

Association between Parents' and Children' Implicit and Explicit Attitudes towards Physical Activity and Sedentary Behaviors

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ABSTRACT

Purpose: The present study aimed to explore the associations between parents' physical activity (PA) and sedentary behaviors (SED) and their explicit and implicit attitudes toward these behaviors and their children's PA and SED, and attitudes. Children's age and parents' gender were taken into account. Method: One hundred and seven dyads composed of one parent (Mage = 42.9 years) and her/his child (Mage = 11.6 years) completed questionnaires assessing behaviors and explicit attitudes toward PA and SED. Implicit attitudes were evaluated with an implicit association test. Results: Parents' PA was positively correlated with their children's PA, especially in children (≤ 12 years). No significant association was noted for SED. The results showed a positive correlation between mothers' explicit attitudes and fathers' implicit attitudes and, respectively, their children's explicit (regardless to their age) and implicit attitudes (> 12 years). Conclusion(s): This study is the first to investigate the association between parents' and their children' implicit and explicit attitudes toward PA and SED. The results indicate that focusing on the increase of PA and the development of positive attitudes toward PA in both children and parents could be an interesting mean to promote PA in interventions aiming to improve families' health.

Keywords: automatic processes, family, health-related behavior, implicit association test (IAT)

INTRODUCTION

The lack of physical activity (PA) is a major risk factor for several chronic diseases (Lee et al., 2012). Research has emphasized the importance of promoting PA and limiting sedentary behaviors (SED, i.e., the time spent sitting or lying down during waking hours, which results in little or no movement) because these two behaviors have independent effects on health (Van Sluijs, Page, Ommundsen, & Griffin, 2010). The current recommendation for health benefits in young people is at least 60 minutes of moderate to vigorous PA (MVPA) every day. Additionally, another recent report suggested that continuous sedentary sequences should be limited to 60 minutes in children and 120 minutes in adolescents (ANSES, 2016). While current evidence indicates the young people in general are aware of the association between an active lifestyle and health (Harris, Cale, Duncombe, & Musson, 2018), several studies have shown that less than 20% of this population meets the PA recommendations (Cooper et al., 2015). In particular, PA decreases by about 4% every year from the age of 5 years, due in large part to the increasing amount of time spent in SED (Cooper et al., 2015). The decrease in PA and rise in SED among youth is a key public health issue because behavioral patterns established in childhood tend to persist into adulthood (Craigie, Lake, Kelly, Adamson & Mathers, 2011). Previous studies have shown that PA in children and adolescents is determined by several factors (see Sterdt, Liersch, & Walter, 2013, for a review), which are directly related to the children or adolescents themselves – e.g., biological factors such as sex, age and ethnicity, and psychological factors like perceived competence, motivation, or perceived barriers – or to their environment – including environmental factors such as access to recreational facilities and sociocultural factors such as parental education and support. Therefore, investigating these

factors and their relationship to PA and SED may provide greater insight into the mechanisms involved when children and adolescents adopt these behaviors. This article particularly focuses on the role played by the main actors in children's social environment: their parents.

Parents can play a critical role in shaping PA and SED in youth through a variety of mechanisms. First, past research has highlighted the contribution of the role modeling effect, i.e., the observation that parental behaviors tend to be imitated by their children. This effect was particularly emphasized in the Theory of Planned Behavior (TPB; Ajzen, 1991), which holds that behavior is mainly determined by an individual's behavioral intention. Intention, in turn, is in part determined by subjective norms, including an injunctive dimension (i.e., the perception of social approval by significant others, which motivates behavior through social reward/punishment) and a descriptive dimension (i.e., the perception of behaviors adopted by significant others; Cialdini, Kallgren, & Reno, 1991). The latter could illustrate a direct influence of the social environment on individuals' behavior, reflecting a role modeling process (McEachan et al., 2016). Recent literature reviews indicate that this phenomenon is consistently observed, regarding both PA (Xu, Wen & Rissel, 2015) and SED (Neshteruk, Nezami, Nino-Tapias, Davison, & Ward, 2017). In particular, the effect was observed regarding screen time – which is the most commonly reported SED (Mansoubi, Pearson, Biddle, & Clemes, 2014). In the case of these behaviors, correlations from small to moderate were observed. These researches hypothesized that the influence of parents' behaviors on children' behaviors to be

unidirectional, i.e., children being the passive recipients of parents' behaviors, norms. However, recent studies provided evidence that parents' behaviors such as PA parenting practices (i.e., "concrete behavioral strategies employed by parents to influence their children's PA", Laukkanen et al., 2018; p. 2691) could occur in response to children-related factors (e.g., PA enjoyment, temperament, age) and children's behaviors (Laukkanen et al., 2018; Sleddens, Gubbels, Kremers, van der Plas, & Thijs, 2017). Notwithstanding this evidence showing the existence of a shared behavioral patterns (i.e., bidirectional relationship), this line of research is still dominated by studies that consider parents as agents influencing children' PA and SED, without taking into account reciprocal processes.

Although the role modeling effect phenomenon appears to be robust, several variables might moderate its strength. First, several reviews have pointed out the stronger associations between parents' PA and young children's PA as opposed to that of early adolescents, suggesting that parents' and children's behavioral patterns related to PA are more similar in younger individuals (Sterdt et al., 2013). Research on SED depending on children's age is still scarce, but an earlier study showed that the time that parents spend on screen-based activities – such as TV – is correlated with the time that their children spend on these activities. However results are inconsistent showing a stronger correlations when the child is 13 years compare to 11 years for TV, but a stronger correlations are found when the child is 11 years compare to 13 years for computer and games (Totland et al., 2013).

Other literature reviews have investigated the link between parents' and children's PA and/or SED depending on the parents' gender. Neshteruk, Nezami, Nino-Tapias, Davison, and Ward (2017) concluded to similar associations between mothers' – versus fathers' – and their children's PA. However, other reviews have observed significantly stronger correlations for father-child PA than mother-child PA (Biddle, Atkin, Cavill, & Foster, 2011; Yao & Rhodes, 2015). The research on SED remains limited because, up to now, PA has often been the primary target of academics. To date, only one literature review reported an implication of parents' gender in the relationship between parents' and children's SED (Neshteruk et al., 2017). Several other studies highlighted that mothers' SED predicted children's SED more strongly than fathers' behavior (Jago et al., 2012; Schoeppe et al., 2017).

In addition to parents' behaviors, research has also shown that their beliefs or attitudes about PA can substantially influence their children's adoption of this behavior (see Sterdt et al., 2013, for a review). However, no study has investigated this relationship for SED. Moreover, the literature is rather scarce regarding the extent to which parents and children share similar perceptions of SED. According to McEachan et al.'s (2016) meta-analysis on health behaviors – including PA – personal attitudes have direct associations with individuals' corresponding health behaviors and/or indirect effects through their intentions. In this vein, one study showed that the more parents are convinced of the importance of PA, the more children tend to display such beliefs, and conversely (Anderson, Hughes, & Fuemmeler, 2009). Nevertheless,

there is currently no scientific evidence that this is the case regarding SED. As with studies examining the relationship between parents' behaviors and those of their children, this line of research considers the relationship between parents' attitudes and those of their children to be unidirectional. To our knowledge, no study has examined the possibility of a reciprocal influence. Nevertheless, by referring to the TPB that highlights the association between attitudes and behaviors, and based on the results of studies that highlighted shared behavioral patterns between parents and children, it is possible to assume that parents and children also shared attitudinal patterns. In other words, parents' attitudes could influence children attitudes and vice versa.

Otherwise, in this line of research, attitudes are measured with questionnaires, because they were conceived as controlled psychological processes. For example, in the TPB, attitudes encompass both instrumental (e.g., healthy–unhealthy, valuable–worthless) and affective (e.g., pleasant–unpleasant, interesting–boring) content. In other words, the previous results can be conceptualized as pertaining to explicit attitudes, i.e., conscious evaluations of the consequences of adopting a behavior. However, there is increasing evidence that PA and SED are also explained by non-conscious processes, particularly implicit attitudes (Rebar et al., 2016).

Implicit attitudes refer to quick and automatic evaluative associations that do not operate under conscious control. To gain access to these associations held in memory, indirect

methods are used, in general based on individuals' reaction times. Previous research findings generally support the hypothesis that PA is partially regulated by non-conscious processes. In particular, a recent meta-analysis concluded that, although small, the association between implicit attitudes toward PA and actual PA behavior is significant (Chevance, Bernard, Chamberland, & Rebar, 2019). This meta-analysis showed that to date, young adults have been the most studied age group. Except for Craeynest et al.'s studies (e.g., Craeynest, Crombez, Deforche, Tanghe, & De Bourdeaudhuij, 2008) conducted in children and adolescents suffering from obesity, no study has yet included either children or adolescents. Moreover, the relationship between implicit attitudes and SED remains largely unexplored.

In summary, the question of how the social environment can transmit more or less positive attitudes toward PA and SED is worthy of consideration, both at explicit and implicit levels. Yet, to our knowledge, only two studies have examined the extent to which explicit and implicit attitudes toward health-related behaviors are shared by parents and their children. Guidetti, Conner, Prestwich, and Cavazza (2012) targeted young adults' (18-22 years) and their parents' attitudes toward food. Regarding explicit attitudes, no correlations emerged between the scores of the young adults and their parents for fruits or snacks. Conversely, the young adults' implicit attitudes toward fruit were significantly predicted by those of their parents in a multivariate model. As noted by the authors, young adults and their parents have considerable shared experience in relation to food. Given that implicit attitudes reflect early socialization

experiences; this shared experience might have been translated into greater similarity in implicit attitudes. In contrast, for explicit food attitudes, more recent and more salient shared experiences (e.g., with friends) might explain the absence of association. In this study, no effect of parents' gender was found.

The second study by Sherman, Chassin, Presson, Seo, and Macy (2009) targeted adolescents (from 10 to 18 years) and their parents regarding tobacco-related attitudes and behaviors. The results indicated that mothers with more positive implicit and explicit attitudes had children with more positive implicit and explicit attitudes. In turn, children's implicit – but not explicit – attitudes predicted smoking initiation 18 months later. This result was explained by the observation that implicit attitudes may be communicated by parents in very subtle ways, such as nonverbal behaviors, which may directly impact young individuals' behavior. In this study, results also showed a positive but not significant association between fathers and children's attitudes.

The present study

The purpose of this study was to investigate whether parents' PA and SED, as well as their implicit and explicit attitudes toward these behaviors, are correlated with those of their children. Based on past research, a positive and significant correlation between parents' PA and SED and their children's behaviors was expected. We also expected positive and significant correlations between parents' scores of explicit and implicit attitudes toward PA and SED and

their children's attitudes toward these behaviors.

These correlations were also examined taking into account two elements. First, we distinguished young children (≤ 12 years) and adolescents (> 12 years). It was hypothesized that the correlation between young children's and their parents' PA would be stronger than the correlation between adolescents' and their parents' PA. In view of the scarcity of past research, it was not possible to make assumptions about age regarding SED and attitudes.

Next, these associations were explored in both mothers and fathers. Despite the admittedly small number of studies on mother-father differences, the results seem to suggest that parent-child relationships are stronger for fathers regarding PA, but for mother regarding SED. Again, in view of the scarcity of past research, no specific pattern was expected regarding attitudes.

METHOD

Participants

One hundred and fifty dyads were proposed to participate to the study. Among them 107 dyads composed of one parent (Mage = 42.9 years; 75% female) and her/his child (Mage = 11.6 years, with 40 children >12 years, 53% female) agreed to participate and were included. Specifically, 74 mothers (Mage = 42.7 years) and their children (39 girls and 33 boys -2 missing data-; Mage = 11.5 years, with 36% >12 years), as well as 27 fathers (Mage = 43.3 years) and their children (10 girls and 17 boys; Mage = 11.6 years, with 41% >12 years) composed the sample of the current study. Six parents did not report their gender and two children did not report their age. Post-hoc power analysis for correlation using G*power indicate no power issue given the present sample size ($q = 0.4$, $\alpha = .05$; $1-\beta = .82$).

Procedure

Participants were recruited in public libraries, recreation centers, and elementary, middle and high schools during the first semester of 2017. These locations were chosen because it is possible to meet both parents and children at the same time, and because they are dedicated to both PA and not PA practice, enabling the recruitment of various profiles of families. When parents accompanied or came to pick up their children to these locations, both were asked to participate in a study. They were informed that the study was about their leisure time and that study participation would last about 15 minutes, consisting of a computer task and a questionnaire to complete. Participants did not receive an incentive for their participation. Only children and adolescents between 8 and 18 years old were included. In this particular age range, children are able to read and understand, and adolescent are still living with their parents (which renders the issue of social influence relevant). Individuals presenting reading or vision disabilities were not included. When the inclusion criteria were met, parent and child were brought to a room loaned to the research team, where they signed written informed consent forms that included more detailed information about the study (consent form in supplementary material), and completed the study in a quiet environment. Parents and children completed the same tasks (i.e., a computerized Implicit Association Test (IAT); Greenwald, McGhee, & Schwartz, 1998, followed by a leisure time questionnaire including sociodemographic information) simultaneously using separate material, and they were instructed not to communicate with each other. To ensure anonymity and to pair the data

from parents with those of their child, participants were attributed matching numbers (i.e., the code included a number for the dyad, and a letter for their status – parent versus child).

Measures

Implicit attitudes.

Implicit attitudes toward PA/SED were assessed using an IAT both in children and parents. The IAT is nowadays considered as a valid tool to measure of inter-individual differences in implicit attitudes (De Houwer & De Bruycker, 2007). This test evaluates the relative strength of association between two concepts held in memory through the participants' reaction times as they categorize stimuli associated with these concepts. More precisely, the IAT compares reaction times when paired categories (i.e., a concept + an evaluative attribute) match, as opposed to contradict, one's implicit associations. Individuals are expected to classify stimuli faster when paired categories are in line with their implicit associations. Following the recommendation from Greenwald, Nosek and Banaji (2003), the IAT was presented on a computer in seven blocks including practice and critical blocks (see Table 1 in supplementary material). The blocks where PA exemplars were paired with positive words, and SED exemplars with negative words, were labeled "compatible," whereas the blocks in which these pairings were reversed were labeled "incompatible." The order of presentation of compatible and incompatible blocks was randomly counterbalanced across participants.

Stimuli associated with positive and negative evaluative attributes were selected based on the material used in previous research (Chevance, Héraud, Guerrieri, Rebar, & Boiché 2017).

Stimuli representing common activities or verbs associated with PA and SED were selected from Chevance et al. (2017). A pool of stimuli was pilot-tested in 60 individuals (including children and adults) to ensure that the words were understood and unambiguously attributed to one of the four conceptual categories at all ages. This preliminary study led to the selection of four words for each category: positive (fun, happy, good, enjoyable), negative (boring, sad, bad, lame), PA (bike, dance, run, swim), and SED (TV, couch, read, sit).

The IAT data were scored using R software. We used the “IAT Score” package to calculate a DW-score (Richetin, Costantini, Perugini, & Schönbrodt, 2015): (1) for each participant, the 10% fastest and slowest latencies were replaced by the last untrimmed latencies for both error and correct responses; (2) the difference between the average latencies of the two critical blocks (i.e., practice and test blocks together) was divided by the pooled standard deviation of all the latencies; and (3) the score was computed based on practice and critical trials together. Scores ranged between 2 and -2, with positive scores indicating favorable implicit attitudes toward PA compared with SED.

Explicit attitudes.

Explicit attitudes toward PA and SED were assessed using the same adjectives as in the IAT for positive and negative categories. The same questionnaire was proposed to children and parents. Questions were based on a questionnaires from previous work carried out with children (Bélanger-Gravel & Godin, 2010; Plotnikoff, Lubans, Costigan, & McCargar, 2013), developed following Ajzen's guideline, with the following stem: "Do you think that practicing PA/SED almost every day is something" The participants rated each item on a Likert-type scale ranging from 1 ("Not at all") to 4 ("Yes, absolutely"). The scores for explicit attitudes toward PA and SED were obtained by subtracting the mean score for negative attributes from the mean score for positive attributes. Scores ranged between -3 and +3 (positive results indicating favorable explicit attitudes toward the targeted behavior). Internal consistency was good ($\alpha = .84$ for explicit attitudes toward PA; $\alpha = .89$ for explicit attitudes toward SED).

Behaviors.

PA was assessed using an adapted version of the self-administered Physical Activity Questionnaire for Children (PAQ-C; Janz, Lutuchy, Wenthe & Levy, 2008). The same questionnaire was proposed to parents and children. Only the part which focuses on free time was used and it was clearly specified to participants that it was AP outside school or work that were assessed. PA was defined as voluntary movements that cause a person to sweat, breathe hard, and increase heart rate, and examples were provided: leisure time PA (e.g., biking with friends), sports (e.g., playing football in a club), or occupational and daily activities (e.g., walking one's dog, cleaning). We evaluated SED based on the PA questionnaire (i.e., same details offered, same procedure, and same stem structure). SED was defined as no or very little movement, and examples were again provided: SED as leisure time activities (e.g., reading, watching TV) or daily activities (e.g., doing homework, writing a report). Participants were asked to report the specific names of PA and SED in which they were engaged during last week with the frequency and duration (i.e., number of sessions and average time per session) of each activity behavior over the last seven days (i.e., "In the past 7 days, how many times did you engage in PA/SED?"). The average times per session were summed to estimate the total amount of time spent in PA and SED in hours per week. The validity and reliability of the PAQ-C have been demonstrated.

Statistical analysis

Pearson correlations were computed to examine the relationships between the parents' and children's PA and SED, and their attitudes toward these behaviors. Correlations were first computed for the whole sample and then for subgroups: (i) parent-young child (≤ 12 years) and parent-adolescent (> 12 years) dyads, and (ii) mother-child and father-child dyads.

Treatment of missing data and order effect.

Outliers regarding PA, SED and explicit attitude scores were checked and extreme values (standardized scores $> \pm 3.29$ SD) were replaced with the most extreme value that nevertheless remained within the normal range value for the identified score (Tabachnick & Fidell, 2007). Next, a significant order effect was observed for the IAT scores: scores were significantly more in favor of PA than SED when compatible blocks were completed first; this effect was observed in both parents: $t(95) = 11.920$; $p < .001$ and children: $t(99) = 6.128$; $p < .001$. Consequently, DW-scores were standardized by group (i.e., parents and children) and the version of the IAT (Compatible followed by Incompatible: CI versus Incompatible followed by Compatible: IC).

Moreover, a few data were missing for six parents, two children and six dyads because they skipped a page or question, or due to technical issues (IAT), but those who did not provide complete data did not differ from those who did for either sex or age ($p_s > .38$). Little's statistical test indicated that missing data could not be considered as missing not at random ($\chi^2 = 24.42, p = .887$). Therefore, to complete missing data, an expectation maximization (EM) procedure was conducted in four distinct subsamples (parents who completed a CI IAT, parents who completed an IC IAT, children who completed a CI IAT, and children who completed an IC IAT). Analyses were performed using the SPSS 21 software.

Results

Correlations in the whole sample

Means and standard deviations for PA and SED behaviors, as well as implicit and explicit attitudes scores, appear in Table 2 in supplementary material regarding the version of IAT and in Table 1 regarding parents' gender and children's age. Pearson correlations between all variables were first computed (Table 2). Regarding the hypothesized positive link between parents' and children's behaviors, we found a positive correlation between parents' and children's PA ($r = .19; p = .05; 95\% \text{ CI } [0.00, 0.36]$), but no association was found for SED ($r = .01; p = .92; 95\% \text{ CI } [-0.18, 0.20]$). For the hypothesized positive link between parents' and children's attitudes, the correlation was not significant between parents' and children's attitudes at either the explicit level – for PA ($r = .10; p = .33; 95\% \text{ CI } [-0.10, 0.20]$) or SED ($r = .09;$

$p = .37$; 95% CI [-0.10, 0.27] – or the implicit level ($r = -.03$; $p = .79$; 95% CI [-0.21, 0.17]).

Correlations in subgroups of children and adolescents

The summary of the correlation between variables of interest regarding children's age is presented in Table 2. For young children between 8 and 12 years, parents' PA was positively correlated with children's PA ($r = .25$; $p = .05$; 95% CI [0.01, 0.47]). No association was found either for SED ($r = .19$; $p = .13$; 95% CI [-0.06, 0.41]), or explicit attitudes for PA ($r = .01$; $p = .95$; 95% CI [-0.24, 0.25] or SED ($r = .12$; $p = .36$; 95% CI [-0.13, 0.35] or the implicit level ($r = -.11$; $p = .38$; 95% CI [-0.34, 0.14]). Regarding these variables, no association was found for adolescents ($ps > .12$).

Correlations based on parents' gender

The summary of the correlation between variables of interest regarding parents' gender is presented in Table 2. Mothers' explicit attitudes toward PA were marginally and positively associated with their children's explicit attitudes toward PA ($r = .22$; $p = .06$; 95% CI [-0.01, 0.42]). No association was found either for PA ($r = .16$; $p = .16$; 95% CI [-0.07, 0.38] or SED ($r = -.03$; $p = .78$; 95% CI [-0.26, 0.20]), or explicit attitudes for SED ($r = .13$; $p = .25$; 95% CI [-0.10, 0.35] or the implicit level ($r = -.00$; $p = .97$; 95% CI [-0.23, 0.22]). Regarding these variables, no association was found for adolescents ($ps > .16$).

Correlations in subgroups of children and adolescents regarding parents' gender

Only two correlations were significant (Table 2). Mothers' PA was positively associated with

their children (less than 12 years) PA ($r = .32$; $p = .03$; 95% CI [0.03, 0.56]) and fathers implicit attitudes was positively associated to adolescent implicit attitudes ($r = .71$; $p = .01$; 95% CI [0.020, 0.92]). Other correlations were not significant ($ps > .14$).

Table 1.

Descriptive statistics for attitudes and behaviors in parents and children regarding parents' gender and children's age

	Mothers	Fathers	Children ≤12 years	Children > 12 years
	M (SD)	M (SD)	M (SD)	M (SD)
Physical activity	110.66 (121.07)	224.41 (227.47)	114.20 (107.88)	149.13 (119.12)
Sedentary behavior	113.65 (106.77)	110.18 (154.33)	103.99 (89.51)	180.51 (149.51)
Explicit attitudes PA	2.17 (0.75)	2.09 (1.20)	1.90 (1.02)	1.51 (0.95)
Explicit attitudes SED	-1.69 (1.22)	-1.91 (1.20)	-0.73 (1.50)	-0.75 (1.28)
Implicit attitudes	-0.02 (1.01)	0.11 (1.02)	-0.03 (1.05)	0.09 (0.91)

Table 2.
Correlations between attitudes and behaviors in parents and children

	Parents (N = 107)	Mothers (N = 74)	Fathers (N = 27)
Children and adolescents (N = 107)			
1. Physical activity	.19*	.16	.28
2. Sedentary behavior	.01	-.03	.09
3. Explicit attitudes (PA)	.10	.22 [†]	-.17
4. Explicit attitude (SED)	.09	.13	.02
5. Implicit attitudes (standardized)	-.03	-.00	-.04
Children < 12 (N = 65)			
		Mothers (N = 46)	Fathers (N = 16)
1. Physical activity	.25*	.32*	.27
2. Sedentary behavior	.19	.08	.34
3. Explicit attitudes (PA)	.01	.19	-.28
4. Explicit attitude (SED)	.12	.22	-.11
5. Implicit attitudes (standardized)	-.11	-.05	-.05
Adolescents > 12 (N = 40)			
		Mothers (N = 26)	Fathers (N = 11)
1. Physical activity	.09	.03	.27
2. Sedentary behavior	-.10	-.08	-.07
3. Explicit attitudes (PA)	.20	.27	.06
4. Explicit attitude (SED)	.03	-.06	.22
5. Implicit attitudes (standardized)	.23	.04	.71**

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Discussion

This study investigated the relationship between parents' and children's PA and SED, as well as between their respective explicit and implicit attitudes toward these behaviors. In line with our first hypothesis, the results highlighted a potential effect of parental role modeling through a significant and positive association between the parents' and their children's PA. This result strengthens the conclusions of previous research in the PA context (Xu et al., 2015). In addition, consistent with our hypothesis regarding children' age, the correlations remained significant only for young children (i.e., ≤ 12 years). This result is in line with previous results showing that the role modeling hypothesis is more systematically observed in children than in adolescents (Sterdt et al., 2013). Parents are the primary caregivers and thus the primary model for their young children, whereas adolescents spend increasing amounts of time away from their parents. Their development is thus substantially impacted not only by their family life, but also by others such as peers (Arnon, Shamai, & Ilatov, 2008).

Previous research on PA showed a similar pattern of association between mothers' versus fathers' PA and that of their children (Neshteruk et al., 2017). However, other reviews highlighted stronger correlations for father-child PA compared to mother-child (Biddle et al., 2011; Yao & Rhodes, 2015). In the present study, the results focused on parents' gender were not significant except when distinguishing parents' gender and children's age. That is, results showed a positive association between mothers and young children's PA but not with fathers. These results are not in line with previous research. Further research is needed to examine this relationship. In particular, future studies could also take into account the role of the children's age in this relation. Also, in the present study the intensities of PA (light, moderate or

vigorous) were not differentiated in the measure of PA. However, research suggested that mothers and father could affect differently their children level of PA (Edwardson & Gorely, 2010). The authors showed that generally mothers' modelling was positively associated with their children's MVPA. By distinguishing PA intensity, further study could be more accurate and have better chance to reveal an association between mothers' versus fathers' PA and that of their children.

Contrary to previous research on screen time (Xu et al., 2015), no association was found between parents' and children's SED, either in the whole sample or in subgroups distinguishing children's age or parents' gender. One major difference between our study and previous research is that our measure encompassed multiple SED. This method may have characterized very particular patterns of activities in leisure time for adults versus children (e.g., listening to music, reading, talking on the phone, doing homework). Future studies should further investigate this issue with a more consensual definition of SED, with a complementary measurement using accelerometer and with a more fine-grained analysis of SED.

Next, our results showed no evidence that parents' attitudes were correlated with those of their children when parent's gender and children's age were not distinguished. At the explicit level, the previous results on the association between parents' and children's attitudes have been inconsistent: although a significant correlation has sometimes emerged for PA (Anderson et al., 2009), this has not always been the case for other health-related behaviors (Guidetti et

al., 2012; Sherman, Chassin, Presson, Seo, & Macy, 2009). At the implicit level, the lack of correlation might have been due to the singularity of PA and SED compared with the previously investigated health-related behaviors, which showed significant parent-child implicit attitudes associations (Guidetti et al., 2012; Sherman et al., 2009).

Nevertheless, when we distinguished our sample for parents' gender, correlation between parents' and children's explicit attitudes toward PA became marginally significant for mothers, but was not significant for fathers. Because mothers generally spend more time than fathers supervising and educating children, the positive benefits of PA that mothers emphasize while educating their children are more likely to be reflected in the positive outcomes their children expect. Otherwise, the results also showed that father's implicit attitudes toward PA were significantly and positively correlated with adolescents' implicit attitudes. In other words, it seems that the more fathers implicitly favored PA compared with SED the more their children did. These results could indicate a distinct and complementary influence of fathers and mothers on children's PA attitudes. The factors on which mothers and children had a relationship could be tangible and conscious (i.e., explicit attitudes), while fathers seemed to play a role in the development of their children's non-conscious processes (i.e., implicit attitudes). The latter takes time to be developed. This could explain why the relationship only appeared during adolescence.

Some limitations should be considered when interpreting the results of this study. First, the

cross-sectional design does not enable a directional interpretation of the significant links observed. Further longitudinal and experimental research is thus needed to investigate the relationships of parents' and children's PA and SED and their attitudes about them. Also, although parents are an important source of influence on children's behaviors, they are not the only one. In children's social environment, friends are also likely to play a critical role in the adoption of health behaviors (e.g., Guidetti et al., 2012), particularly PA and SED (Salway, Sebire, Solomon-Moore, Thompson, & Jago, 2018). Further research is needed to investigate whether meaningful individuals in children's and adolescents' social networks affect their PA and SED. Another limitation is that no distinction was made about attitudes, even though this construct encompasses both affective content (i.e., pleasant versus unpleasant feelings associated with a category of behaviors) and instrumental beliefs (i.e., perceived outcomes of behavior adoption on the long run), which do not affect behaviors in the same way (McEachan et al., 2016). A third limitation is that the results pertaining to the subgroups (i.e., formed according to the children's age or parents' gender distinction) should be considered with caution as the groups were unbalanced and sometimes the sample size is too small to draw firm conclusions. Future studies could investigate the relationships between daughters and sons at different ages and their mothers and fathers to gain a more complete picture of the associations investigated in the current study. Last, this study was based on self-reported PA and SED that induce social desirability bias.

Conclusion

The current study is the first to investigate the association between parents' and children' implicit and explicit attitudes toward PA and SED, in addition to the same association regarding these behaviors. It reports the correlations between parents' and children's behaviors, highlighting the greater sensitivity of young children to parental role modeling regarding PA, and shows that mothers' explicit attitudes toward PA and fathers' implicit attitudes act in a complementary way on the explicit and implicit attitudes of their children, respectively. The results lead to the conclusion that actively including parents in interventions aiming to increase children's and adolescents' PA is worth to be considered. Actual practice of PA, and raising awareness of the benefits of PA and the harmful effects of sedentary behaviors could be a potential way to promote PA within families.

Contributions

Substantial contributions to conception and design : GEB, JB; Acquisition of data : GEB; Analysis and interpretation of data : GEB, JB; Drafting the article or revising it critically for important intellectual content : GEB, JB; Final approval of the version to be published GEB, JB

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Data and Supplementary Material Accessibility

R script, supplementary material and tables accessible here: <https://osf.io/327y8/>

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