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Is a change to active travel to school an important source of physical activity for Chinese children?

Wendy Y. Huang
Hong Kong Baptist University, wendyhuang@hkbu.edu.hk

Stephen H. Wong
The Chinese University of Hong Kong, hsswong@cuhk.edu.hk

Gang He
Capital University of Physical Education and Sports

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Running head: active travel to school and physical activity

Abstract

This study investigated the association between a change in travel mode to school and one-year changes in physical activity (PA) among children in Hong Kong. Data from 677 children aged 7–10 years (56% boys) who participated in the Understanding Children's Activity and Nutrition (UCAN) study were analyzed. During the 2010/11 and 2011/12 school years, the children wore an accelerometer for a week and their parents completed a questionnaire about the children's modes of travel to school and non-school destinations. Associations between a change in the mode of travel to school and changes in moderate-to-vigorous PA (MVPA) were determined using linear mixed models, adjusting for covariates. Compared to children who consistently used passive travel modes, a change from passive to active travel to school was positively associated with changes in the percentage of time spent in MVPA (b = 1.32, 95% CI = 0.63, 2.02) and MVPA min/day (b = 10.97, 95% CI = 5.26, 16.68) on weekdays. Similar results were found for weekly MVPA. Promoting active travel to school may help to combat age-related decline in PA for some Chinese children. However, maintaining active travel to school may not be sufficient to halt the decreasing trend in MVPA with age.

Introduction

The beneficial effects of physical activity (PA) on children's physical and mental health are well established (18). Despite this, age-related declines in PA among children and adolescents have been reported worldwide (3, 19). Low levels of PA are likely to be the result of declining activity in multiple domains including organized sports (4), free playtime (25) and active travel (37). Active travel has been shown to contribute a small, but reasonably important proportion of overall PA in youth (30). For example, cross-sectional studies found that the contribution to daily moderate-to-vigorous PA (MVPA) of a single walking journey to school was approximately 10% (equal to approximately 4.5 min) in primary school children (10) and 16% (equal to approximately 11 minutes) in secondary school children (29). More importantly, active travel to school can be easily incorporated into daily routine (26), thus encouraging active commuting could be a convenient way to increase overall PA (37).

Evidence from cross-sectional studies seems to consistently show that PA levels are higher among active commuters than passive commuters (12). However, relatively few longitudinal studies have examined the associations between change in travel mode to school and change in overall PA. Smith et al. found that grade 5 children who changed from a passive to an active mode of travel to school increased their MVPA by 9 min/day for boys and 6 min/day for girls over a year (27). During the transition from primary to secondary school, a change from a passive mode of travelling to school to walking to school led to a 16% increase in daily MVPA on weekdays (9). Only one long-term study has followed children from 9–18 years into adulthood; it found that young people who consistently used active travel self-reported more time in MVPA in adulthood, compared with those who were identified as persistent passive travelers (39). Most of the previous work has focused on older children (aged 9 or above) and adolescents, who are believed to have a greater propensity to use active modes of travel to school (31). A study among children residing in Southern California found that 20% of young children aged 5–7 years old walked to school, which is a lower proportion than that found for older children and adolescents (31).

As with their Western counterparts, Chinese youths in Hong Kong demonstrate a declining trend in PA levels (6). Their usual travel patterns to school, however, have seldom been investigated. As a typical ultra-dense metropolis, Hong Kong has unique environmental characteristics that may affect the transportation behavior of its residents. Most districts, especially the newly developed towns within the city, are highly self-contained and schooling facilities are generally provided (33). It is expected that children usually attend schools close to their home (20); for example, over 40% of primary school children live within 1 km of their school and 29% of them live within 1–2 km of their school. A short distance between home and school may facilitate an active home–school journey (13, 32). It is also possible that the home–school journey does not significantly contribute to daily PA if it is too short (24). It is not known whether the positive association between active travel to school and overall PA levels seen in previous work also exists for children residing in an ultra-dense metropolis like Hong Kong. The currently available data on travel to school in Hong Kong were collected more than 10 years ago (21). Therefore, this study investigated the association between a change in mode of travel to school and changes in PA in primary school children in Hong Kong.

Methods

Participants

Data from children who participated in Understanding Children's Activity and Nutrition (UCAN) were analyzed. Ethical approval of this study was obtained from the Research

Ethical Committee of the University. The UCAN study is a longitudinal study investigating the determinants of PA and sedentary behavior in Chinese children in Hong Kong. One hundred primary schools located in districts with low, medium and high socio-economic status were approached between June and August 2009 and 24 of them agreed to participate. Students from two randomly selected classes in grades 1 to 3 were invited to take part and parental consent was sought for 1,666 students at baseline. The parents of all of the participating children agreed to complete a questionnaire on the determinants of PA and sedentary behavior; only a subsample of parents agreed to their child wearing an accelerometer. At baseline, the accelerometer data were only collected from 448 children due to the limited number of accelerometers. At the 1-year (T1) and 2-year (T2) follow-ups, accelerometers were collected from all of the children whose parents had agreed. The details of the sampling procedure have been described elsewhere (38).

Three waves of data collection (baseline, T1 and T2) were conducted as close to the baseline time of year as practicable. Trained assessors took anthropometric measurements of the children during school visits. The children were instructed to wear an Actigraph GT3X accelerometer (ActiGraph, Pensacola, Florida, USA), which was attached to an elasticized belt worn at hip level for 8 consecutive days. Parents of each participating child were instructed to complete the questionnaire at home and to return the forms to school in one to two weeks. Starting from T1, the UCAN cohort was further investigated in the objectively assessed built environment. Each child’s residential address was mapped to a tertiary planning unit (TPU), which is the smallest census-based geographic unit (n=287 based on 2006 census data) demarcated by Planning Department of the Government of the Hong Kong Special Administrative Region (1). Such spatial units have been used to select participants who are living in various neighbourhood environments in previous studies (5, 14).

Measurement of PA

The accelerometer has been validated as an objective measure of free-living PA among children (35). Accelerometer data were recorded at 1-minute epochs. The children were told to remove the accelerometers only during swimming, showering, or sleeping. Time spent in MVPA was calculated for two periods: weekdays (school days) and the whole week. ‘Non-wear time’ was defined as at least 60 consecutive minutes of zero counts. To account for total wearing time, relative (% wearing time) values of MVPA were generated in addition to mean minutes per day. Intensities of PA were determined based on the age-specific cut-off counts (36): METs = 2.757 + ($0.0015*\text{counts}\cdot\text{min}^{-1}$) – ($0.08957*\text{age}$) – ($0.000038*\text{counts}\cdot\text{min}^{-1}*\text{age}$). MVPA was defined as ≥ 4 METs because walking, a typical moderate-intensity PA, is associated with an energy cost of this level in youth (2). These cut-points have been shown to have excellent classification accuracy of MVPA in children aged 5 to 15 years (34). The data from the first day was excluded because it was considered as a partial wearing day. To be considered valid for the weekday analysis, accelerometer data should be recorded for at least 10 hours per day for a minimum of 3 weekdays (35). To be included in the weekly analysis, valid data from three or more weekdays and at least one weekend day were required at both time points.

Mode of travel to and from school

To assess the usual travel mode, parents were asked, “How many times does your child usually walk to school in a typical week?” and “How many times does your child usually walk from school in a typical week?” Parents were also asked to record the duration of each walk trip to school. Although previous studies have included cycling when examining travel mode to school, it is not considered a feasible transport mode in Hong Kong. The questions were initially developed for grades 4-6 Chinese children to self-report their travel mode and have been found to be reliable (kappa = 0.612) (17). The children in the current study were too young, therefore, proxy-report by parents were used. The frequency of walks to and from school was totaled. Less than 5% of the parents reported that their children walked to school occasionally (1-4 times/week), with the majority of them reporting only once or twice per week. In order to reflect a more usual mode, active travel was defined as reporting walking to/from school for at least once per day, i.e. ≥5 times/week. All the other children were regarded as using "passive" modes of travel. Changes in travel mode were categorized as "consistent active travel," "change from active to passive travel," "change from passive to active travel" or "consistent passive travel."

Covariates

Body weight, in the minimum clothing possible, and standing height without shoes were measured. BMI was subsequently calculated by dividing weight (kg) by height squared (m^2). Overweight and obesity were classified according to the international standard for children using age- and gender-specific BMI cut-off points (7). The parents reported demographic information including parents' age, sex, educational attainment and the children's date of birth and sex. The parents' educational attainment was then classified into three categories: lower secondary or lower, completed secondary or matriculation, and tertiary qualification (16). The parents were asked how many times their children walked to destinations other than school on weekdays and weekends. The frequency of walking to non-school destinations was calculated by summing non-school walks on weekdays and weekends.

Statistical analyses

The analyses were restricted to the children who provided valid accelerometer data at both T1 and T2 and whose parent returned a questionnaire. Descriptive statistics (mean ± SD) were calculated to describe the average time spent in MVPA and the prevalence of active travel to school at both time points. Cross-sectional associations between travel mode to school and MVPA were determined by general linear regression models adjusting for age and gender. Linear mixed models were used to examine the association between change in mode of travel to and from school and MVPA. No interactions were found in association between change in travel mode categories and change in PA by sex. Hence, data from boys and girls were combined in the regression models. School and TPU were included as random effects in the models to account for the clustering of the outcomes. All of the models were adjusted for age, sex, child's body weight status, parental educational attainment, the values at T1, accelerometer wearing time (for absolute MVPA min/day) and frequency of walking to non-school destinations. The statistical analyses were performed using SPSS version 22.0. A *p* value of 0.05 was used.

Results

Of the 1,666 children recruited at baseline, 677 children (380 boys) consented to wear the accelerometers at both T1 and T2 and their parents returned the questionnaires (Table 1). Of these, 464 children (68.5% of those who consented) were included in weekday MVPA analyses because they provided valid accelerometer data for at least 3 weekdays. The anthropometric and sociodemographic factors of the children who did not provide valid accelerometer data did not differ from those of the children who were included in weekday MVPA analyses. Furthermore, 287 children provided valid accelerometer data for at least one weekend day and thus were included in weekly MVPA analyses. Children who provided valid data for weekly MVPA analyses had parents with higher educational attainment than those who provided incomplete accelerometer data. No differences were found in the other variables between those included in weekly analyses and those who were not. Approximately half of the children usually walked to school. On average, a single home–school journey lasted for 10 minutes.

On weekdays, children who walked to school spent an additional 4 min/day at T1 (51.3 ± 19.1 vs 47.2 ± 19.2) and 5 min/day at T2 (46.7 ± 20.3 vs 41.9 ± 19.3) in MVPA than those who used passive modes of travel. No cross-sectional associations were found between mode of travel to school and weekly MVPA. Table 2 shows the unadjusted mean MVPA at T1 and the changes over the one-year period by change in travel mode category. The majority of the children (80%) were categorized as either "consistent active travel" or "consistent passive travel." There were no differences in the weekday and weekly %MVPA or MVPA min/day across the four categories at T1. Children who changed from a passive to an active mode of travel recorded no changes in MVPA on weekdays or for the whole week, whereas children in the other categories recorded a decrease in weekly MVPA. Compared to those who consistently traveled by passive mode, a change from passive to active mode of travel was positively associated with changes in weekday MVPA (%MVPA: b = 1.32, 95% CI = 0.63, 2.02; MVPA min/day: b = 10.97, 95% CI = 5.26, 16.68) and weekly MVPA (%MVPA: b = 1.76, 95% CI = 0.20, 3.31; MVPA min/day: b = 12.91, 95% CI = 2.24, 23.57) after adjustment for the covariates including walks to non-school destinations (Table 3).

Discussion

This study examined the associations between changes in travel mode to school and changes in MVPA for primary school children in Hong Kong over a one-year period. Age-related decline in MVPA was obvious in all of the children except those who changed from a passive to an active mode of travel to school. Compared to consistent passive commuting, a change from a passive to an active mode of travel to school was positively associated with changes in MVPA. It is important to note that such associations were adjusted for walking trips to non-school destinations in addition to the potential confounders. The findings suggest that promoting active travel to school may be helpful in combating age-related decline in PA for some children. Maintaining active travel to school may not on its own be sufficient to hinder the decreasing trend in MVPA with age (27).

The cross-sectional associations of mode of travel to school with MVPA observed in this study agree with previous work showing that active travel to school is associated with higher PA levels on weekdays (9), but not for the whole week (24) or on weekends (37). However, cross-sectional investigations cannot determine whether active travel contributes to overall PA or if children who tend to be physically active are more likely to choose an active mode of travel. A longitudinal study of 9–10-year-old British children (27) showed that a change to an active mode of travel to school led to a 6-9 min increase in daily MVPA over one-year period. But it was not observed in this study; PA levels of children who changed from passive to active mode of travel remained stable, whereas daily MVPA declined for the children in the other categories. It is noteworthy that the change in MVPA duration was calculated for every 1,000 minutes of wear time in that study (27). Thus, it may not reflect the real changes in MVPA duration. Nevertheless, the current study found that a change to an active mode of travel was effective in hindering the age-related decline in MVPA that was typically seen among the children who did not change their travel mode or who changed to a passive mode over the same period. According to the results from linear mixed models, children who consistently traveled to school by passive mode (37% of the sample) would benefit from an additional 11 min/day of MVPA (23% of daily MVPA on weekdays) by changing to walking to school. This seems to be in line with the reported average walking duration for home–school journeys, i.e., a median of 10 minutes per trip, and also in line with the finding of the 2011 Transport Characteristics Report that the acceptable walking time for Hong Kong people is 10–12 minutes per trip on average (33).

More importantly, the longitudinal associations between active travel to school and overall PA observed in this study were independent of walking trips to non-school destinations. Previous studies, whether cross-sectional (22, 30) or longitudinal (9, 27), have not controlled for walking to non-school destinations when examining relationships between mode of travel to school and PA. Active travel to non-school destinations has been examined separately from active travel to school in Australian (24) and British children (28); the latter study controlled for travel mode to school. Both of these studies found that children (in particular boys) who walked and cycled to non-school destinations recorded higher MVPA minutes than children who used passive travel modes. These findings confirm the contribution of an active home–school journey to overall PA among Chinese children. Interventions to promote an active home–school journey have the potential to increase the daily PA levels of a considerable proportion of Chinese children.

Similar to the findings in 9–10-year-old British children (27), both an unchanging travel mode and a change from active to passive travel were associated with decreased MVPA. This suggests that maintaining an active home–school journey is not sufficient to negate the decline in MVPA with age. Travel patterns tend to be habitual during childhood and remain relatively stable during adolescence (11). In the current study, less than 10% of the children changed residential address over the period. Of those who moved, the majority were still living within the same community. This may explain why the majority (80%) of the children used the same mode of travel to school at T1 and T2. For those children who already walk to school, interventions targeting other opportunities for PA are needed to combat the age-related decline in MVPA.

It is noteworthy that the criteria for “active travel to school” are unique to this study. First, only walking is considered as an active mode of travel. Biking trails are only available in parts of the rural areas in Hong Kong and cycling is usually regarded as a leisure activity rather than a transportation mode. According to the local Travel Characteristics Survey, less than 1% of the primary school children in Hong Kong bike to school (20). All other modes, e.g., public transport, school bus or private car are regarded as passive. There is a concern that children who use public transport may still need to walk to bus or train stations (22). However, due to the high connectivity of the public transport network in Hong Kong, the amount of walking required for connections may be too short to be considered an active mode of travel. Second, only those children who regularly walked to or from school (5 times per week or more) were regarded as active travelers. There is a lack of consensus on valid measures of travel mode to and from school. A recent systematic review found that most of the previous studies asked about the usual mode of travel without providing a precise definition of “usual,” only 3.2% of the studies recorded the frequency of journeys and only 0.6% of them asked about the duration of commuting (15). We found that less than 5% of the children in this study reported irregular frequencies of walking to school such that they were classified as “passive travelers.” Two cross-sectional studies have examined the frequency of travel to school; both of them supported the positive association between active travel to school and overall PA among primary school children (30, 37).

Interpretations of the findings should take several limitations into account. A relatively large percentage of the sample was excluded from the data analyses due to incomplete accelerometer data; however, this percentage is similar to that reported previously (8). It is difficult to ensure compliance in wearing an accelerometer, especially on weekends, and retention strategies need to be strengthened in future research. The trips to and from school were treated equally and were summed to determine travel mode categories in this study. It is possible that the journey from school to home is associated with additional opportunities for PA other than walking. Furthermore, a longer follow-up period is needed to better understand the contribution that active travel to school makes to overall PA, especially when children transition from primary to secondary school (9). Longer distances to school and changes in the environment may affect PA after the transition. The findings presented in this study may be unique to an ultra-dense metropolis. A quarter of the children walked for only 4 minutes from home to school and 75% of the sample walked for under 15 minutes, corresponding to 300 and 1,100 meters traveled respectively (23). Thus, generalization of the findings to other regions should be undertaken with caution.

Conclusion

A change from passive to active travel to school was positively associated with one-year changes in MVPA in primary school children in Hong Kong. Promoting active travel to school may help to combat age-related decline in PA for some children. However, maintaining active travel to school may not be sufficient, on its own, to hinder the decreasing trend in MVPA with age. Other strategies for maintaining and increasing PA need to be considered for young populations residing in ultra-dense metropolis. Understanding factors that influence walking journeys to school warrants future investigation.

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Table 1 Descriptive characteristics of the children at T1

	Sample consented to wear ActiGraph at two time points (n=677)	Sample with valid weekday data[1] (n=464)	Sample with valid weekly data[2] (n=287)
Sex, n (% of boys)	380 (56.1)	251 (54.1)	157 (54.7)
Age (yrs), mean (SD)	8.7 (1.0)	8.6 (1.0)	8.6 (1.0)
BMI (kg/m^2), mean (SD)	17.7 (3.4)	17.6 (3.3)	17.4 (3.0)
Overweight or obese (%)	28.3	26.4	24.0
Parental education (%)*			
Lower secondary or less	37.5	37.7	30.7
Completed secondary	45.8	44.6	49.8
Tertiary	16.7	17.7	19.5
Travel mode to/from school (% active)	52.0	52.2	47.3
Duration (min) of each active trip, mean (SD)	10.4 (9.0)	10.9 (11.3)	11.5 (9.6)
Walk to non-school destinations (n/wk), mean (SD)	1.8 (2.4)	1.7 (2.4)	1.7 (2.4)
Weekday %MVPA (% wearing time), mean (SD)	NA	6.1 (2.5)	6.0 (2.5)
Weekday MVPA (min/d), mean (SD)	NA	49.9 (20.7)	49.9 (21.0)
Weekly %MVPA (% wearing time), mean (SD)	NA	6.7 (3.0)	6.6 (3.0)
Weekly MVPA (min/d), mean (SD)	NA	51.5 (23.3)	51.6 (23.3)

[1] Valid weekday accelerometer data: at least 10 hours/day for ≥ 3 weekdays for T1 and T2

[2] Valid weekly accelerometer data: at least 10 hours/day for ≥ 3 weekdays + ≥ 1 weekend for T1 and T2

BMI, body mass index; MVPA, moderate-to-vigorous physical activity; NA, not applicable

SD, standard deviation

*Parental education level was higher for the sample with valid weekly data

Table 2 Unadjusted mean changes in weekday and weekly MVPA

	n	%MVPA		MVPA minutes	
		T1	Change	T1	Change
Weekday					
Consistent passive	169	5.9 (2.6)	−0.7 (−1.0, −0.3)	48.3 (21.3)	−5.1 (−7.7, −2.4)
Passive to active	52	6.3 (2.4)	0.1 (−0.6, 0.7)*	51.6 (20.0)	0.7 (−4.8, 6.2)*
Active to passive	41	5.7 (2.0)	−0.3 (−0.9, 0.4)	46.5 (17.8)	−2.2 (−7.7, 3.3)
Consistent active	193	6.4 (2.5)	−0.9 (−1.2, −0.6)	51.7 (20.8)	−8.0 (−10.5, −5.4)
Weekly					
Consistent passive	119	6.5 (3.3)	−0.6 (−1.1, −0.1)	50.9 (25.0)	−4.6 (−8.4, −0.9)
Passive to active	30	7.4 (2.8)	−0.1 (−1.6, 1.5)	56.4 (21.2)	0.1 (−10.9, 10.9)
Active to passive	28	6.4 (2.3)	−1.1 (−1.8, −0.3)	48.5 (16.5)	−4.8 (−9.2, −0.4)
Consistent active	108	6.7 (3.0)	−0.5 (−0.9, −0.2)	51.6 (23.3)	−4.3 (−6.9, −1.8)

MVPA, moderate-to-vigorous physical activity
*P <0.05, compared with “persistent active”

Table 3 Associations between change in mode of travel to/from school and change in MVPA

	%MVPA		MVPA minutes	
	Coefficient	95% CI	Coefficient	95% CI
Weekday (n=464)				
Change in travel mode to/from school (reference: consistent passive)				
Passive to active	**1.32**	**0.63, 2.02**	**10.97**	**5.26, 16.68**
Active to passive	0.35	−0.40, 1.10	3.17	−3.02, 9.36
Consistent active	0.05	−0.44, 0.53	0.36	−3.72, 4.43
Age (yr)	−0.16	−0.39, 0.06	**−1.83**	**−3.66, −0.01**
Sex (reference: boys)	**−0.58**	**−1.02, −0.14**	**−3.64**	**−7.27, −0.02**
Body weight status (reference: obese)				
Non-overweight	**0.81**	**0.00, 1.61**	**6.86**	**0.27, 13.45**
Overweight	0.24	−0.69, 1.17	1.36	−6.27, 8.98
Parental education	−0.02	−0.17, 0.13	0.12	−1.14, 1.39
Walk to non-school destinations (n/wk)	0.04	−0.05, 0.13	0.41	−0.33, 1.15
Outcome variable at T1	**−0.44**	**−0.53, −0.34**	**−0.44**	**−0.53, −0.35**
Weekly (n=287)				
Change in travel mode to/from school (reference: consistent passive)				
Passive to active	**1.76**	**0.20, 3.31**	**12.91**	**2.24, 23.57**
Active to passive	−0.19	−1.79, 1.40	−0.66	−11.36, 10.05
Consistent active	0.11	−1.18, 1.40	0.46	−7.99, 8.90
Age (yr)	−0.18	−0.70, 0.34	−1.82	−5.34, 1.70
Sex (reference: boys)	−0.46	−1.50, 0.58	−4.01	−11.26, 3.25
Body weight status				
Non-overweight	**2.30**	**0.59, 4.01**	**16.28**	**4.33, 28.22**
Overweight	1.75	−0.34, 3.83	12.79	−1.82, 27.40
Parental education	0.10	−0.29, 0.48	1.35	−1.13, 3.82
Walk to non-school destinations (n/wk)	0.06	−0.54, 0.19	0.61	−0.80, 2.01
Outcome variable at T1	**−0.36**	**−0.54, −0.19**	**−0.42**	**−0.58, −0.26**

Data are presented as means (95% confidence interval). Linear mixed models with school and TPU as random effects.
MVPA, moderate-to-vigorous physical activity; TPU, tertiary planning unit.