	1.35	18.13	1.42	.159	0.048
	Follow Up	23.08	1.49	17.75	1.56	.022*	0.122
Peripheral Fat Mass (kg)	Baseline	6.52	0.48	5.82	0.5	.334	0.023
	Follow Up	7.17	0.61	5.95	0.63	.187	0.042
Peripheral Fat %	Baseline	32.03	1.68	30.17	1.76	.462	0.013
	Follow Up	34.01	1.81	30.11	1.90	.159	0.048

Whole Lean Body Mass (kg)	Baseline	2.93	0.46	2.88	0.48	.470	0.013
	Follow Up	3.01	0.94	2.88	0.48	.935	0.000
Whole Lean Body Mass %	Baseline	73.67	1.29	75.70	1.35	.300	0.026
	Follow Up	72.03	1.42	75.95	1.49	.073	0.076

528

529 * denotes significant difference between control and intervention groups

530 Table 3. Change scores (SE) and partial η^2 between groups at all time points, controlling for sex,
 531 somatic maturation (baseline), IMD and baseline values

Variable	Time point	Control N= 24		Intervention N= 22		P Value	Partial η^2
		Change Score	(SE)	Change Score	(SE)		
Waist Circumference (cm)	Baseline to Post	1.1	0.5	0.4	0.5	.355	0.030
	Baseline to Follow Up	1.3	0.4	-0.2	0.4	.023*	0.166
BMI Z-score	Baseline to Post	0.042	0.097	0.001	0.102	.792	0.002
	Baseline to Follow Up	0.042	0.096	0.002	.102	.796	0.002
VO ₂ peak (ml/kg/min)	Baseline to Post	4.10	0.90	2.37	0.95	.239	0.052
	Baseline to Follow Up	2.87	1.77	5.25	1.87	.410	0.042
Whole Body Fat Mass (kg)	Baseline to Follow Up	1.84	1.06	-0.31	1.12	.219	0.096
Whole Body Fat %	Baseline to Follow Up	2.04	1.50	-0.68	1.58	.268	0.095
Trunk Fat Mass (kg)	Baseline to Follow Up	1.02	0.45	-0.26	0.48	.090	0.024
Trunk Fat %	Baseline to Follow Up	2.60	1.5	-1.32	1.58	.091	0.022
Peripheral Fat Mass (kg)	Baseline to Follow Up	0.80	0.61	-0.04	0.65	.402	0.008
Peripheral Fat %	Baseline to Follow Up	2.22	1.96	-.330	2.07	.425	0.042
Whole Lean Body Mass (kg)	Baseline to Follow Up	1.36	0.99	0.57	1.05	.623	0.000
Whole Lean Body Mass %	Baseline to Follow Up	-2.04	1.50	0.68	1.58	.268	0.012
BMC (kg)	Baseline to Follow Up	0.07	0.04	0.06	0.04	.925	0.024
BMD (g/cm ²)	Baseline to Follow Up	0.017	0.013	0.005	0.014	.565	0.048

532

533 *denotes significant difference between control and intervention group

