Evidence of moderation effects in predicting active transport to school

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Evidence of moderation effects in predicting active transport to school

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Abstract

Background: Distance from home to school is an important influence on the decision to use active transport (AT); however, ecological perspectives would suggest this relationship may be moderated by individual, interpersonal, and environmental factors. This study investigates whether (i) gender, (ii) biological maturation, (iii) perceived family support for physical activity (PA), and (iv) multiple deprivation moderate the relationship between distance to school and AT.

Methods: 611 children (11-12 years old, 334 females) were recruited from schools in Leicestershire, UK. Gender, family support for PA, and AT were self-reported. Home and school postcodes were used to determine multiple deprivation and distance to school (km). Predicted age at peak height velocity was used to indicate biological maturation.

Results: Logistic regressions revealed the main effects explained 40.2% of the variance in AT; however; distance to school was the only significant predictor. Further analyses revealed that distance to school had a greater negative impact on the use of AT in late-maturing (OR: 3.60, CI: 1.45-8.96), less deprived (OR: 3.54, CI: 1.17-10.72), and children with low family support of PA (OR: 0.26, CI: 0.11-0.61).

Conclusions: This study provides evidence that, although distance to school might be the strongest predictor of AT, this relationship is complex.
Introduction

Regular physical activity (PA) reduces risk of disease [1], improves mental health [2] and extends life expectancy [3]. Incorporating PA into everyday life is imperative especially for children to promote long-term active lifestyles lasting into adulthood [4] and offset the general decline in PA that occurs at approximately 12 years old [5]. However, only 21% of boys and 16% of girls aged 5-15 in the United Kingdom (UK) are meeting guidelines for recommended PA levels [6]. Actively commuting to school (i.e., primarily walking and cycling for the purpose of functional, rather than leisure travel [7]) can provide a convenient and meaningful contribution to increasing PA levels and energy expenditure [8, 9]. To increase the number of children actively commuting, understanding the underlying reasons for this behavioural choice are essential [10].

Distance from home to school is integral in the decision to actively commute to school, specifically the likelihood of utilising inactive transport increases with distance [11, 12]. A longitudinal study exploring 31 mostly socio-cultural and environmental factors found that distance to school (< 1km) was primarily associated with maintenance of active travel over a one year period [13]. Very few UK 9-10 year old children were observed to actively commute when the distance between home and school was over 2km [14], however, this threshold has been suggested to be 8km in 11 year olds [15].

Despite the importance of distance to school, behaviour is guided by multiple levels of influence [16, 17]; at the core of which is individual psycho-biological factors. For example, boys are more likely than girls to actively commute to school [18]. Similarly, biological maturation may also be important when predicting active transport. Adolescents of the same chronological age can vary by up to five years in biological age [19]. The timing and pace of this biological maturation has important consequences for physical, psychological and behavioural development, some of which may impact involvement in PA
For instance, children’s maturation status has been investigated with regards to self-reported [21] and objectively measured PA with equivocal findings reported [22]. Biological maturity has not been explored as a predictor of active school transport.

Interpersonal and socio-cultural influences must also be considered. The central interpersonal guidance on children’s mode of transport decision is their parents/guardians. Children are more likely to actively commute if their parents did so when they were children and if they currently actively commute to work [23]. Positive parental attitudes have been shown to be particularly important for children who lived a short distance from school [24]. Despite active travel being a specific form of PA that may have distinct antecedents, children are more likely to actively commute when their parents value the benefits of PA [25]. Another socio-cultural influence on the decision to actively commute to school is multiple deprivation. A review of predominantly cross-sectional studies concluded that children from low multiple deprivation areas were more likely to actively commute to school [26]; previous explanations included less access to cars [27] and living in urban environments closer to schools [28].

Despite the above knowledge, a key strength of ecological perspectives has generally been overlooked. With a few exceptions [13, 25, 29] researchers haven’t considered how the multiple levels of influence interact with each other. It is currently unknown whether the association between distance to school and active transport is moderated by the individual, interpersonal, and socio-environmental variables described above. Although many factors may influence the decision to active commute, the aim of the present study was to focus on variables that might intuitively moderate the relationship between distance to school and active travel. Prior to considering these moderating effects we expected boys; children who are physically mature, with a supportive family for PA, living in socio-economically deprived areas, and children living closer to school to be more likely to actively commute to school.
(hypothesis 1). With regard to moderating effects, we proposed that as the distance from school increases, the likelihood of boys actively commuting may decrease less rapidly, compared to girls (e.g. because of decreased safety concerns of parents for boys compared to girls [30]) (hypothesis 2). The same can be said for physically more mature children, independent of gender and age in that they are allowed to actively commute to school, and therefore distance to school is less impactful (hypothesis 3). Children whose parents encourage PA to actively commute will be less influenced by the distance to school, compared to those who don’t receive parental support (hypothesis 4). Finally, distance to school may be less of an important influence on the decision to actively commute in areas of multiple socio-economic deprivation (hypothesis 5). This is because families in these deprived areas are less likely to own motorised transport and the child has less choice but to actively commute [27].

Method

Participants

Twenty-four secondary schools within Leicestershire (Midlands County in England) were invited to participate. Seven schools across three local authorities (two independent private schools, five state-funded schools) agreed to participate. Two schools were rural and five schools urban [31]. Using the 2014 index of multiple deprivation (IMD) [32], which ranks areas from 0 (most deprived) to 9 (least deprived), the sampled schools ranked 0 (n=1), 2 (n=4), 5 (n=1) and 7 (n=1). Within our sample (and across the UK), secondary school pupils who live further than 4.8km away from their nearest school are eligible for free transport [33]. Data were collected from 619 11-12 year old children (334 females; mean age = 12.35 years, $SD = 0.29$; ethnicity: White = 80.7%, Asian = 15.4%, Black = 2.7%, other = 1.3%). The study was approved by a university ethics committee and written informed consent was
obtained from each school's head teacher, parent/guardians had an opportunity to withdraw their child from the study, and children provided their written assent.

**Measures**

*Distance to school.* Six/seven digit postcodes of the child’s home and school were entered into Google Maps using the ‘get directions’ function and the walking distance between the two points was recorded in kilometres. Using Google Maps as a GPS mapping resource is a recommended method to measure walking and cycling routes for research [34].

*Biological maturity.* Two anthropometric measurements were taken at school for stretch stature, sitting height, and body mass using a portable stadiometer and electronic scales. From these measurements, a prediction of when age at peak height velocity (APHV) was likely to occur was used to indicate biological maturity [35]. In brief, a gender-specific multiple regression equation that included stature, body mass, sitting height, leg length, chronological age, and their interactions was applied. This technique has been shown to estimate maturity status to within an error of 1.18 years 95% of the time in boys and 1.14 years 95% of the time in girls [35]. To remove the confounding effect of gender (i.e., girls mature earlier than boys) children’s APHV was centred on the mean APHV for their respective gender.

*Family Support for PA.* Questions about children’s perceived family support of PA were adapted from the Amherst Health and Activity study (student survey; [36]). The stem ‘During a typical week how often has a member of your household (for example, your father, mother, brother, sister, grandparent, or other relatives)’ was followed by five items (e.g. ‘Encouraged you to do physical activities or play sports?’). All items were responded to on a 5-point scale ranging from 1 (none) to 5 (daily). The survey was designed to be relevant to all children aged 6 – 17 and all items have been shown to be reliable [36]. The Cronbach’s Alpha coefficient in the present study was .79.
Multiple deprivation. The IMD was calculated based on children’s home postcode. This measure has been used previously in PA-based research [37] and is calculated from a variety of data including average income, employment, health and disability, education, skills and training, housing and services, crime and living environment. The scale ranges from 0 (most deprived) to 9 (least deprived).

Active versus Inactive Travel. Based on previous work [38], participants were asked “How do you get to school?” followed by eight responses: (a) Walk all the way (b) Walk part of the way (c) Public bus (d) School bus (e) Car/taxi (f) Bicycle (g) Train/metro (h) Skateboard or scooter. Participants could mark as many responses as were appropriate to them. Children were classified into two groups (i) active travellers (children who walked all the way, or used a bicycle, skateboard, or scooter), (ii) inactive travellers (all other forms of transport, including those who travelled part of the route actively). We adopted this conservative classification as it is likely that the primary mode of transport for a child who reports part-active travel would be inactive (e.g., walking to the bus stop) [39]. To further justify this choice, we explored differences between part-active and inactive participants in the study variables. MANOVA and follow up univariate test revealed no significant differences across all the variables expect from distance to school ($F (1, 333) = 9.682, p = .002$; part active = $2.9 ± 2.3$ km versus inactive = $4.0 ± 3.0$ km).

Statistical Analysis. We used logistic regression using SPSS (IBM version 21) to test our study hypotheses with active versus inactive travel as the binary coded outcome variable. In the main effects model (hypothesis 1), predictor variables were unstandardised to assist in interpreting odds ratios, however, they were standardised into $Z$ scores (with the exception of the binary coded gender variable) in subsequent models to facilitate interpretation of the interaction terms.

Results
Descriptive statistics

Eight children failed to answer how they travelled to school and were removed from the analysis. Of the remaining 611 participants, 45.3% were classed as inactive travellers, 36% used active transport to school and 18.7% travelled via a combination of active and inactive travel methods (and were therefore classified as inactive). The majority (75.4%) were classified as ‘normal’ according to Cole’s BMI cut points [40]; 39.2% lived within 2km, 59.0% lived within 4km, 76.9% lived within 6km and 82.9% lived within 8km. Descriptive statistics of the sample can be seen in Table 1. Bivariate correlations among constructs are presented in Table 2 for information only.

Primary analysis

The first logistic regression model (hypothesis 1) included all main effects (distance from school, gender, APHV, family support of PA, and multiple deprivation) as predictors of active versus inactive travel to school. The results can be seen in Table 3 and the predictors explained 40.2% of the variance in mode of transport, however, only distance to school was a significant predictor of active transport, after adjusting for other variables. There were no differences in relationships across gender (i.e., no gender × predictor interactions).

To test subsequent hypotheses, each proposed interaction was independently added to the standardised version of the model described above. As shown in Table 3, the interaction between gender and distance to school was not significant; however, APHV, family support for PA, and multiple deprivation significantly moderated the relationship between distance to school and mode of transport. Simple slopes analysis using data ±1 standard deviation from the standardised mean scores revealed that distance to school had a relatively greater negative impact on the use of active travel in children who are biologically late-maturing (i.e., Girls
with APHV ≥ 13.43 years; Boys with APHV ≥ 14.26 years), from less deprived backgrounds (i.e., 8.31 on a 0 – 9 index of multiple deprivation) and with low family support of PA (i.e., 2.36 on a 1 – 5 self-report scale), compared to children who are biologically early-maturing (i.e., Girls with APHV ≤ 11.65 years; Boys with APHV ≤ 12.30 years), from more deprived backgrounds (i.e., 2.89 on a 0 – 9 index of multiple deprivation) and with high family support of PA (i.e., 4.22 on a 1 – 5 self-report scale). See Figure 1 for graphical representation of these moderation effects.

To account for potential school differences we ran the regression models again adjusting for school differences in student catchment area (i.e., school average distance travelled by students; coded as 0 = > 6km, 1 = 5.9 - 3km, 2 = < 3km). All significant relationships remained with the exception of the interaction between distance and deprivation (OR = 2.37, CI = .75 - 7.44, \( p = .14 \)). No changes to our results were seen in further iterations when we adjusted for the fact that two of the sampled schools were privately funded (versus state schools) and that another two of the sampled schools were largely rural (versus urban).

Discussion

Main finding of this study

In accordance with previous research [12-15], the closer to school participants lived; the more likely they were to actively commute. None of the remaining study variables (Gender, APHV, family support of PA, and multiple deprivation) were associated with active transport, when other variables were held constant. However, many of these constructs helped in providing new information demonstrating that the relationship between distance and active transport is moderated by a number of factors. In particular, distance had a greater negative impact on the use of AT in a) late-maturing children, b) less socio-economically deprived children and c) children with low family support of PA.
What is already known on this topic?

Distance to school is arguably the most important influence on children’s decision to use active transport [41, 42]. Other studies have suggested that gender [18], family support for PA [25], and multiple deprivation [26] are also contributing factors. The majority of prior research has failed to adopt an ecological perspective, however, which suggests that behavioural choices are complex decisions based on the interplay between multiple levels of influence.

What this study adds

Biological maturity of children was not associated with active transport in our main effects model; however, our results demonstrated that the influence of distance to school on active travel was stronger in late maturing children. Graph C in Figure 1 illustrates the likelihood of actively commuting decreases considerably as distance to school increases for a later maturing child, to such an extent that a late maturing child (1 SD above the APHV mean) who lives relatively far away (1 SD further than the mean distance) has a probability of near zero of actively commuting to school. In contrast, the likelihood of actively commuting decreases to a much lesser extent in an earlier maturing child. No previous research has examined the association between biological maturity and active transport. The reasons why this moderation effect occurs is unclear, however, parents of physically mature children may be less concerned with safety and allow more independence to actively travel relatively long distances, compared to parents of physically immature children. Future research may wish to explore these potential mechanisms.

In contrast to previous research [26], multiple deprivation did not predict active transport. This is likely due to our focus on models adjusted for other variables, as the bivariate correlation between multiple deprivation and active travel was statistically significant and of moderate magnitude. Nonetheless, our results do suggest that in deprived
areas the influence of distance to school has little impact upon the decision to walk to school, whereas the influence becomes much stronger in less deprived areas. This may be explained by the limited options available to those living in deprived areas, including less access to cars for commuting to school [26] and living in urban environments which are closer to schools [43]. Increased options of active transport for less socially deprived children means the likelihood of active travel decreases markedly as distance increases. When accounting for school differences in catchment areas the interaction between distance and deprivation was no longer significant. This may be because of the similarity and shared variance between catchment area and deprivation (i.e., urban, deprived areas tend to have schools with smaller catchment areas).

Despite literature evidencing a relationship [25, 27], our adjusted main effects model suggests that when distance to school is included as a predictor of active travel, family support for PA offers no additional explanatory utility. However, we did find support for our proposed interaction between distance to school and family support of PA. Specifically, distance to school was a less meaningful influence on the decision to actively commute when family support for PA was present. This means that, unlike findings reported by Panter et al [24], the likelihood of active travel when living near school (i.e., -1 SD below the standardised mean distance from school) was similar whether positive attitudes were conveyed or not. However, the chances of active travel decline much more rapidly as distance increases if positive attitudes are not conveyed. It should be noted, however, that the attitudes measured by Panter et al. [24] differed to those in the present study (attitudes towards active travel versus PA).

Finally, in contrast to previous research [18, 20, 26], our results displayed no significant main or interaction effects of gender. It is unlikely that this was attributable to the inclusion of other variables in our regression models as the bivariate correlation between
gender and active travel was also non-significant. However, it should be noted that within our sample girls lived a mean distance of 5.31km from school whereas boys lived, on average, 3.55km from school. It is unknown why our sample and findings should differ from many others, although studies reviewed by Davison et al. [26] were based in countries other than the UK. School systems differ between countries, for example, in the UK children tend to transition to their next school aged 11 years old, often located further afield compared to their previous school. It is also worth investigating whether the UK perspective on active travel for boys and girls may differ when compared to other countries.

The schools used within this study represent a range of multiple deprivation, included both urban and rural schools, and have a transport policy consistent with the rest of the UK. The results, therefore, have generalisable implications for increasing PA behaviour in schoolchildren. For example, children (and their parents) from less deprived areas may be more likely to choose sedentary travel options, when the distance from school is relatively far. Therefore, enhanced cycling and walking routes from affluent areas not near schools could be the target of environmental intervention. Instead of free bus provision, could supervised cycling, scooting or walking groups be an effective alternative? Finally, parents who do not value and support physical activity may be the focus of educational interventions, especially those who do not live near their child’s school. Future work exploring later maturing children and active travel should also be undertaken.

Limitations of this study

This study did not objectively measure active travel and the sample is taken from a narrow age range, therefore, the findings do not reflect younger or older children whose active travel may be influenced by different variables. Many other factors have been shown to influence active travel that we did not measure, such as weather conditions, neighbourhood characteristics and parental mode of travel to work [10, 44-47]. We chose to identify specific
moderators of the distance to school and active travel relationship, rather than maximise the amount of explained variance in the decision to actively travel to school. The IMD score is a comprehensive indicator of social deprivation; however, it is a normative ranking system used to compare areas, not a true measure of actual deprivation [48]. In addition, using the IMD to make inferences about individual participants may introduce ecological fallacy and potential circularity, whereby the deprivation score is partly based on lack of access to facilities (for example), yet this deprivation leads to a lack of access to facilities [49; 50]. Also assessing biological maturation through predicted APHV with cross-sectional data is likely less accurate than when observed in a longitudinal study [51]. Finally, we did not explicitly investigate mechanisms which may explain some of our findings, including the underlying reasons why socially-deprived and late maturing children are less influenced by distance to school. We have offered speculation on these topics, such as less inactive options available and less safety concerns, however, these should be explicitly tested.

Conclusion

The present study provides evidence that distance to school is the strongest predictor of active transport. However, the study also displayed that this relationship is complex. Late-maturing children, those from socio-economically less deprived backgrounds, and children with low family support of PA should be targeted to help increase active transport uptake, particularly when living relatively far from school. The characteristics of the sampled schools (e.g., state and privately funded, urban and rural) and participants (distance to school, ethnicity, degree of social deprivation, overweight/obese rates) suggest that our sample may reflect UK school children in general.

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References


**Figure 1.** Simple slopes graphs to show interactions between distance to school and family support of PA (A); multiple deprivation (B); and biological maturation (C).

Note: Gender was binary coded as girls = 0 and boys = 1, therefore, the regression equations reflect relationships between predictor variables and active travel in girls. However there was no statistical difference between boys and girls.

Note: The simple slopes analysis used data +/-1 standard deviation from the standardised mean scores to represent ‘nearer’ and ‘further’.

APHV = Age at Peak Height Velocity
### Table 1. Descriptive statistics of study variables and relevant child characteristics

<table>
<thead>
<tr>
<th></th>
<th>All Children</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( n = 611 )</td>
<td>( n = 334 )</td>
<td>( n = 277 )</td>
</tr>
<tr>
<td>Age (years)</td>
<td>12.35 ( \pm .29 )</td>
<td>12.35 ( \pm .29 )</td>
<td>12.36 ( \pm .30 )</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>152.12 ( \pm 7.80 )</td>
<td>152.95 ( \pm 7.83 )</td>
<td>151.13 ( \pm 7.66 )</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>45.69 ( \pm 11.07 )</td>
<td>46.87 ( \pm 11.57 )</td>
<td>44.29 ( \pm 10.30 )</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>19.63 ( \pm 3.77 )</td>
<td>19.92 ( \pm 3.97 )</td>
<td>19.28 ( \pm 3.51 )</td>
</tr>
<tr>
<td>% Overweight/Obese*</td>
<td>-</td>
<td>24.6%</td>
<td>-</td>
</tr>
<tr>
<td>Family support for physical activity</td>
<td>3.29 ( \pm .93 )</td>
<td>3.21 ( \pm .91 )</td>
<td>3.38 ( \pm .95 )</td>
</tr>
<tr>
<td>Multiple deprivation</td>
<td>5.60 ( \pm 2.71 )</td>
<td>5.88 ( \pm 2.73 )</td>
<td>5.27 ( \pm 2.67 )</td>
</tr>
<tr>
<td>Years from age at peak height velocity</td>
<td>-.53 ( \pm 1.02 )</td>
<td>-.19 ( \pm .91 )</td>
<td>-.92 ( \pm 1.00 )</td>
</tr>
<tr>
<td>Predicted age at peak height velocity (years)</td>
<td>12.87 ( \pm 1.00 )</td>
<td>12.54 ( \pm .89 )</td>
<td>13.28 ( \pm .98 )</td>
</tr>
<tr>
<td>Distance from school (km)</td>
<td>4.51 ( \pm 5.01 )</td>
<td>5.31 ( \pm 6.06 )</td>
<td>3.55 ( \pm 3.13 )</td>
</tr>
</tbody>
</table>

*Note. *Values are percentages rather than mean (SD).*
<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Age at peak height velocity</th>
<th>Multiple deprivation</th>
<th>Walking distance from home to school (km)</th>
<th>Family support of physical activity</th>
<th>Active travel vs inactive travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Age at peak height velocity</td>
<td>.37**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Multiple deprivation</td>
<td>-.12**</td>
<td>-.13**</td>
<td></td>
<td></td>
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<td>5</td>
<td>Walking distance from home to school (km)</td>
<td>-.17**</td>
<td>.07</td>
<td>.31**</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>Family support of physical activity</td>
<td>.09*</td>
<td>.03</td>
<td>.11*</td>
<td>-.02</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Active travel vs inactive travel</td>
<td>.07</td>
<td>.03</td>
<td>-.32**</td>
<td>-.47**</td>
<td>-.09*</td>
</tr>
</tbody>
</table>

Note. *p < .05, **p < .01
Table 3. Logistic regression model including main effects predicting active travel (hypothesis 1) and interaction terms (hypothesis 2 - 5)

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Hypothesis 1</th>
<th>Hypothesis 2</th>
<th>Hypothesis 3</th>
<th>Hypothesis 4</th>
<th>Hypothesis 5</th>
</tr>
</thead>
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<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
<td>OR</td>
<td>95% CI</td>
<td>OR</td>
</tr>
<tr>
<td>Constant</td>
<td>1.03</td>
<td>-.09 - .09</td>
<td>.06</td>
<td>-.06 - .06</td>
<td>.07</td>
</tr>
<tr>
<td>Gender</td>
<td>.99</td>
<td>.66 - 1.92</td>
<td>.69</td>
<td>.22 - 2.10</td>
<td>1.13</td>
</tr>
<tr>
<td>Multiple Deprivation</td>
<td>.35*</td>
<td>.90 - 1.08</td>
<td>.94</td>
<td>.73 - 1.21</td>
<td>.92</td>
</tr>
<tr>
<td>Distance (km)</td>
<td>.94</td>
<td>.29* - .43*</td>
<td>.004*</td>
<td>.001* - .02*</td>
<td>.004*</td>
</tr>
<tr>
<td>Family Support of PA</td>
<td>1.10</td>
<td>.71 - 1.24</td>
<td>.92</td>
<td>.70 - 1.20</td>
<td>.92</td>
</tr>
<tr>
<td>Age at PHV</td>
<td>4.78</td>
<td>.81 - 1.39</td>
<td>1.03</td>
<td>.80 - 1.33</td>
<td>2.05</td>
</tr>
<tr>
<td>Gender × Distance from Home to School (km)</td>
<td>2.26</td>
<td>.32 - 16.06</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Age at PHV × Distance from Home to School (km)</td>
<td>3.60*</td>
<td>1.45 - 8.96*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Family Support of PA × Distance from Home to School (km)</td>
<td>-</td>
<td>-</td>
<td>.26*</td>
<td>11 - .61*</td>
<td>-</td>
</tr>
<tr>
<td>Multiple Deprivation Index × Distance from Home to School (km)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.54*</td>
</tr>
</tbody>
</table>

Note. PA = Physical activity; PHV = Peak height velocity; OR = Odds Ratio; CI = Confidence Interval; *p < .05. Predictor variables were unstandardised in the model testing hypothesis 1, and standardised in subsequent mode.