Association between parents’ physical activity and mode of commuting with their offsprings

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Abstract

Background. Some studies have reported a positive association between parents and their offspring's physical activity (PA), but few have examined the difference in these associations concerning both genders. The objective of this study was to establish the association between moderate-vigorous physical activity (MVPA) and mode of commuting (MC) of the parents with their offspring's MC, by gender and age group.

Methods. This cross-sectional study included 686 parents (mothers: 52.8%) and their offsprings (33.8% girls). Each participant completed a questionnaire on PA and MC. Chi-square test, Odds Ratio for categorical variables and lineal regressions for continuous variables were used to examine the associations between the parents and their offspring.

Results. An inverse association was found between fathers-children in the weekend MVPA in children and between mothers-adolescents in out-of-school and weekend MVPA in adolescents, specifically, an inverse association was found in MVPA between mothers-girls and 2) the different parents' MC to work were positively associated with the MC to school in children and adolescents except for the association AC parents-adolescents and specifically, the AC was mainly associated between mothers and girls and boys.

Conclusion. This study emphasizes the importance of involving parents in school-based interventions to create a positive ripple effect in PA-related behaviours.

Background

Regular physical activity (PA) has been associated with numerous health benefits at all stages of life, especially in youth (Poitras et al., 2016; Rhodes, Janssen, Bredin and Warburton, 2017). To obtain these benefits, it is recommended to perform at least 60 minutes/day of moderate-vigorous PA (MVPA) in young people and at least 150 minutes/week of MVPA in adults (WHO, 2010; Piercy et al., 2018). However, a little proportion of children/adolescents (Guthold, Stevens, Riley and Bull, 2020; Vancampfort et al., 2019) and adults (Hallal et al., 2012) meet these recommendations. On the other hand, the studies have shown overall that boys and children are more active than girls and adolescents, respectively (Van Hecke et al., 2016).

Children's PA habits are shaped by their parents, particularly in younger children, compared with adolescents (Ha et al., 2019). It has been estimated that children with active parents are three to four times more active than children with inactive parents (Sims and Bopp, 2019). In addition, a greater PA relationship with children compared to adolescents has been demonstrated (Garcia-Cervantes et al., 2016).

Moreover, the effect of the parent gender on children's PA has been previously examined. For instance, a positive association has been found between mothers’ sport participation and children's leisure-time PA, and it remained significant only in girls (Arlinghaus and Johnston, 2017). Another Brazilian study observed a greater positive association between the mother's PA with adolescent boys and girls, but there was no association for fathers (Christofaro et al., 2018). Furthermore, the PA of both parents presented a greater association with girls than with boys. In contrast, a study demonstrated that only the mother's MVPA was associated with their children's MVPA (Tanaka et al., 2018). Another study showed a significant positive association between fathers and boys only (Schoeppe et al., 2016). Despite that fact, studies have focused on the mother-child relationship, and relatively little attention has been paid to the role of fathers in their children's PA (Neshteruk et al., 2017; Davison et al., 2016). Mothers play a greater role in planning and organizing children's PA, while fathers are more likely to model children's PA (Lloyd et al., 2014). Until now, the evidence on PA gender-specific parental influence (e.g., mother-daughter, mother-son, father-daughter, father-son) is still inconsistent.
It has been established that active commuting to school (ACS) or to work (walking or cycling) is an opportunity to increase PA levels (Martin, Kelly, Boyle, Corlett, and Reilly, 2016; Prince, Butler, Rao and Thompson, 2019). However, around 50% of youths and 75% of adults passively commute to school (Aubert et al., 2018) and to work (Te Velde et al., 2020), respectively. Multiple factors influence whether schoolchildren actively travel to/from school (Rahman et al., 2020). The educational level and body weight (Te Velde et al., 2017), the socioeconomic level (D’Haese et al., 2014) and the unemployment of the parents (Rodríguez-López et al., 2013) are factors that affect children's AC and have been studied. But few studies have linked the parent’s AC with their offspring’s AC and even less take into account gender. A Spanish study observed a positive association between parents’ AC and children's AC (Rodríguez-López et al., 2013). Indeed, the number of step/day of the parents has been positively associated with the number of step/day of the offsprings (Sigmundová et al., 2014), mainly associated between mothers and daughters (Craig et al., 2013). Specifically, it has been reported that for every 1000 step/day that parents increase, their offsprings increase 260 steps/day (Stearns et al., 2016).

Therefore, further quality studies analysing the influence that the fathers’ or mothers’ AC has on boys’ or girls’ ACS, as well as taking in account the age (i.e., children or adolescents) are needed. This would allow targeting interventions to more specific sectors and groups in order to achieve successful results.

According to the previous information, the main objectives of the current study were 1) to establish the association between parents’ and their offsprings PA and 2) to establish the association between parents and their offsprings mode of commuting, determining how the parental association is different by gender and by age groups.

**Methods**

**Study design and participants**

Data were obtained from the study “Cycling and Walk to School” (PACO, for its Spanish acronym), a cross-sectional study focused on promoting PA and, particularly, active commuting to and from school. This study was carried out in Granada (Spain) and Valparaíso (Chile) participating a total of 2,526 children and adolescents and 1,959 of their parents. Twenty schools were invited to participate in the study as a non-randomized sample. Of the total offsprings, 1,807 participants could not be paired with parents’ data and 34 did not report their gender and were excluded (72.8% of the total sample). A total of 572 parents could not be paired with children's data and 703 without gender data were excluded (65% of the total sample). Finally, a total of 686 paired parents (52.8% mothers) and their respective offsprings (33.7% girls) were considered. They belonged to fifteen schools of Granada, Spain (n = 494) and five schools of Valparaíso in Chile (n = 192). The age (mean ± standard deviation) of each group was: parents 43.4 ± 6.5 years old), children 9.7 ± 1.7 years old and adolescents 14.0 ± 1.7 years old.

**Sociodemographic factors**

Participants completed a questionnaire on sociodemographic characteristics, which includes school name, age, birth date, school grade and class, gender, birth country, mother's and father's birth country and full postal address. The parental questionnaire includes sociodemographic variables such as age, gender, monthly income (None; <499€; 500–999€; 1,000–1,499 €; 1,500–1,999 €; 2,000–2,499 €; 2,500–2,999 €; 3,000–4,999 €; >5,000 €) and highest educational level (no study, primary school, secondary school, bachelor, professional, university degree). The monthly income was dichotomized in ≤ 999 € or ≥ 1,000 € and the highest educational level was dichotomized in Secondary/Bachelor's (no study, primary school, secondary school, bachelor) or Professional/University (professional or university degree).
Physical activity

The questionnaire to determine the weekly school and extracurricular PA in children and adolescents was the Youth Activity Profile (YAP). The YAP provides a simple and low-cost method that have already been calibrated and validated to accurately estimate children's MVPA and sedentary behaviours at the group level (Saint-Maurice & Welk, 2015). The self-reported YAP questionnaire comprises three items about participation in different types of activities and sports in the last seven days. The items were “PA in school” (physical education, recess and active commuting to school), “out-of-school PA” (before and after school and PA at the weekend) and “sedentary time” (not considered in current study). Each item was scored on a scale from 1 (low PA) to 5 (high PA) and the average score denotes the YAP score (1–5). The questions were categorized into three areas: PA at school, out-of-school PA and weekend PA. Then, PA in children and adolescents was established by transforming the YAP score to minutes/day in MVPA using the Fairclough equations (Fairclough et al., 2019). We obtained the min/day in MVPA at school, out-of-school MVPA and weekend MVPA, separately for children and adolescents and for boys and girls. The cut-off point to be "physically active" was > 60 minutes/day MVPA (Tremblay et al., 2016) classified as meeting MVPA recommendations. Those children who did not comply were considered as "physically inactive".

The International Physical Activity Questionnaire (IPAQ, short version) was used to assess the parents’ MVPA. This questionnaire has been validated in 12 countries, (Craig et al., 2003; Roman-Viñas et al., 2010) showing acceptable psychometric properties to measure the MVPA levels in one week. The IPAQ allows determining the PA in min/week. Also, this instrument determines intensity categories as sedentary time, light PA, moderate PA and vigorous PA. According to the MVPA international recommendations, parents were classified as physically active when they completed ≥ 150 minutes/week –meeting the recommendations- and physically inactive when they did not reach 150 minutes/week –not meeting the recommendations- (WHO, 2010).

Mode of commuting

The instruments used to assess the mode of commuting were a student (for children and adolescents) and a family (for parents) questionnaire from the PACO Study that have been developed at the University of Granada, Spain, by a group of experts in this topic (https://profit.ugr.es/paco). The questions about the mode of commuting (MC) to school derive from an exhaustive review of previous studies of the scientific literature on AC (Herrador-Colmenero, Pérez-García, Ruiz, and Chillón, 2014) and have been validated in Spanish population (Chillón et al., 2017) and Chilean population (Escobar-Gómez et al., 2020). In children and adolescents, the questions included in the questionnaire were: (1) How do you usually get to school? and (2) How do you usually get home from school?. The possible answers were: walking, cycling, car, motorcycle, school bus, public bus, metro/train and other (the mode description was required). The final variable to analyse was usual active mode of commuting to school. The questions about parent’s MC to work have gone through an exhaustive reliability process (Herrador-Colmenero et al., 2015). In parents, the questions were: (1) How do you usually get to work? and (2) How do you usually get home from work?. The possible answers were: walking, cycling, car, motorcycle, public bus, metro/train or other (the mode description was required).

MC for parents and offsprings was categorized as “active” (walking and cycling) and “passive” (car, motorcycle, bus, metro/train). Also, the “passive” commuting was divided into private mode of commuting (car, motorcycle) and public mode of commuting (public bus, metro, train). In addition, the final variable of usual active commuting included one or two trips to school (to, from or both).

Procedures
The questionnaires (paper-and-pencil) were administered at participating schools between 2015 and 2018. The children and adolescents’ questionnaires were implemented by the researcher staff during the school hours within the physical education lessons and along approximately 30 minutes. Both research team and schoolteachers presented this questionnaire for clarification purposes. The family’s questionnaire was completed once by parents and it was delivered to children and completed at home by parents.

Parents signed an informed consent that described the objectives and characteristics of this study and allowing their offsprings to participate, in accordance with the Declaration of Helsinki. This study was reviewed and accepted by both the Ethical Committee of the University of Granada, Spain (No.162/CEIH/2016) and the Ethical Committee of the Pontificia Universidad Católica de Valparaíso, Chile (CCF02052017).

**Statistical analysis**

Descriptive statistics were calculated for study variables, mean (M) and standard deviation (± SD) for continuous variables and frequency (%) for categorical variables.

The comparison of categorical variables according to gender in each group (parents (mothers and fathers), children (girls and boys), adolescents (girls and boys)) was examined using the Chi-Square test.

To establish the association between the MVPA in parents and offsprings, several lineal regressions through a standardized coefficient ($\beta$) were used for the whole sample, for boys and for girls separately. The min/day of MVPA in children and the dichotomous variable of meeting the recommendations for parents were included. Offsprings’ MVPA was established as the dependent variable. For the MC association several binary logistic regressions were performed. Offspring's MC to school was established as the dependent variable. The references for MC were a) “passive” for active commuting; b) “passive + private” for public commuting; c) “passive + public” for private commuting. The associations were adjusted for parents’ educational level and age of the offsprings. SPSS® v21 (IBM, New York, NY, USA) was used for all the analyses. Also, a $p < 0.05$ value was established as statistically significant.

**Results**

Sociodemographic characteristics of the parents and their offspring are presented in Table 1. Parents of children were younger than parents of adolescents (41.9 ± 5.7 vs. 46.7 ± 7.1, respectively; $p < 0.001$). The maximum educational level reached by mothers of children was higher than by mothers of adolescents ($p < 0.05$). The monthly income for parents of children was higher than parents of adolescents ($p < 0.05$).
Table 1  
Sociodemographic characteristics of the parents of children and parents of adolescents.

|                  | Overall | Parents of children | Parents of adolescents | p-value |
|------------------|---------|---------------------|------------------------|---------|
|                  | N       | (%)                 | N                      | (%)     |         |
| Children gender (n = 686) |         |                     |                        |         |         |
| Girls            | 232     | (33.8)              | 153                    | (34.9)  | 79       | (32.0)  | 0.249   |
| Boys             | 454     | (66.2)              | 286                    | (65.1)  | 168      | (68.0)  |         |
| Children age (M ± SD) | 11.3 ± 2.7 | 9.7 ± 1.7       | 14.0 ± 1.7              |         | **<0.001|
| Parent gender (n = 686) |         |                     |                        |         |         |
| Mothers          | 362     | (52.8)              | 245                    | (55.8)  | 118      | (47.7)  | * 0.026 |
| Fathers          | 323     | (47.2)              | 194                    | (44.2)  | 129      | (52.3)  |         |
| Parent age (Mean ± SD) | 43.4 ± 6.5 | 41.9 ± 5.7       | 46.7 ± 7.1              |         | **<0.001|
| Mother's highest educational level (n = 614) |         |                     |                        |         |         |
| Secondary school / Bachelor's | 330     | (53.7)              | 194                    | (49.7)  | 136      | (60.7)  | * 0.009 |
| Professional / University | 284     | (46.3)              | 196                    | (50.3)  | 88       | (39.3)  |         |
| Father's highest educational level (n = 675) |         |                     |                        |         |         |
| Secondary school / Bachelor's | 314     | (46.5)              | 190                    | (43.9)  | 124      | (51.2)  | 0.066   |
| Professional / University | 361     | (53.5)              | 243                    | (56.1)  | 118      | (48.8)  |         |
| Mother's monthly income (n = 336) |         |                     |                        |         |         |
| <1,000 €         | 127     | (37.8)              | 75                     | (33.0)  | 52       | (47.7)  | * 0.009 |
| >1,000 €         | 209     | (62.2)              | 152                    | (67.0)  | 57       | (52.3)  |         |
| Father's monthly income (n = 463) |         |                     |                        |         |         |
| <1,000 €         | 278     | (60.0)              | 183                    | (57.0)  | 95       | (66.9)  | * 0.045 |
| >1,000 €         | 185     | (40.0)              | 138                    | (43.0)  | 47       | (33.1)  |         |

Statistical differences in Chi-square * p < 0.05; **p < 0.001.

The children and parents’ MVPA and MC separated by gender are presented in Table 2. The percentage of physically inactive girls was significantly higher than the boys for both, children (p < 0.001) and adolescents (p = 0.003). Parents of children and parents of adolescents were also mainly physically inactive (75% and 84.9%, respectively) in both genders (mother and father).
Table 2
Descriptive data of parents’ and their offspring’s physical activity and mode of commuting by gender.

| Offsprings | Children | Adolescents | p-value | Children | Adolescents | p-value |
|------------|----------|-------------|---------|----------|-------------|---------|
|            | Overall  | Girls       | Boys    |          | Girls       | Boys    |        |
|            | N (%)    | N (%)       | N (%)   |          | N (%)       | N (%)   |        |
| MVPA a     |          |             |         |          |             |         |        |
| Physically active | 185 (33.3) | 62 (25.0)   | 111 (88.8) | < 0.001** | 4 (3.1)     | 8 (15.1) | 0.003* |
| Physically inactive | 370 (66.6) | 186 (75.0)   | 14 (11.2)    |          | 125 (96.9)  | 45 (84.9) |
| MC to school |          |             |         |          |             |         |        |
| Active     | 220 (32.1) | 89 (31.1)   | 50 (32.7)    | 0.738    | 52 (31.0)   | 29 (37.2) | 0.333  |
| Passive    | 465 (67.9) | 197 (68.9)   | 103 (67.3)   |          | 116 (69.0)  | 49 (62.8) |
| Parents    |          |             |         |          |             |         |        |
| Parents of children | Overall | Mother      | Father    | p-value | Mother      | Father    | p-value |
|            | N (%)    | N (%)       | N (%)   |         | N (%)       | N (%)   |         |
| MVPA a     |          |             |         |          |             |         |        |
| Physically active | 49 (7.2)  | 7 (2.9)     | 28 (14.4)   | < 0.001** | 3 (2.6)     | 11 (8.5)  | 0.044* |
| Physically inactive | 635 (92.8) | 217 (97.1)   | 166 (85.6)   |          | 114 (97.4)  | 118 (91.5) |
| MC to work |          |             |         |          |             |         |        |
| Active     | 216 (31.6) | 81 (33.2)   | 51 (26.4)    | 0.126    | 44 (37.6)   | 40 (31.0) | 0.276  |
| Passive    | 467 (68.4) | 163 (66.8)   | 142 (73.6)   |          | 73 (62.4)   | 89 (69.0) |

MVPA: moderate-vigorous physical activity; MC: mode of commuting.

Statistical differences in Chi-square * p < 0.05; ** p < 0.001.

a Presents missing data in sample.

The associations between the parents’ MVPA and their offspring's MVPA by gender are presented in Table 3. In the children group, only the fathers’ MVPA was positively associated with girls’ MVPA (β=0.24; 95% CI: 0.00–1.80) and negatively associated with boys’ MVPA (β=0.27; 95% CI: -2.10–-0.19), both of them at the weekend. In adolescents the mothers’ MVPA was negatively associated with the MVPA in all out-of-school (β=0.23; 95% CI: --5.12–0.27) and in girls during the weekend (β=0.38; 95% CI: -2.35 --0.40).
Table 3
Associations between parents' MVPA and their offspring's physical activity by gender.

| MVPA Mother | MVPA Father | MVPA Mother | MVPA Father |
|-------------|-------------|-------------|-------------|
| β 95% CI    | β 95% CI    | β 95% CI    | β 95% CI    |
| **Children**| **Adolescents** | **MVPA total** | **MVPA total** |
| MVPA in school | MVPA in school | All | All |
| All | -0.12 (-3.95-0.37) | -0.07 (-3.60-1.46) | -0.14 (-10.30-2.32) | 0.01 (-7.20-7.55) |
| Girls | -0.03 (-1.97-1.43) | 0.01 (-2.08-2.17) | -0.11 (-7.88-3.47) | 0.19 (-3.18-11.02) |
| Boys | 0.03 (-1.81-2.48) | -0.10 (-3.59-1.48) | -0.02 (-10.53-9.51) | 0.40 (-0.12-17.83) |
| Out-of-school MVPA | Out-of-school MVPA | All | All |
| All | 0.01 (-0.65-0.76) | -0.15 (-0.61-0.00) | -0.23** (-5.12-0.27) | 0.17 (-0.90-4.95) |
| Girls | 0.02 (-0.90-1.06) | -0.08 (-1.61-0.82) | -1.17 (-4.79-1.11) | 0.18 (-1.54-5.67) |
| Boys | 0.06 (-0.72-1.33) | -0.09 (-1.65-0.64) | -0.27 (-8.57-1.81) | 0.24 (-1.54-8.96) |
| MVPA at the weekend | MVPA at the weekend | All | All |
| All | -0.08 (-1.27-0.31) | -0.06 (-1.36-0.58) | -0.20 (-2.53-0.05) | -0.15 (-2.42-0.63) |
| Girls | -0.10 (-1.01-0.33) | 0.24** (0.00-1.80) | -0.38** (-2.35-0.40) | 0.01 (-1.32-1.40) |
| Boys | 0.04 (-0.66-1.00) | -0.27** (-2.10-0.19) | 0.01 (-1.44-1.51) | 0.25 (-0.45-2.28) |

MVPA: Moderate-vigorous physical activity
β: Standardised beta coefficient

** Significant association in lineal regression (p < 0.001)
The associations between the parents’ MC to work and their offspring’s MC by gender are presented in Table 4. Mothers’ AC was associated with the girls’ and boys’ ACS in children (OR = 4.48; 95% CI: 2.01–9.96 and OR = 5.19; 95% CI: 1.92–14.05, respectively). Fathers’ AC to work was only associated with the girls’ ACS (OR = 3.69; 95% CI: 1.83–7.47). Girls presented higher odds to use public commuting if fathers used public commuting. Public commuting was only associated between fathers and girls (OR = 12.62; 95% CI: 2.08–76.55). Mothers of children who used private commuting increased the likelihood that girls and boys also used private commuting (OR = 2.24; 95% CI: 1.32–3.80 and OR = 6.26; 95% CI: 2.84–13.81, respectively). Children had higher odds to use private commuting when fathers used private commuting (girls OR = 3.08; 95% CI: 1.83–5.16 and boys OR = 7.96; 95% CI: 3.48–18.20). In adolescents, no associations were found between parents’ AC to work and offspring’s ACS. In fathers an association with girls was observed in public modes (OR = 6.30; 95% CI: 2.21–17.94) as well as with mothers (OR = 4.59; 95% CI: 1.76–11.94). Also, when mothers used private commuting, boys presented higher odds to use private commuting (OR = 17.21; 95% CI: 2.60-113.70) and when fathers used private commuting, girls showed higher odds to use private modes of commuting (OR = 12.72; 95% CI: 5.01–32.31).
Table 4
Associations between parents’ mode of commuting to work and their offspring’s mode of commuting to school, by gender.

|                     | Mother | Father | Mother | Father |
|---------------------|--------|--------|--------|--------|
|                     | OR     | 95% CI | OR     | 95% CI |
| Children            |        |        |        |        |
| AC to school        |        |        |        |        |
| Passive (Ref.)      | 1      | 1      | 1      | 1      |
| All Active          | 4.96** | (2.68–9.17) | 3.64** | (1.92–6.91) |
| Girls active        | 4.48** | (2.01–9.96) | 3.69*  | (1.83–7.47) |
| Boys active         | 5.19*  | (1.92–14.05) | 3.69   | (0.65–21.09) |
| Public commuting    |        |        |        |        |
| AC + Private (Ref.) | 1      | 1      | 1      | 1      |
| All public          | 1.76   | (0.47–6.67) | 6.28*  | (1.38–28.53) |
| Girls public        | 1.29   | (0.26–6.46) | 12.62* | (2.08–76.55) |
| Boys public         | 4.34   | (0.35–53.25) | NA    | NA    |
| Private commuting   |        |        |        |        |
| AC + Public (Ref.)  | 1      | 1      | 1      | 1      |
| All private         | 3.19** | (2.07–4.93) | 4.09** | (2.66–6.30) |
| Girls private       | 2.24*  | (1.32–3.80) | 3.08** | (1.83–5.16) |
| Boys private        | 6.26** | (2.84–13.81) | 7.96** | (3.48–18.20) |

OR: Odds ratio adjusted for parents’ educational level and age of offspring.
CI: Confidence interval; AC: active commuting. NA: not available data for this group.

* Statistical association in bivariate regression equation (p < 0.05).
** Statistical association in bivariate regression equation (p < 0.001).
Discussion

This study aimed to examine the association between the parents with their offspring’s MVPA and MC of, determining the differences by gender and age groups. The main findings of the study were: 1) an inverse association was found between fathers-children in the weekend MVPA in children and between mothers-adolescents in out-of-school and weekend MVPA in adolescents, specifically, an inverse association was found in MVPA between mothers-girls and 2) the different parents’ MC to work were positively associated with the MC to school in children and adolescents except for the association AC parents-adolescents and specifically, the AC was mainly associated between mothers and girls and boys.

Physical activity

In children, the fathers’ MVPA was only positively associated with the girls’ weekend MVPA. In addition, an inverse association in MVPA between mothers-boys in children, mothers-offspring’s out-of-school MVPA and mothers-girls in the weekend PA in adolescents was found.

Accordingly, a modest and positive association between parent-child PA in a systematic review was found (52% of studies), but no differences were observed in the influence of mothers or fathers on children's PA (Neshteruk et al., 2017). However, previously a positive association was found for fathers-boys and mothers-girls PA (Gustafson & Rhodes, 2006), but the stronger correlation was observed for father-boy PA and lesser association for mothers-boys and mothers-girls PA (Yao and Rhodes, 2015).

Our results in children showed that fathers’ MVPA was positively associated with the weekend MVPA in girls and negatively associated with boys. The positive association between active fathers and active girls can be explained by the role modelling of parents for girls’ PA, especially at the weekend. For example, girls whose parents exercised ≥ 3 times weekly can be almost 50% more active than girls with sedentary parents. This especially occurred at the weekend where there is a greater interaction between parents and children (Madsen, McCulloch and Crawford, 2009). In this regard, it has been reported that the fathers were more likely to offer social support to practice PA than mothers, whose main role is taking care of their children during the weekdays because fathers work long hours during the day (Solomon-Moore et al., 2018). Furthermore, the negative association fathers-boys found in the current study was unexpected, but we assume that fathers are not a role modelling but support the practice (Wright et al., 2019; Jelleyman et al., 2019).

Our results in adolescents showed that the mother’ MVPA was negatively associated with out-of-school MVPA in girls and boys and with girls’ MVPA during the weekend. The other parents’ associations with boys and girls were not significant. These associations can be interpreted as the adolescents’ PA is more independent of the parents’ PA, especially with the mother when the children grow. In this regard, it has been reported in adolescents that, peer, paternal and maternal support decreased with age, whereas independent play increased (Kirby, Levin, and Inchley, 2011). In addition, a qualitative study showed that girl adolescents received more emotional negative support for PA from parents and less tangible support and direct participation from parents in PA with them (Wright et al., 2010). It has been found that it may be that sedentary girls are likely to have sedentary parents, while there may be a weak association between parents and regularly active girls (Bauer et al., 2011).

In general terms, in the current study no positive association parents-offspring’s PA was found. In this regard, a recent systematic review showed a weak correlation between the level of parent and child PA and suggests that we should develop a deeper understanding of associations and mechanisms (Petersen et al., 2020). Future studies and
interventions should enhance the association between parents and their offspring’s PA, especially out-of-school and at the weekend, which seems to be the time where there is a greater association.

Mode of commuting

In the current study, several positive associations between parents and offsprings in the different MC (active, public and private) were found. A greater association was found between mothers’ AC to work with girls’ and boys’ ACS than fathers. The fathers’ AC to work was only associated with the ACS in girls. This finding could be related to a greater degree of care or responsibility assumed by mothers with their children (Zahra, Sebire and Jago, 2015), where mothers were mainly responsible for taking them to school. Another study found that greater mothers’ work flexibility was related to a greater number of children’s active trips (Sener, Lee and Sidharthan, 2019). Furthermore, it was possible to associate the PA of the mothers, but not the fathers, with the ACS of their offsprings (Kobel, Wartha and Steinacker, 2019).

In our study, the association between parents’ AC to work and offspring’ ACS was stronger in children than adolescents. This could be explained by the higher degree of autonomy and independence of adolescents who no longer depend heavily on parents for commuting (Garcia-Cervantes et al., 2016). In addition, it has been studied that the parents perceived lower barriers in adolescents than children (Huertas-Delgado et al., 2018; Aranda-Balboa et al., 2019; Palma et al., 2019). These factors would cause adolescents to choose a different MC than their parents because they independently commute to school empowered by social interaction among peers (Lopes, Cordovil, and Neto, 2018).

The general results of the current study showed a positive association between public commuting of parents and girls. But no associations between mothers-boys or fathers-boys were observed. These results could be explained by a possible greater independence of boys compared to girls, which has been previously reported (Barnett et al., 2019). Girls would prefer to be accompanied by their parents, or parents impose more barriers for independent commuting to girls (Larsen et al., 2009). Using public transport is important, since along with walking, they are considered the two best options for independent mobility in children and adolescents (Sarjala, Broberg and Hynynen, 2016). Previous studies have indicated that parents feel more secure and less afraid to allow boys to walk further from home than girls (Carver et al., 2010; Esteban-Cornejo et al., 2016). This would affect girls’ ACS and increase the use of passive MC.

In the current study, a positive association was observed between the parents’ private MC and their offspring’s MC. This association was even higher than the observed with AC, especially among parents and adolescents. A greater positive association between mothers and boys’ adolescents in private commuting was found. Likewise, a strong association between fathers with adolescents’ girls in this mode was observed. In this regard, a Spanish study in schoolchildren of 9–12 years (Solana et al., 2018) observed an inverse association between the fact that it is more convenient to drive and the accompaniment of their offspring on foot to school. Parents’ convenience of using the car to carry their children has been previously reported as one of the main barriers to ACS (Faulkner et al., 2010; Trapp et al., 2011). In addition, in the case of adolescents, it has been reported that they prefer to be driven to school (Mandic et al., 2017) than another MC. The main problem is that these preferences of young people to use passive MC could be transferred to adult life (Solana et al., 2018). The findings from the current study about passive commuting are relevant, since not only are children more likely to use ACS if parents use AC, but also children are still more likely to use passive MC when parents do too.

Active families
Given that the associations in MVPA and MC could also be bi-directional, that is, they can be benefiting parents and offspring (Niermann, Gerards and Kremers, 2018). Accordingly, we propose a classification of families according to whether they have reached the MVPA recommendations and according to their use AC (Fig. 1). It is important to note that compliance with the MVPA recommendations has been considered as a behaviour that is above the AC to be considered active (Mora-González et al., 2017). However, the contribution that the AC has as a mean to achieve the recommendations cannot be ignored either.

Therefore, the proposal includes “Active family” as those parents and offsprings that meet the MVPA recommendations and use AC; “Moderately active family”, those who use AC, but parents or offspring do not meet MVPA recommendations; “Moderately passive family”, the families where neither parents nor offsprings meet the MVPA recommendations, but some perform AC; and “Passive family”, that includes the families where parents and offsprings do not meet MVPA recommendations and use passive MC.

Limitations

The main limitation of the study was the cross-sectional design and, therefore, no cause and effect relationship can be established in the associations found. A longitudinal study would be required to determine the direction of the relationship. There was a relevant loss data of sample regarding the initial data collection, because the questionnaires were incomplete. Also, a non-randomised sample was included, therefore it is not possible to generalize results to the population. In addition, a self-reported questionnaire, that has a lower objectivity to determine the PA than devices such as accelerometers, was used.

Finally, in relation to the mode of commuting, we did not have the distance to and from school (continuous value) and it was not used to establish their impact on AC.

Conclusions

The results have demonstrated a low association between the parents-offspring’s MVPA. However, a strong association was found between the MC to work of parents and MC to school of their offspring. It was not possible to establish a clear association of the fathers’ AC over the mother or vice versa about ACS of their boys and girls offsprings. Increasing the parents’ AC to work could mean an improvement not only in their own levels of MVPA, but also in the MVPA levels and ACS of their offspring. Otherwise, attention should be given to the use of passive modes of parents, which are largely associated with the passive modes in children. The results suggest the importance of involving families in the design, implementation and evaluation of interventions in the PA and ACS in children and adolescents.

Declarations

Ethics approval and consent to participate

The study in accordance with the Declaration of Helsinki was performed. In addition, was reviewed and accepted by both the Ethical Committee of the University of Granada, Spain (No.162/CEIH/2016) and the Ethical Committee of the Pontificia Universidad Católica de Valparaíso, Chile (CCF02052017).

Consent for publication

Not applicable
Availability of data and material

The dataset supporting the conclusion of this article is available from PACO Study upon reasonable request and the completion of a data transfer agreement with Profith research group, University of Granada, Spain.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

Study conception and design: F.R.-R., F.J.H.-D., P.Ch. Acquisition of data: M.J.A.-B., Y.B.-R. Analysis and interpretation of data: F.R.-R., F.J.H.-D., P.Ch. Drafting of manuscript: F.R.-R., F.J.H.-D., M.J.A.-B., Y.B.-R., P.Ch. Critical revision: F.R.-R., F.J.H.-D., M.J.A.-B., Y.B.-R., P.Ch.

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References

1. Aranda-Balboa MJ, Huertas-Delgado FJ, Herrador-Colmenero M, et al. (2019). Parental barriers to active transport to school: a systematic review. International Journal of Public Health 1–12.
2. Arlinghaus KR, Johnston CA. Engaging fathers in the promotion of healthy lifestyle behaviors. Am J Lifestyle Med. 2017;11(3):216–9.
3. Aubert S, Barnes JD, Abdeta C, et al. Global matrix 3.0 physical activity report card grades for children and youth: results and analysis from 49 countries. Journal of Physical Activity Health. 2018;15(2):251–73.
4. Barnett A, Sit CH, Mellecker RR, et al. Associations of socio-demographic, perceived environmental, social and psychological factors with active travel in Hong Kong adolescents: the iHealt (H) cross-sectional study. Journal of transport health. 2019;12:336–48.
5. Bauer KW, Neumark-Sztainer D, Fulkerson JA, Hannan PJ, Story M. Familial correlates of adolescent girls’ physical activity, television use, dietary intake, weight, and body composition. International Journal of Behavioral Nutrition Physical Activity. 2011;8(1):25.
6. Carver A, Timperio A, Hesketh K, et al. Are children and adolescents less active if parents restrict their physical activity and active transport due to perceived risk? Soc Sci Med. 2010;70:1799–805.

7. Chillón P, Herrador-Colmenero M, Migueles JH, et al. Convergent validation of a questionnaire to assess the mode and frequency of commuting to and from school. Scand J Public Health. 2017;45(6):612–20.

8. Christofaro DGD, Andersen LB, Andrade SM, et al. Adolescents’ physical activity is associated with previous and current physical activity practice by their parents. The Journal of Pediatrics. 2018;94(1):48–55.

9. Craig CL, Cameron C, Tudor-Locke C. Relationship between parent and child pedometer-determined physical activity: a sub-study of the CANPLAY surveillance study. International Journal of Behavioral Nutrition Physical Activity. 2013;10(1):8.

10. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-country reliability and validity. Medicine science in sports exercise. 2003;35(8):1381–95.

11. Davison KK, Gicevic S, Aftosmes-Tobio A, et al. Fathers’ representation in observational studies on parenting and childhood obesity: a systematic review and content analysis. Am J Public Health. 2016;106:e14–21.

12. D’Haese S, Van Dyck D, De Bourdeaudhuij I, et al. The association between objective walkability, neighborhood socio-economic status, and physical activity in Belgian children. International journal of behavioral nutrition physical activity. 2014;11(1):104.

13. Escobar-Gómez D, Rodríguez-Rodríguez F, Villa-González E, et al. Fiabilidad y viabilidad de un cuestionario autorreportado sobre el modo, tiempo y distancia de desplazamiento en niños y adolescentes. Retos. 2020;37(37):379–85.

14. Esteban-Cornejo I, Carlson JA, Conway TL, et al. Parental and Adolescent Perceptions of Neighborhood Safety Related to Adolescents’ Physical Activity in Their Neighborhood. Res Q Exerc Sport. 2016;87:191–9.

15. Fairclough SJ, Christian DL, Saint-Maurice PF, et al. Calibration and Validation of the Youth Activity Profile as a Physical Activity and Sedentary Behaviour Surveillance Tool for English Youth. International Journal of Environmental Research Public Health. 2019;16(19):3711.

16. Faulkner GEJ, Richichi V, Buliung RN, et al. What’s “quickest and easiest?”: parental decision making about school trip mode. International Journal of Behavioral Nutrition Physical Activity. 2010;7:62–73.

17. Garcia-Cervantes L, Rodriguez-Romo G, Esteban-Cornejo I, et al. Perceived environment in relation to objective and self-reported physical activity in Spanish youth. The UP&DOWN study. Journal of Sports Science. 2016;34(15):1423–9.

18. Gustafson SL, Rhodes RE. Parental correlates of physical activity in children and early adolescents. Sports Med. 2006;36:79–97.

19. Guthold R, Stevens GA, Riley LM, et al. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1· 6 million participants. The Lancet Child Adolescent Health. 2020;4(1):23–35.

20. Ha AS, Ng JYY, Lonsdale C, Lubans DR, Ng FF. Promoting physical activity in children through family-based intervention: protocol of the “Active 1 + FUN” randomized controlled trial. BMC Public Health. 2019;19(1):218.

21. Hallal PC, Andersen LB, Bull FC, et al. Global physical activity levels: surveillance progress, pitfalls, and prospects. The Lancet. 2012;380(9838):247–57.

22. Herrador-Colmenero M, Pérez-García M, Ruiz JR, et al. Assessing modes and frequency of commuting to school in youngsters: a systematic review. Pediatric exercise science. 2014;26(3):291–341.
23. Herrador-Colmenero M, Ruiz JR, Ortega FB, et al. Reliability of the ALPHA environmental questionnaire and its association with physical activity in female fibromyalgia patients: the al-Ándalus project. Journal of sports sciences. 2015;33(8):850–62.
24. Huertas-Delgado FJ, Chillón P, Barranco-Ruiz Y, et al. Parental perceived barriers to active commuting to school in Ecuadorian youth. Journal of Transport Health. 2018;10:290–6.
25. Jelleyman C, McPhee J, Brussoni M, et al. A cross-sectional description of parental perceptions and practices related to risky play and independent mobility in children: the New Zealand state of play survey. Int J Environ Res Public Health. 2019;16(2):262.
26. Kirby J, Levin KA, Inchley J. Parental and peer influences on physical activity among Scottish adolescents: a longitudinal study. Journal of Physical Activity Health. 2011;8(6):785–93.
27. Kobel S, Wartha O, Steinacker JM. Correlates of active transport to school in German primary school children. German Journal of Sports Medicine. 2019;70:67–74.
28. Larsen K, Gilliland J, Hess P, Tucker P, Irwin J, He M. The influence of the physical environment and sociodemographic characteristics on children's mode of travel to and from school. Am J Public Health. 2009;99(3):520–6.
29. Lloyd AB, Lubans DR, Plotnikoff RC, et al. Maternal and paternal parenting practices and their influence on children’s adiposity, screen-time, diet and physical activity. Appetite. 2014;79:149–57.
30. Lopes F, Cordovil R, Neto C. Independent Mobility and Social Affordances of Places for Urban Neighborhoods: A Youth-Friendly Perspective. Frontiers in psychology. 2018;9:2198. https://doi.org/10.3389/fpsyg.2018.02198.
31. Madsen KA, McCulloch CE, Crawford PB. Parent modeling: perceptions of parents’ physical activity predict girls’ activity throughout adolescence. J Pediatr. 2009;154(2):278–83.
32. Mandic S, Hopkins D, García Bengoechea E, et al. Adolescents’ perceptions of cycling versus walking to school: Understanding the New Zealand context. Journal of Transport Health. 2017;4:294–304.
33. Rahman ML, Moore A, Smith M, Lieswyn J, Mandic S. A conceptual framework for modelling safe walking and cycling routes to high schools. Int J Environ Res Public Health. 2020;17(9):3318.
34. Martin A, Kelly P, Boyle J, et al. Contribution of walking to school to individual and population moderate-vigorous intensity physical activity: systematic review and meta-analysis. Pediatr Exerc Sci. 2016;28(3):353–63.
35. Mora-Gonzalez J, Rodríguez-López C, Cadenas-Sanchez C, Herrador-Colmenero M, Esteban-Cornejo I, Huertas-Delgado FJ, Ardoy D, Ortega F, Chillón P. Active commuting to school was inversely associated with academic achievement in primary but not secondary school students. Acta paediatrica. 2017;106(2):334–40.
36. Neshteruk CD, Nezami BT, Nino-Tapias G, et al. (2017). The influence of fathers on children's physical activity: a review of the literature from 2009 to 2015. Preventive medicine 102, 12–19.
37. Niermann CY, Gerards SM, Kremers SP. Conceptualizing family influences on children's energy balance-related behaviors: Levels of Interacting Family Environmental Subsystems (The LIFES Framework). Int J Environ Res Public Health. 2018;15(12):2714.
38. Palma X, Chillón P, Rodríguez-Rodríguez F, et al. (2019). Perceived parental barriers towards active commuting to school in Chilean children and adolescents of Valparaiso. International Journal of Sustainable Transportation 1–8.
39. Petersen TL, Møller LB, Brønd JC, Jepsen R, Grøntved A. Association between parent and child physical activity: a systematic review. International Journal of Behavioral Nutrition Physical Activity. 2020;17:1–16.
40. Piercy KL, Troiano RP, Ballard RM, et al. The physical activity guidelines for Americans. J Am Med Assoc. 2018;320(19):2020–8.
41. Poitras VJ, Gray CE, Borghese MM, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. Appl Physiol Nutr Metab. 2016;41(6):197–239.
42. Prince SA, Butler GP, Rao DP, et al. Evidence synthesis Where are children and adults physically active and sedentary? – a rapid review of location-based studies. Health Promotion Chronic Disease Prevention in Canada: Research Policy Practice. 2019;39(3):67.
43. Proith. (2016). Pedalea y anda al cole. Disponible en: http://proith.ugr.es/paco.
44. Rhodes RE, Janssen I, Bredin SSD, et al. Physical activity: health impact, prevalence, correlates and interventions. Psychol Health. 2017;32(8):942–75.
45. Rodríguez-López C, Villa-González E, Pérez-López IJ, et al. Family factors influence active commuting to school in spanish children. Nutrición Hospitalaria. 2013;28:756–63.
46. Roman-Viñas B, Serra-Majem L, Hagströmer M, et al. International physical activity questionnaire: reliability and validity in a Spanish population. European Journal of Sport Science. 2010;10(5):297–304.
47. Saint-Maurice PF, Welk GJ. (2015). Validity and calibration of the youth activity profile. PloS one 10(12).
48. Schoeppe S, Robl M, Liersch S, et al. Mothers and fathers both matter: the positive influence of parental physical activity modeling on children's leisure-time physical activity. Pediatric exercise science. 2016;28(3):466–72.
49. Sigmundová D, Sigmund E, Vokáčová J, et al. Parent-child associations in pedometer-determined physical activity and sedentary behaviour on weekdays and weekends in random samples of families in the Czech Republic. International Journal of Environmental Research Public Health. 2014;11(7):7163–81.
50. Solomon-Moore E, Toumpakari Z, Sebire SJ, et al. Roles of mothers and fathers in supporting child physical activity: a cross-sectional mixed-methods study. BMJ Open. 2018;8(1):e019732.
51. Sarjala S, Broberg A, Hynynen A. Children and youth transport in different urban morphological types. Journal of Transport Land Use. 2016;9(2):87–103.
52. Sener IN, Lee RJ, Sidharthan R. An examination of children's school travel: A focus on active travel and parental effects. Transportation Research Part A: policy Practice. 2019;123:24–34.
53. Sims D, Bopp M. (2019). Using parental active travel behavior and beliefs to predict active travel to school among children. International Journal of Sustainable Transportation 1–6.
54. Solana AA, Mandic S, Lanaspa EG, et al. Parental barriers to active commuting to school in children: does parental gender matter? Journal of Transport Health. 2018;9:141–9.
55. Stearns JA, Rhodes R, Ball GD, et al. A cross-sectional study of the relationship between parents’ and children's physical activity. BMC Public Health. 2016;16(1):1129.
56. Tanaka C, Okuda M, Tanaka M, et al. (2018). Associations of physical activity and sedentary time in primary school children with their parental behaviors and supports. International journal of environmental research and public health 15(9), 1995.
57. Te Velde SJ, Haraldsen E, Vik FN, et al. Associations of commuting to school and work with demographic variables and with weight status in eight European countries: The ENERGY-cross sectional study. Preventive medicine. 2017;99:305–12.
58. Trapp GSA, Giles-Corti B, Christian HE. On your bike! a cross-sectional study of the individual, social and environmental correlates of cycling to school. Int. International Journal of Behavioral Nutrition Physical Activity.
59. Tremblay MS, Carson V, Chaput JP, et al. Canadian 24-hour movement guidelines for children and youth: an integration of physical activity, sedentary behaviour, and sleep. Appl Physiol Nutr Metab. 2016;41(6):311–27.

60. Vancampfort D, Van Damme T, Firth J, et al. Correlates of physical activity among 142,118 adolescents aged 12–15 years from 48 low-and middle-income countries. Prev Med. 2019;127:105819.

61. Van Hecke L, Loyen A, Verloigne M, Van der Ploeg HP, Lakerveld J, Brug J, De Bourdeaudhuij I, Ekelund U, Donnelly A, Hendriksen I, Deforche B. Variation in population levels of physical activity in European children and adolescents according to cross-European studies: a systematic literature review within DEDIPAC. International Journal of Behavioral Nutrition Physical Activity. 2016;13(1):70.

62. WHO. Global recommendations on physical activity for health. Geneva: World Health Organization; 2010.

63. Wright MS, Wilson DK, Griffin S, Evans A. A qualitative study of parental modeling and social support for physical activity in underserved adolescents. Health Educ Res. 2010;25(2):224–32.

64. Wright KE, Furzer BJ, Licari MK, et al. The effect of parental logistic support on physical activity in children with, or at risk of, movement difficulties. Journal of Science Medicine in Sport. 2019;S1440-2440(19):30410–4.

65. Yao CA, Rhodes RE. Parental correlates in child and adolescent physical activity: a meta-analysis. International Journal of Behavioral Nutrition Physical Activity. 2015;12(1):10.

66. Zahra J, Sebire SJ, Jago R. “He’s probably more Mr. sport than me”—a qualitative exploration of mothers’ perceptions of fathers’ role in their children’s physical activity. BMC Pediatr. 2015;15(1):101.

**Figures**

**Figure 1**

Proposal for classification of families according to compliance with MVPA recommendations and the use of active MC.