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Title: Activity Levels, Dietary Energy Intake, and Body Composition in Children Who Walk to School
Year of publication: 2007
Citation: Ford, P. et al. (2007) 'Activity Levels, Dietary Energy Intake, and Body Composition in Children Who Walk to School' Pediatric Exercise Science, 19 (4) 393-407
Link to published version: http://journals.humankinetics.com/pes-back-issues/PESVolume19Issue4November/ActivityLevelsDietaryEnergyIntakeandBodyCompositioninChildrenWhoWalktoSchool

Pediatric Exercise Science, 2007, 19, 393-407

Activity Levels, Dietary Energy Intake, and Body Composition in Children Who Walk to School

Paul Ford, Richard Bailey, Damian Coleman, Kate Woolf-May, and Ian Swaine

Although differences in daily activity levels have been assessed in cross-sectional walk-to-school studies, no one has assessed differences in body composition and dietary energy intake at the same time. In this study of 239 primary school children, there were no significant differences in daily activity levels, body composition, or estimated dietary energy intake between those who walk to school (WALK) and those who travel by car (CAR; $p < .05$). WALK children were more active between 8 a.m. and 9 a.m. and 3 p.m. and 4 p.m. than CAR children ($p < .05$). In addition, there were no significant differences in the main analysis when participants were subgrouped by gender and age.

A prominent United Kingdom survey has suggested that 30% of boys and 31% of girls (2–15 years old) are overweight, and 16% of boys and girls are obese (49). Cross-sectional literature proposes that those children who are more physically active have a lower incidence of obesity than those who are less active (4,5,10,22). Current U.K. recommendations are that children and adolescents take part in at least 60 min of moderate to vigorous physical activity (MVPA) most days of the week to bring positive health outcomes (11). Unfortunately, it has been identified that 20% of boys and 30% of girls do less than 30 min of MVPA each day (49).

Physical activity during childhood is naturally sporadic, and accumulated bouts throughout the day (such as walking to school) are more likely to allow children to meet recommended activity levels than adult-type blocks of sustained activity (53,54). It has been suggested that there has been a reduction in childhood physical activity levels and that this reduction is related, to some degree, to the decrease in active traveling and physical education time allocated at school (5,10,48,53). Initiatives such as "walk-to-school bus schemes" have been introduced to emphasize the importance of physical activity and to encourage children to be more active from a young age, which might lead to future positive health outcomes (5,24,45,54). There is a lack of supporting evidence, however, as to whether such schemes are of any significant benefit (9,10,13,25). Until such research is conducted, perhaps it can be questioned as to why these schemes are so strongly promoted when the

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intensity and duration of the activity might be insufficient to elicit positive health adaptations (48).

There are a number of cross-sectional studies that have suggested that walking to school is associated with increased daily activity levels (2,8,9,39,47), but these studies have not assessed whether walking to school is associated with adaptations in health, such as body composition. Numerous studies and literature reviews have identified a negative relationship between body composition and level of physical activity (1,50) and that physical activity interventions alone might reduce body fat levels in obese children and adolescents (25,26,31,36,56). Because of the often short duration and low intensity for the period of walking to school, with many children “strolling” short distances, it might be hypothesized that this form of physical activity might not be related to alterations in body composition (38,48). Similarly, the supporting literature is based on changes in obese children and adolescents, who might find it easier to elicit changes in body fatness as a result of their preintervention excess amounts of adipose tissue compared with leaner individuals. Previous work has suggested that such activity needs to be performed consistently for longer than 10 min at moderate intensity to elicit health benefits in adults (41,59), which might not occur during the walk because of traffic junctions. Furthermore, although it might be observed that some children have an increased level of daily activity and reduced body fatness related to the walk to school, both these variables can easily be affected by covariates such as gender and age, which should be taken into account.

In addition, among adults there is evidence to suggest that when people increase their energy expenditure through physical activity, there are alterations in daily energy intake (26,44), which will affect energy balance (23). Based on this, when trying to identify if the energetic cost of walking to and from school is associated with body composition adaptations (3,25,26), there is a need to identify if walkers have not altered their habitual dietary energy intake. Such alterations in dietary energy intake are unlikely to occur because of the short duration of walking to and from school. Nevertheless, it is important to measure this variable in order to help assess the relationship between activity and body composition variables, which to the present authors’ knowledge has not been performed previously.

The purpose of this study was to compare daily activity levels, estimated dietary energy intake, and body composition in primary school children who walk to and from school with those who travel by car.

Methods

Sample Selection

Fifteen primary schools (located in southeastern England) were contacted regarding their involvement in this study. Two schools agreed to take part. On average, 48% of the children walked to and from school. In total, 438 pupils ages 5–11 years old were informed of this study using a school assembly and a participant/parent information sheet. Attached to the document were the respective assent and consent forms (28). The institutions ethics committee approved all documentation and methods for this study. The children were allocated to one of two groups: children who habitually travel to and from school by car (CAR) or children who habitually walk to and from school for periods > 10 min, more than three times a week, for a period > 15 weeks (WALK). Individuals who did not meet these criteria were excluded from this study. After reviewing information, 166 pupils did not return completed informed consent, and a further 33 did not meet activity group allocations based on a description of their habitual mode of travel to and from school provided by the participants' parents. Therefore, 239 participants were invited to take part in this study (Table 1). Participants were subgrouped by gender and age, with participants being grouped as an infant (ages 5–7 years old, reception to Year 2) or junior age pupil (ages 7–11 years old; Year 3 to Year 6).

Physical Activity

Daily activity levels were objectively measured using accelerometers (Manufacturing Technologies Inc, Shalimar, FL). The MTI accelerometer model 7164 was previously known as the CSA accelerometer (43). The MTI accelerometer is a uniaxial motion sensor, which is designed to detect accelerations ranging in magnitude from 0.05 to 2.00 G. These parameters mean that most human movement is detected in the vertical plane, and high frequency motions, such as vibrations from powered children's toys, are discounted. The filtered signal is digitized into counts, and the magnitudes of these counts are summed using defined epoch (time) intervals (52). Previous research has reported that the device provides a valid measure of physical activity with children, using the doubly labeled water method as the criterion (14,15), as well as reproducible results, with a coefficient of variance of 4–5% and an intraclass correlation > 0.8. A 60-s epoch setting was used for our study because it allows for long-term measurements and valid assessments of childhood activity, unlike hour-by-hour recordings (35,43,55).

Eleven accelerometers were used for this study. After distribution, participants were directed to wear the monitors from 7 a.m. to 9 p.m. each day. The monitors were worn on elastic belts around the waist, with the monitor being placed on the right hip (19,29,43,46). Participants were informed that they should remove the monitor only when bathing, swimming, or going to bed. To get a valid and reliable representation of mean daily activity, participants were asked to wear the monitor for five consecutive days (Wednesday–Sunday) (52). The monitor was worn both on weekdays and weekends, because previous studies had suggested that activity levels vary significantly during these two periods (52). To get a good representation of activity levels from these two different periods, data was excluded from our study if there was <12 hr and <10 hr of monitoring during weekdays and weekend days, respectively, and if activity was not monitored between 8 a.m. and 9 a.m. and 3 p.m. and 4 p.m. during school days, matching protocols used previously (9). The rationale behind the longer monitoring duration during weekdays relates to the differences between these two periods based on previous validation investigations (52). If there were any excluded days during the present study, the participant's activity was remonitored on a separate occasion.

Dietary Energy Intake

Dietary energy intake was estimated by using a 3-Day Dietary Recall Sheet. Participants were given a sheet to complete with their parents at the end of each

Table 1 Descriptive Data for Participants, *M* (*SD*)

	All Data		Boys		Girls		Infants		Juniors	
Participants	**WALK**	**CAR**	**WALK**	**CAR**	**WALK**	**CAR**	**WALK**	**CAR**	**WALK**	**CAR**
Sample size	108	131	59	66	49	65	31	63	77	68
Age (years)	8.3 (1.9)	7.9 (2.0)	8.3 (2.1)	7.8 (2.2)	8.2 (1.7)	7.9 (1.8)	5.7 (0.8)	6.1 (0.8)	9.2 (1.8)	9.5 (1.2)
Body mass (kg)	30.1 (8.1)	30.0 (9.0)	30.1 (7.9)	29.8 (8.9)	30.0 (8.5)	30.0 (9.2)	22.0 (4.3)	24.3 (5.2)	33.2 (7.1)	35.1 (8.7)
Body height (m)	1.33 (0.1)	1.31 (0.1)	1.33 (0.1)	1.31 (0.1)	1.32 (0.1)	1.31 (0.1)	1.18 (0.1)	1.21 (0.1)	1.38 (0.1)	1.4 (0.1)
Body mass index	20.1 (4.6)	19.3 (4.7)	20.1 (4.4)	19.6 (5.0)	20.2 (4.9)	19.0 (4.5)	17.5 (2.7)	18.0 (2.9)	21.2 (4.8)	20.5 (5.7)

day for 3 consecutive days. They were asked to note all food and drink they had consumed throughout each day. Consumption periods were classified as breakfast, lunch, dinner, and snacks. Calorific intake was then calculated using DietMaster Pro Version 6 Software (Lifestyles Technologies Inc, Valencia, CA). Once all 3 days were calculated, the mean habitual daily values (kcals) were recorded for each participant. In terms of the validity and reliability of this technique, Johnson et al. (30) concluded that repeated 24-hr dietary recalls provided reasonable accuracy in estimating dietary energy intake using the doubly labeled water method. Similarly, Livingstone et al. (32) demonstrated the accuracy of the assessment with the double-labeled water method with 78 children ages 3–18 years old.

Body Composition

Body composition was measured by air displacement plethysmography, using the BodPod Self-Test (ST) device (Life Measurements Inc, Concord, CA) on a single testing occasion. The BodPod provides raw body volume (BV; liters) (12). Because raw BV measurement is adversely influenced by lung volume and adiabatic conditions created by the participant's presence, however, the actual BV is corrected for thoracic gas volume (TGV; liters) and body surface area. Actual BV is calculated according to Dewit et al. (12). TGV predictions were calculated using age-specific algorithms (18). Percentage body fat was calculated using the Lohman equation (33), which uses age- and gender-specific values. Participants were asked to wear minimal clothing (swimming costume) in the device and were instructed to wear a swim hat and remove all jewelry. Body mass was measured to the nearest 0.1kg. Three 20-s repeated measurements were made and the mean of these was calculated and used as the percentage body fat measure. The BodPod is the best and most cost-effective alternative to assessing body composition for children when a 4-component model cannot be used (12,16,17,21,22,37,42). Although the BodPod S/T does not directly measure lung volume (12), it has been shown that this only introduces a small bias when appropriate child prediction equations are used (18,40) and overcomes the errors encountered when children perform a lung function assessment (17). In terms of its validation, Gately et al. (21) compared percentage body fat levels from the BodPod with the criterion 4-C model in obese children and identified a significant correlation ($r^2 = .95$) and moderate limits of agreement (±3.6%) between the two methods. Likewise for reliability, Claros et al. (7) reported a 1.7% intraday CV and 3.1% interday CV for a group of children.

Data Analysis

All the descriptive results for this study were presented as mean ± one standard deviation. Data were analyzed (all participants, males and females, and infants and juniors) using SPSS Version 13.0 (SPSS Inc, Chicago, IL). Parametric analyses involved the Kolmogorov-Smirnov Test, with Lilliefors Significance Correction. If data were nonparametric, they were converted into their natural logarithm value to observe whether this changed their distribution. If they remained nonparametric using the same parametric analysis procedures, however, they were analyzed in their original format. Following this, differences between the groups (and subgroups) for all daily activity level and body composition variables were measured using a Mann-Whitney U Test, because of the data being nonparametric even after log transformation. Alternatively, differences between the groups (and subgroups) for estimated dietary energy intake were calculated using an independent *t* test (with Levene's Test), because the data were parametric. Although statistical significance was accepted as $p < .05$, Bonferroni adjustments were made based on the multiple statistical testing.

Results

All mean results for the variables measured during this study can be seen in Table 2. As expected, statistically significant findings were observed between WALK and CAR (983.2 activity counts/min and 762.7 activity counts/min, $p < .05$) during the time periods for the journeys to and from school (8–9 a.m. and 3–4 p.m.). For no other time period analyzed (overall weekday and weekend [7 a.m.–9 p.m.], school time [9 a.m.–3 p.m.], and outside school hours [< 8 a.m. and > 4 p.m.]), however, did the comparisons between WALK and CAR reach statistical significance ($p < .05$). In addition, there were no statistical significant differences in estimated dietary energy intake (kcal) or body composition variables (% body fat and fat mass [kg]) between WALK and CAR ($p < .05$).

All mean results for the variables measured during this study, subdivided for male and female and infant and junior participants, can be seen in Tables 3 and 4, respectively. It was observed that there was a statistical significant difference in activity levels during the journeys to and from school between WALK and CAR in both males and females (1,034.7 activity counts/min and 780.6 activity counts/min, and 919.7 activity counts/min and 744.1 activity counts/min, respectively, $p < .05$). Likewise, it was observed that there was a statistical significant difference in activity levels during the journeys to and from school between WALK and CAR in both infants and juniors (972.6 activity counts/min and 755.7 activity counts/min, and 986.2 activity counts/min and 769.0 activity counts/min, respectively, $p < .05$). There were no other additional time period classifications, however, in which a statistically significant difference was observed in either gender or age grouping after Bonferroni adjustments. Similarly, there was no statistical significant difference in estimated dietary energy intake or body composition variables between WALK and CAR in either gender or age grouping after Bonferroni adjustments.

Discussion

This study measured differences in primary school children who walk to and from school compared with those who travel by car. Although there were differences in activity levels for the journey to and from school, there were no significant differences in total daily activity levels, estimated dietary energy intake, and body composition between the two groups. In addition, the present study's findings also suggest that there were no additional differences between the groups when participants were subgrouped by gender and age. The results of this study are limited by lack of causality, however, because of the cross-sectional design.

Participants who walk to and from school were more active between 8 a.m. and 9 a.m. and 3 p.m. and 4 p.m., but this does not affect their total daily activity levels.

Table 2 **Daily Activity Levels, Estimated Dietary Energy Intake, and Body Composition in Children Who Walk to School (WALK) and Who Are Transported by Car (CAR), *M* ± *SD***

		95% CI			95% CI		
	WALK group	**Lower**	**Upper**	**CAR group**	**Lower**	**Upper**	***p* value**
Weekday (activity counts/min)	607.2 ± 169.7	572.8	641.6	604.8 ± 169.9	574.6	635.0	.929
Weekend (activity counts/min)	673.0 ± 379.8	596.0	750.0	580.6 ± 288.1	529.4	631.8	.115
In school (activity counts/min)	569.7 ± 156.0	538.1	601.3	624.8 ± 196.1	589.9	659.6	.62
Out school (activity counts/min)	514.3 ± 242.2	465.3	563.4	533.5 ± 242.6	490.4	576.7	.492
To and from school (activity counts/min)	983.2 ± 303.4*	921.7*	1,044.7*	762.7 ± 190.8*	728.7*	796.6*	.000*
Estimated dietary energy intake (kcal)	1,649.8 ± 395.4	1,572.1	1,727.5	1,705.2 ± 428.2	1,628.4	1,781.9	.319
% body fat	16.4 ± 7.2	14.9	17.9	16.2 ± 8.2	14.6	17.7	.753
Fat mass (kg)	5.4 ± 3.5	4.7	6.1	5.4 ± 3.5	4.7	6.2	.803

Note. 95% CI = 95% confidence interval.

*$p < .05$.

Table 3 Daily Activity Levels, Estimated Dietary Energy Intake, and Body Composition in Male and Female Children Who Walk to School (WALK) and Who Are Transported by Car (CAR), *M* ± *SD*

			95% CI			95% CI		
		WALK group	**Lower**	**Upper**	**CAR group**	**Lower**	**Upper**	***p* value**
Weekday	male	642.4 ± 192.5	589.3	695.4	631.8 ± 171.1	588.7	674.9	.888
(activity counts/min)	female	563.9 ± 125.8	525.2	602.6	620.6 ± 404.1	534.5	619.1	.982
Weekend	male	715.3 ± 357.0	616.9	813.7	631.5 ± 330.4	548.3	714.7	.174
(activity counts/min)	female	620.6 ± 404.2	496.3	745.0	528.0 ± 227.6	469.8	586.3	.719
In school	male	596.0 ± 162.3	551.2	640.7	685.2 ± 222.1	629.3	741.1	.036
(activity counts/min)	female	537.3 ± 143.2	493.3	581.4	562.4 ± 141.7	526.1	598.7	.368
Out school	male	558.2 ± 272.7	483.0	633.3	531.5 ± 227.3	474.3	588.8	.807
(activity counts/min)	female	460.3 ± 187.8	402.6	518.1	535.6 ± 259.3	469.2	602.1	.256
To and from school	male	1,034.7 ± 337.6*	941.7*	1,127.8*	780.6 ± 202.2*	729.7*	831.5*	.000*
(activity counts/min)	female	9,19.7 ± 244.4*	844.5*	994.9*	744.1 ± 178.0*	698.6*	789.7*	.000*
Estimated dietary	male	1,648.9 ± 404.9	1,539.5	1,758.4	1,633.6 ± 373.0	1,538.9	1,728.3	.831
energy intake (kcal)	female	1,650.8 ± 388	1,536.8	1,764.8	1,779.2 ± 470.3	1,657.7	1,900.7	.134
% body fat	male	13.9 ± 5.5	12.3	15.5	15.1 ± 7.6	12.9	17.3	.644
	female	19.2 ± 7.8	16.8	21.6	6.4 ± 4.2	14.9	19.4	.250
Fat mass (kg)	male	4.5 ± 2.4	3.8	5.2	5.0 ± 3.6	3.9	6.0	.796
	female	17.2 ± 8.6	5.1	7.7	5.8 ± 4.1	4.8	6.9	.456

Note. 95% CI = 95% confidence interval.

*$p < .05$.

Table 4 **Daily Activity Levels, Estimated Dietary Energy Intake, and Body Composition in Infant and Junior Pupils Who Walk to School (WALK) and Who Are Transported by Car (CAR) *M* ± *SD***

			95% CI			95% CI		
		WALK group	**Lower**	**Upper**	**CAR group**	**Lower**	**Upper**	***p* value**
Weekday (activity counts/min)	infants	578.4 ± 147.6	511.2	645.6	570.8 ± 171.9	526.0	615.6	.487
	juniors	615.3 ± 175.5	574.9	655.7	635.6 ± 163.3	595.1	676.0	.298
Weekend (activity counts/min)	infants	645.6 ± 314.6	502.4	788.8	519.8 ± 241.4	456.9	582.7	.061
	juniors	680.6 ± 397.6	589.1	772.1	635.8 ± 316.5	557.4	714.2	.849
In school (activity counts/min)	infants	569.6 ± 152.0	500.4	638.8	614.2 ± 203.1	561.3	667.1	.634
	juniors	569.7 ± 158.1	533.4	606.1	634.4 ± 190.6	587.1	681.6	.042
Out school (activity counts/min)	infants	455.6 ± 227.6	352.0	559.2	468.4 ± 219.9	411.1	525.8	.626
	juniors	530.8 ± 245.1	474.4	587.2	592.6 ± 248.7	531.0	654.3	.144
To and from school (activity counts/min)	infants	972.6 ± 263.9*	852.5*	1,092.7*	755.7 ± 197.7*	704.1*	807.2*	.000*
	juniors	986.2 ± 315.2*	913.6*	1,058.7*	769.0 ± 185.6*	723.0*	815.0*	.000*
Estimated dietary energy intake (kcal)	infants	1,551.7 ± 457.1	1,377.9	1,725.6	1,666.0 ± 425.4	1,555.2	1,776.9	.196
	juniors	1,688.8 ± 364.1	1,603.8	1,773.7	1,741.9 ± 430.9	1,633.3	1,850.4	.523
% body fat	infants	13.3 ± 4.8	10.8	15.7	14.0 ± 8.1	11.6	16.4	.774
	juniors	17.1 ± 7.5	15.4	16.9	17.8 ± 7.9	15.8	19.8	.541
Fat mass (kg)	infants	3.2 ± 1.9	2.2	4.2	3.8 ± 2.9	2.9	4.7	.325
	juniors	5.9 ± 3.5	5.1	6.7	6.7 ± 4.1	5.6	7.7	.226

Note. 95% CI = 95% confidence interval.

*$p < .05$.

Similarly, there are no other differences in the other time period classifications during weekdays or on the weekend. Metcalf et al. (38) saw similar results, which can potentially be attributed to both studies using the same device to measure activity and same time period classifications. Metcalf et al. (38) concluded that the period of walking to and from school only accounted for 2% of total weekly activity levels for their participants and suggested that this therefore has a relatively minor impact on total activity levels. These results contradict Alexander et al. (2), Cooper et al. (8), Cooper et al. (9), Michaud-Tomson et al. (39), and Sirard et al. (47), who suggest overall daily activity levels are increased by walking to school. Michaud-Tomson et al. (39) used pedometers and questionnaires to track physical activity levels, which might explain the difference in results. Freedson et al. (20), Goran (22), and Ward et al. (55) have all suggested that accelerometers are a more accurate and reliable tool for measuring activity than either pedometers or questionnaires. Alexander et al. (2), Cooper et al. (8), Cooper et al. (9), and Sirard et al. (47) all used accelerometers to assess activity. The difference in results in those studies compared with this study, however, can potentially be attributed to the different methods used; these previous studies mainly focused on specific age ranges and have adopted different protocols for activity assessment in terms of monitoring periods and accelerometer data handling, which affect cross-study comparisons of results.

A major problem with the use of accelerometers to measure physical activity is that there are no standardized methods for data-collection procedures (20). In addition, there is debate as to what data-processing technique to use with missing data, when the participants have not met the monitoring criteria. Ward et al. (55) discuss the implications of data inclusion, removal, and imputation and highlight that selection bias will likely lead to inaccurate representation of results. There is also discussion on how to "clean" spurious data, created through brief accelerometer malfunctions or possible participant tampering, because this can affect the accuracy of results (55). There is also a lack of agreement on how to report activity: total counts, average counts, or minutes of moderate to vigorous physical activity (MVPA). With the latter, investigator subjective opinion in selecting which threshold value to use and how to account for activity interruption will potentially affect the comparisons of results between studies, because they are based on different assumptions (35), which is a limitation of the study by Cooper et al. (8). Recently, Freedson et al. (20), Mâsse et al. (35), and Trost et al. (51) have attempted to resolve such problems by creating consensus guidelines, but this does not aid in the interpretation of prior work. For these reasons, it is difficult to compare our results with those of previous studies.

Although walking to school might be too short to bring other benefits (48), it is plausible that the activity could be associated with body composition changes, because fat metabolism is independent of exercise intensity (34,58). It was identified in the present study, however, that there was no difference in body composition between the groups. Although cause and effect can not be attributed as a result of the study design, the nonsignificant difference can perhaps be attributed to the lack of impact that walking to school has on total daily activity levels, as illustrated in the introduction. Furthermore, the association between adiposity reductions through increased activity levels in a pediatric population is largely supported in previous literature by studies using participants who have excess adipose tissue at the start of the program. The findings in the present study corroborates with Metcalf et al. (38) who measured skinfold thickness in children who walked to school. Metcalf et al. (38) used limited detail of this aspect of their study in their report, however, and it has been suggested that estimation of fatness from subcutaneous skinfold thickness is less accurate than more recent techniques such as the BodPod (22). Heelan et al. (27) reported that body mass index (BMI) was not significantly reduced when walking to school. It is not possible to compare their BMI differences with the lack of difference in our body fatness measures, however (57).

As mentioned in the introduction, dietary energy intake was estimated because of its relation with energy balance and body composition (23). Adult research has suggested that increased activity can be associated with an altered appetite and energy intake (26), so it was important to take this into account when trying to identify if walking to and from school was related to body composition. Although causality cannot be attributed, this study suggests that walking to and from school was not associated with a changed mean daily total dietary energy intake, which was expected because of its short duration and low intensity. The measurement of children's dietary energy intake remains very challenging and is potentially a limitation to the present investigation. The accuracy of some methods used with children is often confounded because of the reliance on others to recollect the child's dietary energy intake. Similarly, as with any subjective self-report questionnaire, there is always reduced accuracy as a result of the possibility of bias, level of nutrition knowledge, and motivation (6,22). The inability to correctly appraise serving sizes, the perceived value of the food items to be recalled, and the fact that children tend to better remember preferred foods as larger portions further decreases validity (22). Such lack of accuracy and reproducibility might potentially lead to a type II error; however, by using a 3-day recall rather than a "one-off" assessment, literature suggests that it enhances the accuracy of the measurement and reduces the chance of incurring an error (30).

The present study showed no additional differences in daily activity levels in males and females or infant and junior participants between WALK and their CAR contemporaries than were shown when the group was analyzed as a whole. This finding is supported by Metcalf et al. (38), who reported no differences according to gender between the two groups in their study. At the same time, this finding contradicts Cooper et al. (9), who identified a gender difference, suggesting that males (not females) who walk to and from school were more significantly active after school hours ($p < .05$). A limitation of their study, however, was that the after-school period included the journey home from school, which could have potentially affected the result.

A limitation of the present study, apart from the aforementioned lack of causality, is that the impact of any gender or age influences on the results might have been better shown with the use of a multiple analysis of covariance (MANCOVA), rather than the multiple separate Mann Whitney U tests and *t* tests. It was not possible to do such a test, however, because much of the data was nonparametric in both normal and log-transformed states. Performing the MANCOVA would have incurred several errors because of the incorrect assumptions that the parametric test would have taken into account for the present study's data.

In addition to this, it should be acknowledged that a type II error might have occurred because most of the findings in the present study were negative, especially because accelerometer and dietary intake values might have a large variance, and body composition was only assessed on a single occasion. Although it is accepted that the method for dietary energy intake is not a criterion measure, throughout this article it is classed as an estimated measure. Furthermore, previous authors such as those highlighted in the Methods section support the protocols and procedures used in the present study, concluding that they give valid, reproducible results for activity levels, dietary intake, and body composition. For example, several authors have emphasized that using a 60-s epoch setting for measurements rather than hour-by-hour recordings will help reduce variances in the data, because the larger recording epochs do not provide sufficient resolution (35,43,55). Likewise, during a single body composition assessment using the BodPod S/T, there are three repeated measures, meaning that variability of a single measure is accounted for. Moreover, the large sample size in the present study accounts for such variances occurring in the data, which therefore reduces the chance of any type II errors occurring. In addition to this, the chance of a type I error has been accounted for by using the Bonferroni adjustments based on the multiple statistical tests as previously discussed. If it were not for this adjustment, some variables in the subgroup analysis would have been significantly different ($p < .05$; see Tables 3 and 4), which would have potentially been erroneous.

Conclusion

This is the first study to combine measures of daily activity levels, estimated dietary energy intake, and body composition in primary school children who walk to and from school and those who travel by car. Although walking increased activity levels going to and from school, according to our study, whether primary school children walk to and from school or travel by car seems to have little influence on total daily activity levels, body fatness, and estimated dietary energy intake. It would not be valid, however, to conclude that the journey is of no benefit to primary school children, especially with the lack of causality in the findings. The process of walking to and from school carries the ability to promote the adoption of an active lifestyle throughout childhood, which might aid in future maintenance of habitual activity levels and health through adulthood.

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