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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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29

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 completed
39 in October 2010, March-April 2011, and June-July 2011 respectively. Outcome measures were
40 BMI z-score, waist circumference, body composition assessed using DEXA (baseline and
41 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 from
45 baseline to follow up were observed between groups (control 1.3 cm, intervention -0.2 cm, p
46 $= 0.023$). Favourable changes in body composition were observed in the intervention group;
47 however, none of these changes reached statistical significance. No significant differences in
48 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 insufficient
55 physical activity increase the risk of developing cardiometabolic disease (2, 3, 16). Over the
56 last decade childhood obesity has increased (UK) (8, 40). Concurrently CRF, an independent
57 risk factor for cardiometabolic (CM) disease, has decreased independent of changes in body
58 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). Schools
62 provide an ideal opportunity to implement an intervention designed to improve PA since
63 children spend approximately half of their waking hours in school (15). Health promoting
64 curriculum based interventions have been found to be successful in children, especially when
65 utilising a multi-disciplinary approach, which combines PA and diet, and uses established
66 behaviour change and social support processes (21, 43). Several intervention studies have
67 aimed to increase PA, reduce sedentary time and improve nutritional intake in children in
68 order to reduce CM disease risk, often reporting mixed levels of success (18, 30, 37, 38). These
69 studies typically include measures of body size such as body mass index, skin fold thicknesses
70 and waist circumference rather than composition. Furthermore the majority of studies
71 assessed CRF in the field using the 20m multi-stage shuttle runs test, which although valid and
72 reliable does not provide a direct assessment of peak oxygen uptake (VO_2 peak). The
73 Children's Health, Activity and Nutrition: Get Educated! (CHANGE!) intervention was designed
74 to improve PA levels and healthy eating behaviours of 10-11 year old children using a school-
75 based curriculum intervention delivered by in-service teachers (14). The main intervention

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

90

91 **Materials and Methods**

92 **Participants and Study Design**

93 After receiving institutional ethical approval 12 primary schools from the Wigan Borough in
94 North West England were recruited to participate within the clustered randomized controlled
95 pilot trial, registered with Current Controlled Trials (ISRCTN03863885). All children within
96 Year 6 (10 - 11.9 y) were invited to take part in the CHANGE! study from each school (N = 420).
97 At baseline informed parental consent and participant assent was received from 318
98 participants (75.7% participation rate), the results of the whole sample are reported

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

121 **Intervention Design**

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

135

136 **Outcome Measures**

137 **Anthropometrics**

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

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

145 **Body Composition**

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

157

158 **Somatic Maturation**

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

162

163 **Estimation of Deprivation**

164 To account for the known associations between deprivation and health outcomes, postcodes
165 for the primary address of each participant were collected and indices of multiple deprivation

166 score (IMD) were calculated using Geoconvert (<http://geoconvert.mimas.ac.uk/>) which uses
167 data from the National Statistics Postcode Database November 2010. The IMD score was then
168 retained for analysis.

169

170 **Cardiorespiratory Fitness (VO₂peak)**

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

$$183 \quad Fr = v^2 / (g \times l)$$

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

185 The protocol involved 2 minute incremental stages; stage 1 was programmed to individual
186 walking speed equivalent to Fr 0.25; stage 2 was programmed to a speed equivalent of Fr 0.5;
187 subsequent stage increments were based on researcher judgement using respiratory
188 exchange ratio (RER) and heart rate (HR) of participant as a guide and either involved an

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

194

195 **Statistical Analysis**

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

210

211 **Results**

212 Participant characteristics are presented for the control and intervention groups in Table 1.
213 Groups were well matched at baseline. Table 2 shows adjusted means (SD) for measures at
214 baseline, post intervention and follow up. For the comparison of mean values between
215 groups, there were no significant differences for any values at post intervention. There were
216 also no significant differences for any values with the exception of significantly lower trunk
217 fat mass (control group 4.7 kg, intervention group 3.1 kg, $p = 0.041$, partial $\eta^2 = 0.098$, medium
218 effect size) and trunk fat mass % in the intervention group in comparison to the control group
219 at follow up (control group 23.08%, intervention group 17.75%, $p = 0.022$, partial $\eta^2 = 0.122$,
220 medium effect size). Table 3 displays adjusted mean change scores between baseline and post
221 intervention, and between baseline and follow up, when controlling for baseline values, sex,
222 maturity, and IMD. For the change score analysis there were no significant differences
223 between groups for baseline to post intervention change scores. A significant difference
224 between groups for waist circumference change between baseline and follow up was
225 observed after controlling for sex, maturity, baseline values, and IMD (control waist
226 circumference change: 0.013 cm, intervention change score: -0.002cm, $p=0.023$, partial $\eta^2 =$
227 0.166, medium effect size) (Table 3). There were no other statistically significant differences
228 between groups for changes between baseline and follow up for any of the other measures.
229
230 The adjusted body composition (DEXA) measures showed favourable improvements in the
231 intervention group in comparison to the control group in a range of measures (Tables 2 and
232 3); however, none of these changes with the exception of mean trunk fat and trunk fat%
233 reached statistical significance ($p > 0.05$). Whole body fat mass decreased by 0.31 kg in the
234 intervention group and increased by 1.84 kg in the control group (partial $\eta^2 = 0.096$ medium
235 effect size), and whole body fat % reduced in the intervention group by 0.68 %, whereas the

236 control group increased by 2.04 % (partial $\eta^2 = 0.095$, medium effect). There was a slight
237 decrease in trunk fat mass of 0.26 kg in the intervention group, and an increase of 1.02 kg in
238 the control group (partial $\eta^2 = 0.024$, small effect). Trunk fat % reduced in the intervention
239 group by 1.32 % and increased by 2.6 % in the control group, however this change score trend
240 did not reach statistical significance ($p = 0.091$, partial $\eta^2 = 0.022$, small effect). Peripheral fat
241 mass also decreased slightly in the intervention group (0.04 kg) and a small increase was
242 observed in the control group (0.80 kg, partial $\eta^2 = 0.008$, negligible effect). Peripheral fat
243 mass % decreased by 0.33% in the intervention group and increased by 2.22% in the control
244 group (partial $\eta^2 = 0.042$, small effect). Whole body lean mass % increased in the intervention
245 group slightly (0.68%) in comparison to a small decline in the control group (-2.04%), however
246 this trend was not statistically significant ($p = 0.268$, partial $\eta^2 = 0.012$, small effect). Between
247 baseline and post intervention the control group exhibited greater changes in VO_2 peak (4.1
248 ml/kg/min) than the intervention group (2.37 ml/kg/min). Despite this, the intervention
249 group exhibited a greater increase in VO_2 peak between baseline and follow up (5.25
250 ml/kg/min) in comparison to the control group (2.87 ml/kg/min) however this difference did
251 not reach statistical significance ($p=0.410$, partial $\eta^2 = 0.042$, small effect).

252

253 **Discussion**

254 This cluster randomised study aimed to assess the effects of the school-based CHANGE! PA
255 and healthy eating intervention on body composition and cardiorespiratory fitness in a sub-
256 sample of 10 to 11 year old children. A significant intervention effect was detected at follow
257 up for adjusted mean waist circumference change scores, mean trunk fat mass and trunk
258 fat %. Furthermore, there were also favourable improvements in body composition (DEXA)
259 measures in the intervention group in comparison to the control group (Tables 2 and 3);

260 however, none of these changes reached statistical significance ($p > 0.05$), which may be due
261 to the small sample size involved in the sub-sample cohort. Despite the lack of statistically
262 significant findings, medium and small effect sizes were observed that suggested the
263 intervention may have been beneficial.

264

265 The results of the present study add a degree of support to the existing evidence of the
266 effectiveness of combined curriculum based PA and nutrition interventions on lifestyle-
267 related health outcomes. The changes observed in mean trunk fat (mass and %) and waist
268 circumference suggest reductions in central adiposity in the intervention group. Waist
269 circumference and DEXA assessed trunk fat predict visceral fat (11, 41) and are positively
270 associated with cardiometabolic risk factors in children (5, 39). The small to medium
271 improvements in central adiposity observed, equating to a change score difference of 1.5cm
272 between the control and intervention group at follow up, may be associated with reduced
273 disease risk therefore representing an important intervention effect. Significant differences
274 in waist circumference were also observed between the intervention and control groups in
275 the main CHANGE! trial, however these improvements were statistically significant at post
276 intervention only. Other physical activity and dietary intervention studies have reported
277 improvements in waist circumference, for example the Lekker Fit! (26) study conducted with
278 9-12 year old children reported significant improvements in waist circumference in the
279 intervention group, however their reported decrease in waist circumference was greater at
280 0.71 cm (26). Unlike the main CHANGE! study, no significant changes in BMI Z-scores were
281 observed between the intervention and control groups either at post intervention or follow
282 up, though the intervention group exhibited smaller Z-score changes between baseline and
283 follow up (0.01 Z-score units) than the control group (0.48 Z-score units, partial $\eta^2 = 0.056$,

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

293

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

303

304 When assessing change in VO_{2peak} from baseline to follow up the control group slightly
305 increased VO_{2peak} (adjusted mean (SE) change = 2.87 (1.7) [95% CI -2.8, 4.2] ml/kg/min),
306 whereas the intervention group increased VO_{2peak} by over 5 ml/kg/min. The difference in
307 VO_{2peak} between groups did not reach statistical significance ($p = 0.410$). Other studies have

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

320

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

331 studies should build-in thorough process evaluation measures to provide this important
332 information going forwards.

333

334 *Strengths and Limitations*

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

351

352 Teachers received training on how to deliver the intervention lessons; however, there were
353 no on-going procedures in place to monitor progress or to evaluate delivery of lessons,
354 therefore intervention fidelity is unknown. The study used reference standard measurement

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

367

368 *Conclusions*

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

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516 **Tables**

517 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)

518

519 BMI = Body mass index

520 Table 2 Adjusted mean (SE) and partial η^2 for waist circumference, BMI Z-score, and VO₂peak at
 521 baseline, post intervention and follow up (where available), controlling for somatic maturation, IMD
 522 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

523

524 * denotes significant difference between control and intervention groups

525 Table 3. Change scores (SE) and partial η^2 between groups at all time points, controlling for sex,
 526 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	-3.30	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

527

528 *denotes significant difference between control and intervention group

