



26 increased in importance over the last few years.<sup>2,3</sup> Given that the school environment is an  
27 ideal context to promote healthy habits<sup>4</sup> it is essential to identify factors that may influence  
28 both adolescents' health and learning in this context.

29 Many different variables may affect academic achievement at school. Some of them  
30 may be directly related to the individuals, but others may be related to different  
31 characteristics of the school context.<sup>5</sup> One of those influence variables may be the level of  
32 adolescents' PA practice, which has recently been related to an improvement in cognitive  
33 processes, and consequently an improvement in academic achievement.<sup>6,7</sup> There is also  
34 evidence that related variables, such as being overweight and obese, are associated with  
35 higher levels of school absenteeism and lower academic achievement.<sup>8,9</sup> Other authors  
36 suggest that the relationship between PA and academic achievement may also be explained  
37 by psychosocial factors.<sup>10</sup> According to this hypothesis, adolescents with higher levels of PA  
38 would be more likely to assume certain behavioural patterns, which could indirectly favour  
39 better academic achievement.

40 According to literature, the measurement of academic achievement has been addressed  
41 through three different procedures. Firstly, through standardised tests, which have led to  
42 international assessments of education systems.<sup>11</sup> Secondly, through the compilation of  
43 students' marks, considering all the subjects studied or just a small selection.<sup>12</sup> Thirdly,  
44 academic achievement has been obtained, in some cases, by asking students to complete  
45 questionnaires.<sup>9</sup> Although students' marks could not be considered as an objective method to  
46 internationally compare academic achievement, they do represent a legal criterion to assess  
47 this in the Spanish context. Moreover, this indicator may have a strong influence on the  
48 students' future, both in terms of social and employment perspectives.

49 Different cross-cutting<sup>13-15</sup> or school-based intervention<sup>16-17</sup> studies have explored the  
50 relationship between PA levels and academic achievement. Most studies have shown a  
51 positive relationship between these two variables,<sup>9,18,19</sup> although to date these associations  
52 have proved to be generally weak,<sup>3,20</sup> or even negative.<sup>13</sup> In addition to these inconsistencies  
53 in the literature, it is also complicated to establish conclusions about that relationship, as most  
54 of the studies have been carried out via questionnaires, and therefore the results may be  
55 biased by the different data collection procedures.<sup>21</sup>

56 As far as methodological deficiencies are concerned, studies related to academic  
57 achievement do not usually provide PA intensity.<sup>18</sup> PA must be assessed based mainly on two  
58 parameters: its intensity and the time that individuals spend at a certain intensity during a  
59 specific period of time. The scientific evidence that emerges from associating these two  
60 concepts is used to establish the international PA recommendations to maintain good health  
61 during adolescence. International organisations recommend that school-aged youths  
62 accumulate at least 60 minutes of daily PA at a moderate to vigorous intensity.<sup>22</sup> However,  
63 many adolescents do not accumulate sufficient moderate-to-vigorous physical activity  
64 (MVPA) to satisfy current recommendations.<sup>23</sup> With respect to the importance of gender in  
65 the relationship between MVPA and academic achievement, results do not seem to be  
66 conclusive. Studies that have used self-reported measures of MVPA have found a positive  
67 relationship in both genders.<sup>24</sup> Using objective measurement, results showed a long-term  
68 positive impact of MVPA on academic attainment during adolescence, especially in girls who  
69 met MVPA recommendations.<sup>14</sup> However, other studies did not find any significant  
70 relationship between adolescents' PA and academic achievement in any gender.<sup>13,21,25</sup> Further  
71 research is warranted to better understand gender influence.

72           Given the existence of some controversy in literature about the relationship between PA  
73 and academic achievement, we would like to explore it further, suggesting another more  
74 complicated conceptual association. As previously suggested in literature<sup>21</sup> the association  
75 between these variables may not be linear. Therefore, we hypothesised that MVPA would be  
76 related to academic achievement according to a U-shaped non-linear explanatory model.

77           The objectives of this study were two-fold. 1) To examine the relationship between  
78 objectively assessed MVPA and academic achievement in adolescents, contemplating the  
79 possibility of both linear and non-linear associations. 2) To explore the relationship between  
80 the level of compliance with MVPA recommendations in adolescents and academic  
81 achievement depending on the gender.

82

## 83 **METHODS**

### 84 **Participants**

85           Participants in this study were recruited from the student population of seven secondary  
86 schools in the city of Huesca (Spain) during the academic course 2011-2012. Assent from  
87 455 adolescents aged between 13 and 15 years old and written informed consent from their  
88 parents or tutors were obtained. After applying exclusion criteria, 301 of the 455 eligible  
89 adolescents (46.51% boys, M=14.17, SD=0.63) were included in the final study (66.15%  
90 completion rate). This study obtained the approval of the Clinical Research Ethics Committee  
91 of Aragon (Spain).

92

### 93 **Instruments**

#### 94 *Academic achievement*

95           The educational centres' management teams provided the students' marks for all school  
96 subjects (i.e., 11 subjects, according to the Spanish education system) at the end of the school  
97 year. Individual marks for each subject were assessed using a scale from 0 to 10; where 0-4.9  
98 denotes failure, >5 denotes a pass, and 10 denotes excellence. Academic achievement was  
99 calculated as the average mark of all subjects, which was used as a continuous variable.

#### 100 ***Moderate-to-vigorous physical activity***

101           The GT1M accelerometer (Actigraph, model 7164) was used to continuously assess  
102 objective PA. To obtain the data, each participant was assigned an accelerometer to record  
103 their PA during all waking hours over a 7-day period. Participants wore the accelerometers  
104 on their right hip and were told to remove them only during sleep time and water-based  
105 activities. The cut-points used in this study were 0-99, 100-2291, 2292-4007,  $\geq 4008$  counts;  
106 for sedentary, light, moderate and vigorous physical activity, respectively.<sup>26</sup> All data were  
107 downloaded and analysed using the ActiLife software v.21.

108           Before further processing, an activity recording of 10 hours' wear time per day, for at  
109 least four days (three weekdays plus one weekend day), was required as inclusion criterion<sup>27</sup>  
110 Non-wear time was defined as a period of 10 consecutive minutes registering zero counts per  
111 minute (cpm), allowing up to two minutes recording 0-100 cpm during that period.<sup>28</sup>  
112 Accelerometers were set to register the number of counts at 30-second epoch.<sup>29</sup> The daily  
113 time spent at moderate and vigorous PA intensities was added and integrated into one  
114 variable, daily MVPA. After that, average minutes of weekly MVPA were calculated.  
115 Weekly MVPA was used to estimate the level of compliance with daily recommendations for  
116 adolescents (i.e., 60 minutes per day). An ordinal variable called 'Grade of compliance with  
117 MVPA recommendation' was created to segment the sample: <30 minutes of MVPA per day  
118 (group 1); 30-50 minutes of MVPA per day (group 2); 50-70 minutes of MVPA per day

119 (group 3); 70-90 minutes of MVPA per day (group 4); >90 minutes of MVPA per day (group  
120 5).

### 121 *Covariates*

122 A series of potential confounders were included: socioeconomic status, body mass index  
123 (BMI), type of school (i.e., public or state-subsidised private school), and gender. According  
124 to the theoretical framework, all these variables may have the capacity to bear an influence  
125 on academic achievement.<sup>9,11</sup> Socioeconomic status was calculated using the validated  
126 questionnaire FAS II, categorising participants depending on their status (i.e., high, medium  
127 or low).<sup>30</sup> BMI was calculated using self-reported values of height and weight. Participants  
128 were categorised as underweight, normal-weight, overweight and obese, according to the  
129 standards for children and adolescents from Centers for Disease Control and Prevention.<sup>31</sup>

### 130 **Procedure**

131 Prior to carrying out this study at the different secondary schools, a meeting was held  
132 with each school management team to address objectives, requirements and repercussions of  
133 the study. After their approval, potential participants and their parents were informed about  
134 the research project through information meetings and informational brochures, respectively.  
135 Subsequently, self-reported data were collected and participants were monitored for one  
136 week via the accelerometers. All data collection processes were conducted by the research  
137 team with the cooperation of the physical education teachers.

138

### 139 **Data Analyses**

140 Means and standard deviations (SD) were calculated to describe participants'  
141 characteristics. Differences between boys and girls were explored using the independent-  
142 samples t-test. Cohen's d effect size statistic was also calculated for every comparison of  
143 means.

144 Based on the evidence suggested by previous research,<sup>15</sup> both linear and non-linear  
145 hypothesis were tested. Firstly, a structural equation modelling (SEM) analysis was  
146 performed in order to test the linear hypothesis. According to the model proposed, MVPA  
147 during weekdays and MVPA during weekend days were hypothesised to have a directional  
148 causal effect on the latent variable, 'Academic achievement'. The latter was indirectly  
149 assessed through the average marks obtained in three specific subjects (i.e., language and  
150 literature, mathematics and foreign language [English or French]). The choice of these  
151 subjects was based on the fact that they are compulsory right through secondary school.  
152 Gender, BMI and socioeconomic status were considered as covariables, testing their  
153 predictive capacity on the rest of the variables studied. Model fit was tested using Chi-square  
154 ( $X^2$ ), the Root Mean Square Error of Approximation (RMSEA), the Standardised Root-Mean-  
155 Square Residual (SRMR), the Incremental Fit Index (IFI) and the Tucker Lewis Index (TLI).  
156 Secondly, a curvilinear regression was conducted to test PA predictive capacity on academic  
157 achievement in a non-linear model. In order to reduce the PA variable dispersion, the  
158 categorised variable, 'grade of compliance with MVPA recommendation', was used instead  
159 of a continuous variable.

160 Finally, one-way analysis of variance (ANOVA) and Scheffé's post-hoc tests were  
161 carried out to compare academic achievement among the categories of compliance with  
162 MVPA recommendations, depending on the participants' gender. Bootstrapping was used to  
163 generate a confidence.<sup>32</sup> If zero was included in the confidence interval, then the effect was

164 considered to be non-significant. All these analyses were performed using the SPSS statistical  
165 package (version 21.0) and IBM AMOS Graphics.

166

## 167 **RESULTS**

168 Values of participants' marks and MVPA levels are displayed in Table 1. Gender  
169 differences were found with respect to academic achievement and MVPA levels. Girls  
170 showed statistically significant higher marks than boys in language ( $p<.01$ ), mathematics  
171 ( $p<.01$ ) and foreign language ( $p<.01$ ), as well as in the average marks of all subjects ( $p<.01$ ).  
172 Boys engaged in significant higher levels of MVPA, both on weekdays ( $p<.01$ ) and during  
173 the week as a whole ( $p<.01$ ). No gender differences were found in MVPA levels on weekend  
174 days.

175 [Table 1 near here]

176 In order to test the linear relationship possibility, a SEM analysis was conducted. The  
177 'type of school' variable was finally excluded from the model to improve model fit:  $\chi^2=16.80$   
178 ( $gl=10$ ;  $\chi^2/gl=1.68$ ); RMSEA=.05 (confidence interval: LO=.00; HI=.09); SRMR=.02;  
179 IFI=.99; TLI=.98. Table 2 shows the regression weights associated with the SEM analysis  
180 carried out. It should be pointed out that MVPA on weekdays was found to be negatively  
181 associated with academic achievement ( $\beta=-.21$ ;  $p=.02$ ). With respect to the covariates, gender  
182 was significantly related to MVPA as well as academic achievement. According to this  
183 model, boys showed higher levels of MVPA ( $\beta=.29$ ;  $p<.01$ ), whilst girls obtained better  
184 academic achievement values ( $\beta=-.15$ ;  $p=.02$ ). Moreover, participants belonging to higher  
185 categories of BMI had lower values of academic achievement ( $\beta=-.16$ ;  $p<.01$ ). Significant  
186 standardised estimations and proportion of variance explained are summarised in Figure 1.



187 [Table 2 near here]

188 [Figure 1 near here]

189 With respect to the non-linear hypothesis, regression analysis results (see table 3)  
190 showed that the model with a quadratic relationship was the only one that presented a  
191 significant association between MVPA and academic achievement, both in the sub-sample of  
192 boys ( $F=4.12$ ;  $R^2=.06$ ;  $p=.02$ ) and in the total sample ( $F=3.29$ ;  $R^2=.02$ ;  $p=.04$ ). The sub-  
193 sample of girls did not show any significant relationship between both variables in either of  
194 the two models. The explained variance of the significant models was small (from .02 to .06).

195 [Table 3 near here]

196 Finally, academic achievement was compared among the different groups of  
197 compliance with MVPA recommendations, showing significant differences in both girls  
198 ( $F=3.16$  [4, 156];  $p=.02$ ) and boys ( $F=2.75$  [4, 135];  $p=.03$ ). Scheffé's post-hoc group  
199 comparisons and bootstrap confidence intervals are shown in Table 4. According to this  
200 analysis, girls belonging to group 1 (<30 minutes of MVPA per day) recorded higher school  
201 marks in comparison to those belonging to group 5 (>90 minutes of MVPA per day). Further,  
202 girls belonging to group 4 (70-90 minutes of MVPA per day) recorded higher school marks  
203 in comparison to those belonging to group 2 (30-50 minutes of MVPA per day) and group 5  
204 (>90 minutes of MVPA per day). Moreover, those boys whose MVPA levels were close to  
205 the recommendations (i.e., 50-70 minutes of MVPA per day; group 3) tended to record the  
206 highest academic marks, in comparison to groups 1 (<30 minutes of MVPA per day), 4 (70-  
207 90 minutes of MVPA per day) and 5 (>90 minutes of MVPA per day).

208 [Table 4 near here]

209

## 210 **DISCUSSION**

211       The aim of this research was to verify the existing relationship between PA levels,  
212 compliance with MVPA recommendations and academic achievement in adolescents, as well  
213 as to analyse possible existing differences in these relationships depending on the gender.  
214 Both linear and non-linear approaches were explored in order to clarify the inconsistency  
215 shown in previous research.

216       The results obtained in this study confirm the initial hypothesis about the existence of a  
217 significant relationship between variables. According to the structural equations model, PA  
218 on weekdays was negatively associated with academic performance, whereas PA during the  
219 weekend had no significant relationship. These results are consistent with the findings of  
220 Esteban-Cornejo and colleagues.<sup>13</sup> In contrast, most previous studies have suggested a  
221 positive relationship between PA and academic achievement.<sup>19,24,33</sup> This discrepancy may be  
222 due to the way in which data were collected. In this sense, the work by Syväoja and  
223 colleagues<sup>21</sup> concluded that objectively assessed and self-reported MVPA may reflect  
224 different constructs regarding the association with academic achievement. Moreover, most  
225 previous research, based on data collected via accelerometers, found no association between  
226 variables.<sup>6,21,25,34</sup> In other cases, this relationship has been considered to be significant  
227 depending on the gender<sup>14</sup> or subject assessed,<sup>15</sup> thus supporting the need to further explore  
228 this controversy.

229       The quadratic regression model shows a correlational pattern according to which  
230 students with very low and very high levels of PA tend to obtain lower average marks. On the  
231 contrary, students whose MVPA levels are close to the daily recommendation for adolescents  
232 (i.e., 60 min of MVPA) tend to obtain higher average marks. The regression curve is coherent  
233 with the results obtained in the ANOVA analysis, showing that a higher level of achievement

234 is associated with average MVPA of 50-70 minutes a day. A similar correlational pattern has  
235 previously been described in research performed with self-reported data in the Spanish  
236 context.<sup>35</sup> In sum, according to the results obtained in the current study, it can be suggested  
237 that the non-linear model seems to be more consistent when explaining the association  
238 between PA and academic achievement, which is also consistent with the initially proposed  
239 hypothesis.

240 This relationship goes in the same direction as previous studies.<sup>14,36,37</sup> These studies  
241 showed that academic achievement was only influenced (either positively or negatively) by  
242 PA carried out by students at specific levels of intensity/duration. The aforementioned studies  
243 coincide in pointing out that the influence on academic achievement becomes significantly  
244 positive at intensities between moderate and vigorous; although in most cases, the data used  
245 by the authors to reach this conclusion are not objective. On the other hand, there are studies  
246 that show that PA can also have a negative influence on academic achievement at very high<sup>38</sup>  
247 or very low<sup>39</sup> levels, as we found in this study. Therefore, we can theorise in this regard that  
248 students whose PA levels are close to daily recommendations will have a more organised and  
249 orderly lifestyle, will receive cognitive benefits and will satisfy a series of favourable  
250 behaviours with respect to their academic achievement.

251 When addressing the controversy of the role played by gender in the relationship  
252 between PA and academic achievement, the results of the study only showed a significant  
253 association in the case of males. This conclusion contradicts the results obtained by Kwak  
254 and colleagues,<sup>14</sup> according to which the positive effect of PA is only expressed in female  
255 students. This discrepancy may be explained due to contextual differences. This work was  
256 carried out in Sweden, a country where the gender gap in terms of economics, health and  
257 education is smaller than in the Spanish case,<sup>40</sup> and therefore, the opportunities of female

258 students enjoying higher levels of PA may perhaps be greater. These results strongly support  
259 the need to perform interventions geared towards increasing PA opportunities for the female  
260 gender in some specific contexts.

261 According to our results, the levels of PA expressed by participants vary significantly  
262 depending on gender, as male students showed higher levels of MVPA than female students.  
263 This significant difference could affect the results. It could be hypothesised that PA has a  
264 different influence on academic achievement depending on the moment of the week (i.e.,  
265 weekdays/weekend). Boys showed higher levels of MVPA on weekdays, when physical and  
266 academic activities (both curricular and extracurricular) are more likely to coexist. Therefore,  
267 MVPA could lead to higher organising demands when carried out on weekdays, which could  
268 be related to higher academic achievement.

269 Referring to the rest of covariables included in the model, SEM analysis shows that  
270 students with higher BMI are more likely to obtain worse academic achievement. These  
271 results are fully consistent with previous research.<sup>8,9</sup> The detrimental effect that BMI could  
272 cause on academic achievement might provide stakeholders with greater evidence to target  
273 children's and adolescents' obesity as a priority in terms of public health.

274 In the same vein as all the studies reviewed, which share the same characteristics as this  
275 study, we observe that, despite being significant, the relationship between variables gives rise  
276 to a reduced predictive value model. As explained in the theoretical framework, academic  
277 achievement is a phenomenon with a multicausal nature, determined by multiple  
278 psychosocial and environmental factors linked both to the family and to the school context, as  
279 well as to certain typical genetic conditioning factors of each individual. The variables linked  
280 to lifestyle simply form a small part of a complex map of factors that interact together to

281 explain academic achievement. It is logical, therefore, that our predictive model explained a  
282 low percentage of the total variance of such a complicated phenomenon.

283 The main strength of this research is the use of objective data to quantify participants'  
284 PA level. To date, there are not many research projects that study the relationship between  
285 these two variables in adolescents, making use of accelerometer. As this is, to our knowledge,  
286 the third study in the Spanish context<sup>13,16</sup> that associates the two variables mentioned, making  
287 use of objective data, the relevance of the study carried out is clear.

288 Several research perspectives emerge from this current study. A longitudinal study  
289 could be set out, monitoring students' PA levels and academic achievement during the entire  
290 schooling period. On the other hand, other factors linked to lifestyle and its relationship with  
291 academic achievement<sup>2</sup> could be analysed, such as the type of physical activity performed,<sup>37</sup>  
292 physical condition<sup>21,25</sup> and dietary habits.<sup>9</sup> This type of variable has not been contemplated in  
293 this study as it belongs to a different research perspective, far removed from the interests  
294 pursued herein.

## 295 **Limitations**

296 This study also has several limitations. First, the study design is cross-sectional, which  
297 limits the extent of the inferences we can make regarding the direction of the observed  
298 associations. Second, given that accelerometers only measure accelerations on the vertical  
299 axis, and they cannot show the intensity of activities such as skating, cycling, rowing or  
300 weight lifting, there could be some misleading PA data. Moreover, as they are not compatible  
301 with water, they cannot record swimming or other aquatic activities, which could  
302 underestimate PA levels. Furthermore, accelerometer-assessed MVPA only focuses on the  
303 amount of time spent at those intensities, but not into the type of activity or motor skill  
304 performed. Finally, the study sample, although representative of the population of the schools

305 from which it was drawn, is not necessarily representative of the larger adolescent  
306 population, which limits the external validity of these findings.

### 307 **Conclusions**

308       Based on evidence found in our data, firstly it seems appropriate to affirm that students  
309 with very low or very high levels of MVPA tend to obtain worse academic achievement,  
310 whilst students who satisfy the recommendations for adolescents (60 minutes a day of  
311 MVPA) tend to obtain better academic achievement. Secondly, it concludes that gender has a  
312 great influence on the relationship between PA and academic achievement.

313       Further evidence about this relationship seems necessary to enable us to provide clearer  
314 guidelines about PA practice in order to obtain a better equilibrium in the time distribution of  
315 adolescents' daily activities (either academic, educational, PA-related or leisure activities,  
316 etc.), as well as assessing possible interventions in order to increase academic achievement  
317 through PA.

318       This study reinforces the scientific evidence that associates variables such as PA levels  
319 and academic achievement. Based on this relationship, we can identify students who need  
320 special attention in the design of strategies to increase academic achievements by improving  
321 optimal PA levels. Based on previous studies, some of the strategies used within the school  
322 context to increase academic achievement could focus on offering a variety of participation  
323 opportunities in PA, promoting students' autonomy, developing joint strategies between  
324 different social sectors (e.g., town councils, neighbourhoods and schools), engaging families  
325 and counselling adolescents for them to organise their time correctly and be able to include  
326 50 to 70 minutes of MVPA in their lifestyle.

327

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470 **TABLES**

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Table 1. Mean and Standard Deviation of Participants' Marks and MVPA Levels by Gender.

	All participants		Boys		Girls		<i>t</i>	<i>d</i>
	<i>N</i> =301		<i>n</i> =140		<i>n</i> =161			
	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>		
Age	14.17	.63	14.21	.67	14.13	.59	-1.00	.13
Language mark (0-10)	5.88	2.08	5.37	1.93	6.33	2.12	4.06**	-.47
Mathematics mark (0-10)	5.88	2.05	5.50	1.95	6.20	2.07	2.99**	-.35
Foreign language mark (0-10)	6.12	2.24	5.63	1.96	6.56	2.38	3.73**	-.43
All subjects mark (0-10)	6.56	1.60	6.16	1.46	6.9	1.65	4.07**	-.48
MVPA on weekdays (min)	61.30	28.48	70.11	30.81	53.65	23.87	-5.13**	.60
MVPA on weekend days (min)	43.19	36.71	45.87	39.68	40.87	33.88	-1.17	.14
Weekly MVPA (min)	56.31	27.84	63.48	30.75	50.06	23.41	-4.21**	.49

Notes: \*=  $p < .05$ ; \*\*=  $p < .01$ 

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Table 2. Regression Weights of Structural Equation Model.

Parameters		Estimates	Bootstrapping	
			95% confidence interval	
			Lower	Higher
MVPA at weekends	Gender	5.07	-2.05	13.31
MVPA on weekdays	Gender	16.78**	11.75	22.55
MVPA at weekends	Socioeconomic status	-4.41	-12.08	3.49
MVPA on weekdays	Socioeconomic status	.33	-5.59	6.28
MVPA at weekends	BMI	-3.72	-8.87	2.28
MVPA on weekdays	BMI	-2.27	-7.42	3.04
Academic achievement	MVPA on weekdays	-.01*	-.02	-.01
Academic achievement	MVPA at weekends	.004	-.002	.01
Academic achievement	Socioeconomic status	.34	-.01	.71
Academic achievement	Gender	-.59*	-.96	-.18
Academic achievement	BMI	-.56**	-.88	-.31
Language marks	Academic achievement	1.00**	1.00	1.00
Foreign language marks	Academic achievement	.97**	.87	1.06
Mathematics marks	Academic achievement	.91**	.84	1.01

Note: \*= p< .05; \*\*= p< .01

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Table 3. Summary of Model and Parameter Estimations.

	Equation	Summary of model					Parameter estimations (standardised parameters)		
		R <sup>2</sup>	F	gl1	gl2	Sig.	Constant	b1	b2
Girls	Linear	.00	.23	1	148	.63	7.07	-.06	
	Quadratic	.00	.14	2	147	.87	6.95	.05	-.02
Boys	Linear	.00	.00	1	123	.96	6.13	.01	
	Quadratic	.06	4.12*	2	122	.02	4.49*	1.36	-.22*
All participants	Linear	.01	1.65	1	273	.20	6.84	-.10	
	Quadratic	.02	3.29*	2	272	.04	5.94*	.68	-.13*

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479 Note: \*=p<.05

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Table 4. Academic Achievement Depending on Group of Compliance with MVPA Recommendations. Multiple Comparisons from Scheffe Test.

Group of compliance with MVPA recommendations		Girls			Boys		
		Difference of means	Bootstrapping		Difference of means	Bootstrapping	
			95% confidence interval			95% confidence interval	
			Lower	Higher		Lower	Higher
1	2	.65	-.10	1.33	-.81	-1.61	.06
	3	.19	-.63	.93	-1.19*	-2.02	-.32
	4	-.66	-1.54	.30	-.32	-1.27	.46
	5	1.33*	.12	2.72	-.34	-1.22	.52
2	1	-.65	-1.33	.10	.81	-.06	1.61
	3	-.47	-1.07	.26	-.38	-1.23	.39
	4	-1.31*	-2.15	-.42	.50	-.41	1.37
	5	.68	-.47	2.00	.48	-.35	1.32
3	1	-.19	-.93	.63	1.19*	.32	2.02
	2	.47	-.26	1.07	.38	-.39	1.23
	4	-.84	-1.79	.12	.87*	.03	1.67
	5	1.14	-.16	2.47	.85*	.05	1.70
4	1	.66	-.30	1.54	.32	-.46	1.27
	2	1.31*	.42	2.15	-.50	-1.37	.41
	3	.84	-.12	1.79	-.87*	-1.67	-.03
	5	1.98*	.59	3.40	-.02	-.74	.81
5	1	-1.33*	-2.72	-.12	.34	-.52	1.22
	2	-.68	-2.00	.47	-.48	-1.32	.35
	3	-1.14	-2.47	.16	-.85*	-1.70	-.05
	4	-1.98*	-3.40	-.59	.02	-.81	.74

Notes: \*=p<.05; 1= <30 minutes of MVPA per day; 2= 30-50 minutes of MVPA per day; 3= 50-70 minutes of MVPA per day; 4= 70-90 minutes of MVPA per day; 5= >90 minutes of MVPA per day

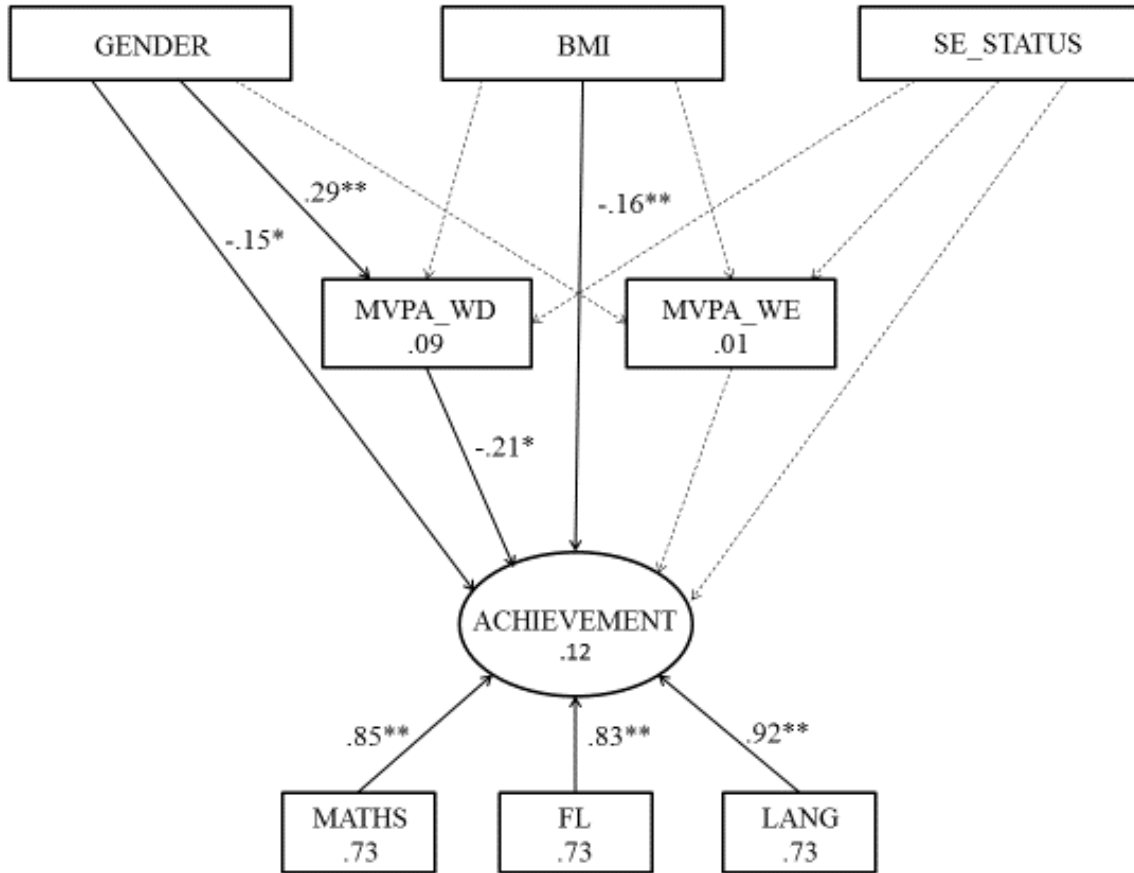
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Figure 1. Summary of Structural Equation Model Outcomes. Standardised Estimations.



Notes: Straight line = significant estimate; Broken line = non-significant estimate; \* = p < .05; \*\* = p < .01. Proportion of variance explained is shown below the name of each variable. Significant standardised estimates are shown next to straight lines. BMI: Body mass index. SE\_STATUS: Socioeconomic status. MVPA\_WD: Moderate-to-vigorous physical activity on weekdays. MVPA\_WE: Moderate-to-vigorous physical activity on weekend days. ACHIEVEMENT: Academic achievement based on marks of three subjects (mathematics, foreign language and language and literature). MATHS: Mathematics mark. FL: Foreign language mark. LANG: Language and literature mark.