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ORIGINAL RESEARCH

Family Car Ownership: Driving Inactivity in Young People? Cross-Sectional and Longitudinal Analyses in the International Children's Accelerometry Database

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Background: Ubiquitous car ownership may affect children's activity and health. We assessed the cross-sectional and longitudinal associations between household car ownership and children's daily time spent sedentary (SED) and in moderate to vigorous physical activity (MVPA). ***Methods:*** Pooled cohort data were from the International Children's Accelerometry Database. Outcome measures were average daily accelerometer-measured SED and MVPA (in minutes per day). Exposures were household car ownership (none, 1, and ≥2) and change in car ownership. Associations were examined using multivariable mixed-effects linear regression. ***Results:*** Mean age of participants (N = 4193) was 10.4 years (SD = 2.0), 53.4% were girls, and mean follow-up duration (N = 1333) was 3.3 years (SD = 1.1). Cross-sectionally, household car ownership was associated with higher SED (vs none: 1 car: $\beta = 14.1$ min/d, 95% CI, 6.7–21.5; ≥2 cars: 12.8, 95% CI, 5.3–20.4) and lower MVPA (vs none: 1 car: $\beta = -8.8$, 95% CI, –11.9 to –5.7; ≥2 cars: $\beta = -8.8$, 95% CI, –12.0 to –5.7). Associations were stronger in boys than girls and in children from lower socioeconomic backgrounds (SED only). Prospectively, there were no associations with increased car ownership. Reductions in household car ownership (of which 93.1% had ≥ 2 cars at baseline) were associated with a greater reduction in MVPA (vs no change: $\beta = -8.4$, 95% CI, –13.9 to –3.0) but not SED. ***Conclusions:*** Children in households with car access were more SED and less active than those without. Losing access to a second car was associated with greater decreases in MVPA, potentially related to losing access to activity-enabling environments. Reducing car access and use are important public health targets (eg, reducing air pollution), but their potential impact on children's activity opportunities should be mitigated.

Keywords: children and adolescents, active travel, climate change, epidemiology

Key Points

- Children in households with access to a car were more sedentary and less active than those without. There was no difference between access to 1 or 2+ cars.
- Losing access to a second car was associated with greater decreases in children's MVPA compared to those in households keeping the same number of cars over time. This is potentially related to losing access to activity-enabling environments.

Physical activity in young people is associated with multiple mental, social, and physical health benefits, both in the short and long term,[1] but many young people worldwide do not meet the World Health Organization guidelines for moderate to vigorous physical activity (MVPA).[2,3] Moreover, they spend large amounts of time being sedentary (SED), posing further health risks.[4,5] Ecological models suggest that physical activity is influenced by factors at the individual, interpersonal, environmental, regional/national policy, and global levels.[6] In recognition of the need to promote physical activity, physical activity programs have been evaluated that target factors at the individual, interpersonal, and organizational levels, generally with limited effects.[7–9] This has led to calls for higher level action, such as regional, state, or national policies affecting young people's activity behavior.[10,11] These affect a greater number of individuals, potentially enabling a shift in the population-level distribution of physical activity and its associated health outcomes.

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Global trends in city planning and urban design encourage car use by separating people's residences from the destinations they need to access regularly, such as shops and schools. Although the environmental and health impacts of environments conducive to car use are well documented,[12] in the past 25 years, United Kingdom (UK) car ownership increased by 40% to 32.9 million in 2023.[13] A similar increase has been observed in Australia.[14] UK and United States (US) households now have access to an average of 1.2 and 2.0 cars, respectively.[15,16] From a political perspective, it may not be desirable or feasible to target reductions in car ownership per se. Aiming to make multiple car ownership less attractive may be a more feasible policy option. Indeed, most change in car ownership occurs between single and 2-car ownership.[17] Multiple car ownership is particularly common in families: In the UK and Australia, households with 5- to 11-year-olds are most likely to own ≥ 2 cars,[14,18] and becoming a parent is associated with car acquisition.[18]

Household car ownership may impact children's activity levels. Panter et al's[19] framework for environmental determinants of active travel in youth proposes household car access as a determinant of travel mode choice and physical activity and that associations may be moderated by age, sex, and socioeconomic position (SEP). Evidence shows that children living in households with access to a car are less likely to walk or cycle to school,[20] and associations between household car ownership and accelerometer-measured time spent SED and in MVPA have been shown in adults[21] and UK[22–24] and Ugandan[25] primary school children but not in South African primary school children.[26] Previous research exploring associations with children's activity has mostly been cross-sectional, relied on self-reported activity,[27,28] and focused on car ownership per se (ie, no vs any car),[20,22,26] lacking the heterogeneity and sample size to assess differences between single and multiple car ownership and the longitudinal data to assess associations with changes in exposure.

The primary research questions addressed here, therefore, are: (1) Is number of cars in the household (none, 1, or ≥ 2 cars) associated with children's accelerometer-assessed time spent in SED and MVPA, and (2) Is change in number of cars in the household associated with change in children's time spent in SED and MVPA? Secondary research questions address whether the association differs by demographic characteristics and day of week, to what extent travel mode to school explains this association, and associations with secondary outcomes (intensity categories and adiposity, as a closely related health outcome of physical activity behavior[1]).

Methods

The International Children's Accelerometry Database (ICAD) is a large, multicountry data pooling project. ICAD pooled data from 23 pediatric studies from 10 countries across Europe, North and South America, and Australia, all of which used the waist-worn ActiGraph accelerometer (Pensacola, FL). The original set-up of ICAD and its update have been described in detail elsewhere.[29,30] This analysis used data from the second release of the database (ICAD2).

Research Ethics Approval

All studies contributing data to ICAD received ethical approval for their data collection and sharing of data and obtained written parental consent and child assent prior to data collection (further details available in study-specific publications).

Sample

Studies were included if they provided data on household car ownership on at least one measurement occasion, enabling inclusion of 5 studies from 3 countries: Australia (CLAN, HEAPS), the UK (PEACH, SPEEDY), and Brazil (Pelotas; see Supplementary Table S1 [available online] for study overview). All studies provided data for cross-sectional analyses, with only Pelotas not contributing to the longitudinal analyses. All data were collected between 2001 and 2013 and pooled in 2016–17. Participants were eligible for inclusion in the analyses described here if they provided at least one wave of valid data for household car ownership and accelerometry.

Main Exposure: Household Car Ownership

Parent-reported household car ownership was available in all studies; additional child-reported data were used in the SPEEDY study. Household car ownership was categorized into no, 1, or ≥2 cars (see Supplementary Table S2 [available online] for data harmonization procedures) based on data availability and distribution. We defined change in car ownership as "no change," "increase," and "decrease."

Outcome Assessment

Raw accelerometer files were reprocessed using specifically developed and commercially available software (KineSoft version 3.30) to create standardized outcomes. The processing protocol is freely available online (http://www.mrc-epid.cam.ac.uk/research/studies/icad/). Raw Actigraph data files were reintegrated to files with 60-second epochs to facilitate comparison across studies, and periods of at least 60 minutes of consecutive zeros (with a tolerance of 2 min of nonzero interruptions) were identified and excluded,[31] as was any time between 11 PM and 6 AM. Accelerometer-registered wear time was defined as average daily valid wear time across all valid days. Intensity thresholds corresponding to SED and MVPA were derived using previously applied cut points (≤100 counts per minute [cpm] and ≥ 2000 cpm, respectively),[32] with the MVPA threshold corresponding to a walking speed of ~3 to 4 km/h in children.[33] Average minutes per day spent SED and in MVPA were calculated by summing all minutes wherein the activity count met the criterion for that intensity, divided by the number of valid days. For secondary analyses, intensity-specific cut points for moderate physical activity (MPA, 2000–3999 cpm) and vigorous physical activity (VPA, ≥4000 cpm) were applied.[32] Participants with ≥8 hours wear time on ≥4 days (including 1 weekend day) were included in the analyses. Analyses were stratified for weekdays (including ≥3 weekdays) and weekends (including ≥1 weekend day).

Covariates

Participant sex was self- or parent reported, and age in years was preferentially calculated from date of birth and first date of accelerometer measurement. Where this was unavailable, we used age at assessment as provided by the original investigators. Measured height (in meters) and weight (in kilograms) were used to ascertain age- and sex-specific BMI z-score (2006 World Health Organization child growth standards, implemented as "zscore06" in Stata). Parent-reported maternal education was used as a proxy for family SEP (up to and including completion of compulsory education [low/medium SEP] vs any postcompulsory education or vocational training [high SEP]). Travel mode to school was predominantly child reported, except for the younger cohorts of CLAN and HEAPS in which it was parent reported. A dichotomous variable indicated use of an active (walk, cycle, scooter) or inactive (car, bus, etc) travel mode to school. Full harmonization details for all covariates are available on the ICAD website: (http://www.mrc-epid.cam.ac.uk/research/studies/icad/data-harmonisation/).

Statistical Analyses

Analyses followed a prespecified protocol and were performed using Stata (version 14.2). Descriptive statistics are presented as means (SD) or proportions for continuous and categorical/dichotomous variables, respectively. Drop-out analyses compared participants (1) included in the cross-sectional analyses with those excluded and (2) included in the longitudinal analyses versus those only included in the cross-sectional analyses. For the cross-sectional analyses, all waves of data were included, and a 3-level structure was applied (wave, child, study). Clustering at school level was not included due to the lack of information available for one study (Pelotas) and for consistency with other ICAD analyses. Complete-case mixed-effects linear regression models with random intercepts at child and study level were used to estimate the association between car ownership (categorical, using "no car" as reference) and SED/MVPA, adjusting for accelerometer wear time (model 1), sex, SEP, age, and BMI *z*-score (model 2).

The longitudinal association between change in car ownership and change in each outcome was assessed using complete-case mixed-effects linear regression models with 2 levels (child, study) and random intercepts at the study level. For each participant, data from the longest available follow-up were used. Models of accelerometer-based outcomes were adjusted for sex, SEP, baseline age, BMI *z*-score, and car ownership, and change in age and accelerometer wear time.

Secondary analyses using the same modeling approach estimated the association for SED and MVPA separately for week and weekend days and for MPA, VPA, and BMI *z*-score. For the latter, model 1 assessed unadjusted associations, whereas model 2 adjusted for sex, SEP, and age. The model with change in BMI *z*-score as the outcome was adjusted for sex, SEP, baseline age and car ownership, and change in age. A sensitivity analysis to investigate the impact of choice of accelerometer cut point was conducted for the main MVPA analyses (using ≥ 3000 cpm).

In the main cross-sectional models, effect modification by country, sex, SEP, and age (categorized as ≤ 7, 8–11, and ≥ 12 y) was investigated by including an interaction between the modifier of interest and the main exposure variable and performing a Wald test. Longitudinally, only effect modification by country was investigated. A post hoc analysis explored whether the association differed by study by testing the interaction between study and car ownership. In cross-sectional models, the extent to which any association was explained by travel mode to school (active vs inactive) was assessed by calculating the percentage change in the beta-coefficient comparing model 2 with and without travel model included as a covariate (both models fit to the same sample of individuals). This was not explored longitudinally due to limited longitudinal data on travel mode.

Results

Of 6396 participants across the 5 studies, 4193 provided sufficient data for inclusion in the cross-sectional analyses (contributing 5971 observations across the waves) and 1333 for longitudinal analyses (from 4 studies). Figure 1 presents a flowchart of studies and participants; Table 1 provides a summary of the baseline characteristics for the cross-sectional sample. Those included in the cross-sectional analyses were slightly younger and engaged in more MVPA than those excluded (Supplementary Table S3 [available online]). Those included in the longitudinal analyses were younger, had lower BMI *z*-scores, and were more likely to be from higher SEP households than those excluded.

Cross-Sectional Associations

Table 2 shows that in adjusted cross-sectional models, compared with no household car access, children in households with access to one or more cars spent more time in SED and less time in MVPA, with no dose–response relationship. These findings were similar across weekdays and weekends but more pronounced for MPA than VPA, with the latter not statistically significant. There was no evidence that car ownership was associated with BMI *z*-score. Sensitivity analysis using a higher cut point for MVPA attenuated the effect estimate but did not alter the conclusions (data not shown).

Effect modification analyses in the adjusted models (Figure 2) demonstrated significant interactions with sex for both SED and

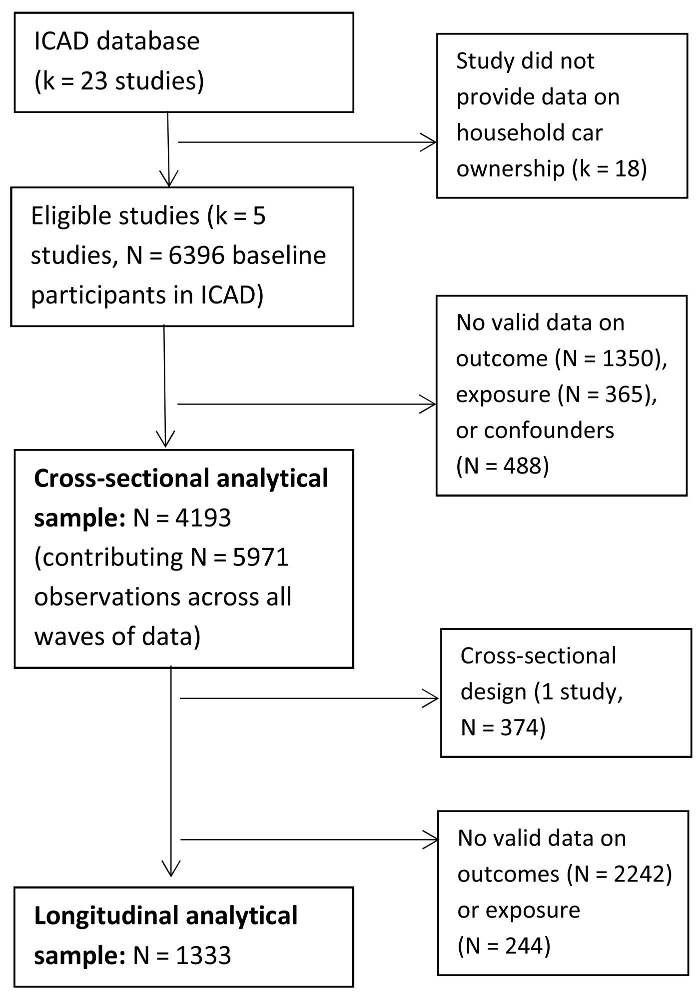

Figure 1 — Flowchart of participants. ICAD = International Children's Accelerometry Database.

MVPA (see Supplementary Table S4 [available online] for results of all interactions tests). For both outcomes, the association was stronger in boys than girls; the association with SED in girls did not reach statistical significance. In addition, there was a suggestion of a country by SED interaction, with stronger associations and a clear dose–response relationship in Brazilian children but no association in UK/Australian children. No differences were observed between the UK and Australia. A significant interaction with SEP indicated a positive association with SED in children from low/medium SEP households but no association in those from higher SEP households.

Inclusion of travel mode to school led to an attenuation of the associations with daily SED and MVPA (Supplementary Table S5 [available online]). Specifically, in 1-car households, travel mode to school attenuated the magnitude of the associations with both SED and MVPA by 14.4%. Attenuation of the association was larger for greater car ownership: 24.0% (SED) and 21.1% (MVPA). In all analyses, the main associations between car ownership and activity intensity remained statistically significant after inclusion of travel mode to school.

Table 1 Descriptive Characteristics of Participants in Cross-Sectional Analyses (N = 4193)

Variable	Mean (SD) or N (%)
Age in years	10.3 (2.0)
BMI *z* score	0.5 (1.1)
Sex (% female)	2239 (53.4%)
Maternal education (low/medium SEP)	2084 (49.7%)
Car ownership	
No car	377 (9.0%)
1 car	1246 (29.7%)
2 or more cars	2570 (61.3%)
Total daily average, min:	
SED	349.1 (104.2)
MVPA	67.3 (28.3)
Monitor wear time	766.5 (94.6)

Abbreviations: BMI *z* score, standardized body mass index; MVPA, moderate to vigorous physical activity; SED, sedentary; SEP, socioeconomic position.

Longitudinal Associations

Participants included in longitudinal analyses (N = 1333) had a baseline age of 9.8 (2.0) years, 54.5% were girls, and 58.2% came from a high SES household (Supplementary Table S3 [available online]). Mean follow-up was 3.3 (1.4) years, during which time spent in SED increased by 94.3 (83.8) minutes per day and MVPA decreased by 11.5 (27.9) minutes per day. The majority of households (73.1%) had access to ≥ 2 cars at baseline; 8.1% of households increased the numbers of cars (89.8% 1-car households at baseline), 7.7% decreased (93.1% ≥2-car households at baseline), and the remaining 84.2% reported no change. Supplementary Table S6 (available online) presents the descriptive data on change in car ownership and change in SED and MVPA by change in car ownership.

There was no evidence of associations between increased car ownership and change in SED, MVPA, or BMI *z*-score (Table 3). In contrast, a decrease in car ownership was associated with a greater decrease in MVPA but not with change in SED or BMI *z*-score. The association with change in MVPA was most pronounced at weekends and of similar magnitude for MPA and VPA. There was no difference in association by country (Wald test: SED: $P = .957$; MVPA: $P = .752$) or study (SED: $P = .593$; MVPA: $P = .791$).

Sensitivity analysis using a higher cut point for MVPA attenuated the size of the estimate but did not alter the conclusion (data not shown). Post hoc analyses stratified by baseline car ownership showed similar lack of associations for gaining a second

Table 2 Cross-Sectional Association Between Household Car Ownership and Children's Accelerometer-Measured Activity Intensity (in Minutes Per Day) and BMI *z* Score (SD Units)

	Model 1[a]		Model 2[b]	
	1 car	≥2 cars	1 car	≥2 cars
Total daily average				
SED	17.0 (8.2 to 25.7)	18.0 (9.2 to 26.8)	14.1 (6.7 to 21.5)	12.8 (5.3 to 20.4)
MVPA	−8.6 (−12.1 to −5.2)	−8.8 (−12.3 to −5.2)	−8.8 (−11.9 to −5.7)	−8.8 (−12.0 to −5.7)
Weekday average				
SED	15.3 (6.4 to 24.2)	17.2 (8.1 to 26.2)	13.5 (5.9 to 21.2)	13.0 (5.2 to 20.8)
MVPA	−8.2 (−11.8 to −4.6)	−9.5 (−13.1 to −5.9)	−8.5 (−11.8 to −5.3)	−9.8 (−13.1 to −6.5)
Weekend day average				
SED	17.7 (6.6 to 28.7)	17.1 (5.9 to 28.3)	13.5 (3.6 to 23.4)	10.5 (0.5 to 20.5)
MVPA	−9.0 (−13.9 to −4.1)	−6.6 (−11.5 to −1.6)	−8.6 (−13.3 to −4.0)	−6.0 (−10.6 to −1.3)
Total daily average				
MPA	−7.7 (−10.2 to −5.2)	−8.4 (−11.0 to −5.9)	−7.7 (−9.9 to −5.5)	−8.3 (−10.6 to −6.1)
VPA	−0.9 (−2.3 to 0.6)	−0.3 (−1.8 to 1.2)	−1.0 (−2.4 to 0.4)	−0.5 (−1.9 to 0.9)
BMI *z*-score	0.01 (−0.1 to 0.1)[c]	−0.04 (−0.2 to 0.1)[c]	0.03 (−0.1 to 0.1)[d]	−0.01 (−0.1 to 0.1)[d]

Abbreviations: BMI *z*-score, standardized body mass index; SED, sedentary; MVPA, moderate to vigorous physical activity; MPA, moderate physical activity; SEP, socioeconomic position; VPA, vigorous physical activity.

N observations = 5971. Numbers in Cells Represent Beta Coefficient and 95% Confidence Interval, Using "No Car" as Reference Category

[a]Multilevel linear regression model with random intercept adjusted for accelerometer wear time. [b]Additionally adjusted for age, sex, BMI *z*-score (except where BMI *z*-score is outcome), and maternal education (SEP). [c]For BMI *z*-score, model 1 is an unadjusted multilevel linear regression model with random intercept. [d]For BMI *z*-score, model 2 is a multilevel linear regression model with random intercept adjusted for sex, SEP, and age.

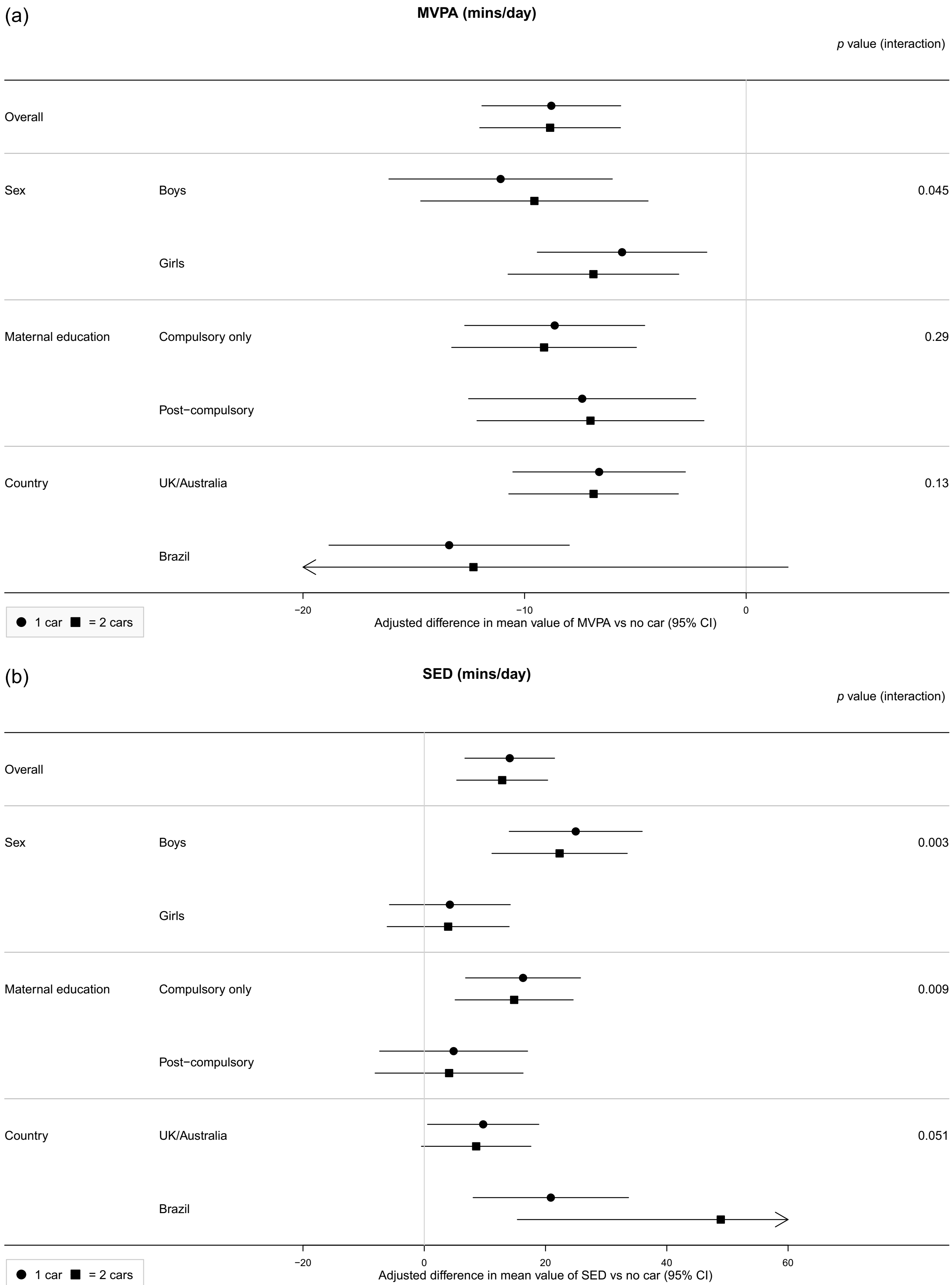

Figure 2 — Results of interaction analyses subgroup estimates for average daily MVPA (a) and SED (b). MVPA indicates moderate to vigorous physical activity; SED, sedentary.

Table 3 Longitudinal Association Between Change in Household Car Ownership (Reference Category: No Change) and Children's Accelerometer-Measured Activity Intensity (in Minutes Per Day) and BMI z-Score (SD Units). Numbers in Cells Represent Beta Coefficient and 95% Confidence Interval

	More cars at follow-up	Fewer cars at follow-up
Total daily average		
SED	2.5 (−10.6 to 15.7)	0.4 (−11.5 to 12.3)
MVPA	−3.9 (−10.0 to 2.1)	−8.4 (−13.9 to −3.0)
Weekday average		
SED	0.2 (−13.8 to 14.3)	1.9 (−10.8 to 14.6)
MVPA	−3.4 (−9.8 to 2.9)	−6.8 (−12.5 to −1.0)
Weekend day average		
SED	2.8 (−18.4 to 24.0)	−0.9 (−20.1 to 18.3)
MVPA	−3.3 (−13.9 to 7.3)	−12.3 (−21.9 to −2.8)
Total daily average		
MPA	−3.9 (−8.2 to 0.3)	−4.0 (−7.8 to −0.1)
VPA	−0.1 (−3.2 to 3.0)	−4.4 (−7.2 to −1.6)
BMI *z*-score	0.05 (−0.1 to 0.2)	−0.03 (−0.1 to 0.1)

Abbreviations: BMI *z*-score, standardized body mass index; MPA, moderate physical activity; MVPA, moderate to vigorous physical activity; SED, sedentary; SEP, socioeconomic position; VPA, vigorous physical activity.

[a]Multilevel linear regression model with random intercept adjusted for baseline data for age, sex, BMI *z*-score (except when BMI *z*-score is outcome), maternal education (SEP), and car ownership, and change in age and accelerometer wear time (except when BMI *z*-score is outcome; N observations = 1333).

car and similar, but stronger, associations for those losing access to a second car (data not shown). Too few participants lost or gained access to a car to run stratified models (N = 7 and N = 11, respectively).

Discussion

Summary of Main Findings

In this large, heterogeneous international sample of school-aged children, we confirmed that household car ownership was cross-sectionally associated with children spending more time in SED and less time in MVPA, but there was no evidence of a dose-dependent association. These associations were similar across weekdays and weekends but more pronounced for MPA than VPA and could be explained, in part, by children's travel mode to school. Associations with SED were stronger for boys, in those from lower SEP households, and in Brazilian children relative to their respective reference groups. There was no association between car ownership and BMI *z*-score. Longitudinally, against a backdrop of decreasing MVPA and increasing SED, those children living in households losing access to a second car recorded larger decreases in MVPA compared with children living in households where car access remained the same. The magnitude of this association was larger at weekends. No associations were observed between reduced car ownership and change in SED or BMI *z*-score or for increased car ownership with any outcome.

Comparison With Previous Literature

Previous systematic reviews also identified that, cross-sectionally, car access was negatively associated with physical activity in children and adolescents,[20,27,28] although this evidence predominantly relied on associations with reported activity and active travel. More recent publications have supported these findings using accelerometer-measured activity intensity[22,23] but, in contrast to our findings, also reported that MVPA decreased incrementally with increasing car access.[23] This study adds to this limited evidence by using a large heterogeneous, international sample with accelerometer-measured activity, allowing for exploration of difference in effect for subgroups and investigating associations with a range of outcomes. The observation that the positive association with time spent SED is strongest for boys and those from lower SEP backgrounds is novel and speaks to the different ways in which subgroups accumulate their physical activity, such as using active travel when access to a car is limited. This issue warrants consideration in future interventions and policy action.

Our results also corroborate the findings from a recent multi-country cross-sectional study in adults, which reported a negative association between car ownership and device-measured MVPA, although they found that the strength of the association was context dependent with larger differences in the US compared with other countries.[21] In our analysis, few country-specific associations were observed. Cross-sectionally, we observed a stronger, dose–response relationship among Brazilian participants for SED. It is important to note that the distribution of car ownership differed by study, with Brazilian participants making up 57.7% of the "no car" sample. Unfortunately, we were unable to include the Brazilian study in the longitudinal analyses due to lack of follow-up data. Car ownership is known to be context dependent and influenced by economic (eg, income), environmental (eg, home location), and social (eg, family composition) factors.[34] In the context of a high-density, lower resource setting, greater car ownership, therefore, appears to be associated with more time spent in SED independent of family-level SEP. The lack of a similar association for MVPA suggests that greater car ownership may be associated with a less incidental activity of lower intensity (eg, light physical activity) without impacting higher intensity activity (eg, MVPA). Previous research indicated that adults who reported higher levels of recreational walking and overall physical activity were more likely to travel further by car,[35] suggesting that car access can facilitate higher intensity leisure activity.

Prospectively, we found that losing access to a second car was associated with greater decreases in MVPA, particularly at the weekend, whereas acquiring a second car was not associated with changes in activity. Change in family car ownership may be due to a variety of factors, including changes in family composition, income, or home/work location, all of which may also influence children's access to places to be active. Unmeasured confounding may exist; and therefore, it is not possible to know whether the observed changes in MVPA are directly attributable to reduced car access. The findings do, however, highlight that some climate change mitigation strategies, such as discouraging multiple car ownership, may inadvertently be negatively associated with children's physical activity, particularly during leisure time. Complementary actions that facilitate access to leisure activities via public transport or active travel may be needed. This work also highlights the complex interplay between social, economic, and environmental factors impacting car ownership, car use, and children's activity levels. Further quantitative analyses into changes in ownership and use of car in the context of families as well as qualitative investigations of the (implicit) value of family car ownership and use may help shed light on this.

Emerging literature highlights not only the potential of increases in physical activity to contribute positively to climate change[36] but also how the changing climate may impact participation in physical activity[37] and how physical activity participation and promotion may increase carbon emissions (eg, through motorized transport to activity venues, heating or cooling of sports venues) and have other detrimental effects on planetary health.[37–39] The findings presented here suggest that children may be particularly dependent on motorized transport to access places offering opportunities for higher intensity physical activity during leisure time, which has also been observed in South African children.[26] This may be because of decentralized locations of youth sport opportunities, observed globally,[40] which leads to greater dependency on (safe) motorized travel for participation. For example, Bunds et al[40] showed that US families with a child in a regionally competitive youth swim team would drive, on average, 2222 miles (3500 km) annually to attend training and competitions. In addition, a study in Norwegian adolescent soccer players highlighted that despite most players living within cycling distance (<3 km), the majority reported being driven to practice.[41] This phenomenon is referred to as the "insularization of children's individual life spaces": the ferrying of children from home to school to leisure activities.[42] This has consequences not only for planetary health but also for inequalities in physical activity participation as low-income families may not have the resources required to facilitate access. Future research should further develop theories to guide research into the complex relationship between household car access and physical activity, including consideration of car use patterns, access to alternative modes of transport, and urban design features. Research should also consider the role of organized sports for both young people's physical activity and planetary health and identifying ways to improve all children's access to leisure-time activities.

Strengths and Limitations of this Study

This study is the largest analysis to date of the association between car ownership and children's device-measured activity intensity and anthropometry outcomes as well as the first to assess this association prospectively. The pooling and harmonization of data in ICAD ensure comparability of data across different studies and contexts. We observed substantial heterogeneity in car ownership, and change in car ownership, which often is lacking in single-study analyses. We adjusted the models for relevant confounders and explored interactions by key characteristics. As processing decisions may affect accelerometer-based variables, we used preestablished and frequently applied processing methods and a frequently used accelerometer cut point to define MVPA. Sensitivity analyses using a different cut point demonstrated limited impact on the main conclusions drawn.

We were unable to account for car use and car dependency or (changes in) family or economic circumstances that may impact car ownership and use. In addition, data were collected between 2001 and 2013. Although this may impact on the *prevalence* of exposures and outcomes, it is unclear whether this would impact the *associations* between them. We acknowledge that travel and activity habits were significantly affected by the policy response to the COVID-19 pandemic and that contemporary research is required to confirm the generalizability of these findings to the postpandemic context. The samples included are not nationally representative, although they are largely representative of the population from which they were drawn. Although there was sufficient heterogeneity in exposures and outcomes to run the longitudinal analyses, the sample size was substantially reduced compared with the cross-sectional sample due to nonresponse and missing data. Some differences were observed between those included and excluded from the longitudinal analyses, affecting the generalizability of these findings. Future research should study these associations in other large heterogeneous samples.

Implications

Reducing car access and use are important policy targets to achieve improvements in air pollution and congestion and related population health indicators. Targeting multiple car ownership may be politically more attractive than targeting car ownership per se, but our findings suggest that such policies may have mixed impacts on children's activity. The cross-sectional results from these analyses suggest that children living in households with access to either one or multiple cars have similar levels of activity and adiposity and that potentially making multiple car ownership less attractive would have limited impact. However, the longitudinal results suggest that losing access to multiple cars may have negative implications for children's activity levels, particularly at weekends, which implicates car ownership as an enabler of activity outside of school for some children. It is unclear how these changes are related to concurrent changes in economic or family circumstances or reduced access to activity opportunities. It does, however, suggest that the effect of interventions on out-of-school activity[9] might depend on car access and that facilitating activity as part of daily life is critical to countering this impact. Our finding that travel mode to school partly explained the associations observed, combined with previous evidence suggesting that switching to more active modes does not necessarily lead to compensatory decreases in activity,[43] indicates that active travel could serve this purpose. Our results suggest that the development of urban and transport planning strategies that promote public transport and active travel and reduce car dependency, such as carpooling and future-proofing new developments, should be prioritized and include consideration of locations of young people's activity. Future policy decisions on reductions in car ownership and use should consider ways of negating the potential negative impact on children's activity opportunities.

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Nonidentifiable data can be made available to bona fide researchers on submission of a reasonable request, following standard ICAD data request procedures (see for information: http://www.mrc-epid.cam.ac.uk/research/studies/icad/). The principles and processes for accessing and sharing data are outlined in the MRC Epidemiology Unit Data Access and Data Sharing Policy.

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