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Parental correlates of physical activity in children and early adolescents

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Parental Correlates of Physical Activity in Children and Early Adolescents

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Abstract

This article is intended to unite the existing research on parental influences on children's physical activity behaviours in order to establish direction for future research and improve existing child physical activity intervention programmes. A comprehensive, 34-study review of parental correlates of child physical activity was conducted and six variables were examined. There were significant correlations found between parental support and child physical activity level. Results for an association between parental and child physical activity levels, however, were mixed. There were not enough studies to draw conclusions about single-parent families, family socioeconomic status and ethnicity. Finally, there were some weak inter- and intra-generational sex correlations, but these results were mostly inconclusive. Possible mechanisms, including parental support, modelling, shared activities, societal differences by generation, minority groups and genetics are discussed, and recommendations are made on translating experimental results into tangible intervention efforts essential for disease prevention through increased physical activity.

Regular physical activity is a well documented contributor to the health and quality of life for people of all ages.[1,2] Despite the accumulation of evidence for its health benefits, physical activity levels in developed nations (e.g. Canada, US, UK and Australia) are quite low.[3-6] It has been estimated that 59% of Canadian women and 52% of Canadian men are physically inactive,[7] and similarly, 65% of American women and 51% of American men do not engage in vigorous physical activity lasting ≥10 minutes per day.[4] Thus, there is a need to understand the factors influencing physical activi-

ty and to develop effective intervention programmes.

Physical activity is also a moderate predictor of the short- and long-term health of children.[8,9] There is substantial evidence that diseases for which sedentary behaviour is a risk factor, such as coronary heart disease, develop over a lifetime,[10] and there is also evidence for the notion that physical activity behaviours established in youth may persist into adulthood.[10] Population surveys indicate that many youth are not meeting current physical activity guidelines.[11] In particular, recent evidence shows that 33% of American children (aged 13–18 years)[12] and 58% of Canadian children (aged 12–19 years) are physically inactive and that as many as 84% of Canadian children are not active enough to meet international guidelines.[7] These disquieting statistics call for an understanding of determinants of physical activity in youth in order to develop appropriate interventions designed to reduce the risk of disease and mortality.

The correlates of physical activity in children and adolescents have been previously explored in a review by Sallis et al.[11] They found that the most consistent correlates of physical activity in children (aged 3–12 years) were male sex, parental overweight status, physical activity preferences, intention to be active, perceived barriers (inverse), previous physical activity, healthy diet, programme/facility access, and time spent outdoors.[11] Consistent correlates of adolescents' (aged 13–18 years) physical activity were male sex, ethnicity (Caucasian), age (inverse relationship), perceived activity competence, intentions, depression (inverse relationship), previous physical activity, community sports, sensation seeking, sedentary after school and on weekends (inverse relationship), parental support, support from others, sibling physical activity, direct help from parents, and opportunities to exercise.[11] These variables, and other potential correlates from various studies can be classified into several broad categories for the purpose of analysis:

- fixed biological variables (e.g. age, sex, ethnicity);
- cognitive variables (e.g. goal orientation, intention);
- behavioural variables (e.g. participation on sports team, sedentary time);
- social variables (e.g. parent modelling, parental/peer/sibling/teacher/coach support);
- physical environment variables (e.g. opportunity to be physically active).

By categorising the correlates of physical activity and youth, it becomes possible to distinguish between variables that can be actively manipulated by intervention programmes, such as parental support, and those that can only serve as markers of potential risk or targets of future intervention strategies, such as sex and age. This differentiation of modifiable correlates allows for more efficient planning of intervention efforts.

Social variables may represent some of the most important modifiable factors for youth physical activity. In particular, the influence of parents may be of paramount importance. Bandura's Social Cognitive Theory (1986) provides a theoretical basis for examining the parent-child interaction as it relates to physical activity behaviours.[13] More specific models of youth physical activity have been developed. Welk[14] proposed a social-cognitive framework specific to children, while Taylor et al.[15] put forth a model that considers both parent and child behaviours and cognitions in the context of environment. [15] Clearly, parents are one of the most important socialising agents for children, and their physical activity behaviours are generally considered to be one of the strongest determinants of a child's activity patterns.[16] Presumably, parents not only serve as role models but also as 'gate-keepers' to physical activity, driving children to sporting events or registering them in exercise classes or sports lessons.

Parental support and modelling are relatively well accepted as possible mechanisms for parent-child aggregation of physical activity, but there are other possible interpretations. Specifically, the concepts of shared activities, societal differences by generation, genetic heredity, and the implications of being in a minority group have all been mentioned in the discussion of mechanisms of parent-child interactions.

Thus, the purpose of this article is to unite the existing research on parental influences on children's activity behaviours in order to establish direction for future research and improve existing child physical activity intervention programmes. The pre-

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vious review by Sallis et al.[11] included brief commentary on correlates of parent and child physical activity, but this review will elaborate on potential mechanisms and deepen the discussion of this subset of literature.

This is a systematic review and follows standard principles and procedures as outlined in the second edition of *Systematic Reviews in Health Care* by Egger et al.[17] The inclusion criteria required that the study measured children's physical activity *and* measured either parents' physical activity or children's perceptions of their parents' physical activity. Furthermore, we included only studies examining youth ranging in age from 3–18 years. There were no inclusion restrictions placed on outcome of studies, nor on study designs and methodologies, with the exception of the aforementioned measure of physical activity. Children in this review are defined as boys and girls aged 3–12 years, while adolescents are boys and girls aged 13–18 years. Distinctions between children and early adolescents were made in this review only if they were made in the articles examined. Regarding definitions of physical activity versus exercise, of 34 studies, ten examined physical activity only, two focused specifically on exercise, while 24 either used the terms interchangeably or were aware of the distinction but evaluated both variables together (e.g. measured both energy expenditure and sports participation and reported one set of results). Because of this, the results will be reported in accordance with the terms or definitions used in each study. In general discussion, the term 'physical activity' was used since exercise is by definition a subset of physical activity.

As per guidelines from Egger et al.,[17] an online search was conducted on five journal databases: MEDLINE, PsycINFO, PubMed, Academic Search Elite, and Sport Discus using the keywords 'parental influence', 'influences on child physical activity', 'parent-child', 'physical activity' and 'exercise' in some combination. Articles found were subsequently scanned for additional references. Thirty-four studies met the inclusion criteria (see table I). Study quality was assessed, data were extracted, and results were analysed and presented; these findings are all presented in subsequent sections. Due to the heterogeneity in this particular group of studies with respect to variables examined and results reported, and the fact that there are very few findings in certain areas (e.g. socioeconomic status, single-parent families), a meta-analysis may have provided precise but spurious results.[17] Additionally, although there is no minimum number of studies required for a meta-analysis, a statistical evaluation on this subset of research may be misleading and we believe the current systematic review is more valuable in this area at the present time.

The current article includes an additional nine studies on the topic from Sallis et al.[11] Furthermore, we have focused specifically on behavioural correlates of child physical activity because these are directly related to actual behaviour, whereas many of the social cognitive variables examined in other studies and in the Sallis et al.[11] review are only moderately related. This particular body of literature is relatively unexplored, and thus we consider it appropriate to carefully and clearly establish any direct relationships before considering indirect correlates of behaviour.

This review has been divided into sections corresponding to the major potential mechanisms of intergenerational relations (parental modelling and parental support), and fixed demographic variables (number of parents in family, family socioeconomic status, ethnicity and sex), after an examination of the variables and findings of all 34 studies. The variables in these sections have been evaluated such that correlates are deemed to be 'strong' if >60% of studies in the particular section support the same correlate, moderate if 34–59% of studies supported a particular correlate, and 'weak' if <33% of studies supported a correlate (based on variable strength criteria from Sallis et al.[11]).

1. Parental Physical Activity Level

Twenty-four of the 34 studies reviewed measured the relationship between parental physical activity level and their children's physical activity level. All 24 were carried out between 1985 and 2003; of these, 20 were cross-sectional and four were longitudinal. In terms of the quality of physical activity measures, six studies used accelerometers, six exclusively used previously validated questionnaires or physical activity recalls, while the remaining 12 used questionnaires or interviews created specifically for the particular study without providing prior/

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Table I. Breakdown and summaries of studies reviewed

Study (year)	Country	Study type	Participants	Measures	Outcomes
Gottlieb and Chen[18] (1985)	US	CS	2695 youth (aged 11–15y, 47.3% male)	Questionnaire on heart health knowledge: including PA and leisure activities of child; exercise of parents	Parental exercise, father's occupation, and ethnicity are significantly related to frequency of exercise; parental exercise had stronger influence on frequency of exercise in girls
Godin et al.[19] (1986)	Canada	CS	198 youth (aged 12–14y, 50.5% male) and their parents	Questionnaire on perception of parents' PA (given to youth) and questionnaires on exercise habits for parents and youth (2 different questionnaires)	Perception of parent PA did not vary by youth sex; correlation b/w perception of mother PA and youth PA in 13y boys and 14y girls and boys and 12y girls; correlation b/w perception of father PA and youth PA in 12y girls and boys and 13y girls
Godin and Shephard[20] (1986)	Canada	CS	698 youth (aged 12–15y, no sex split)	Questionnaire: Fishbein model variables, current PA habits, past PA (parent and child), perception of parent's PA level and SES	Strength of child's intention to exercise associated with mother's intention, father's current PA, and family SES
Perusse et al.[21] (1988)	Canada	CS	7320 pairs of parent-biological offspring (no mean age or sex split)	Questionnaire: PA habits and other lifestyle components	EE and activity level b/w fathers and offspring and mothers and offspring were significantly correlated
Sallis et al.[22] (1988)	US	CS	95 Anglo and 111 Mexican-American families: 301 children (mean age 12y, 52% male); 188 mothers, 100 fathers	PA interview (EE and time in hard activity); BMI	Moderate familiar aggregation of PA was found; Mexican-American had higher correlation; mother-child correlations were usually higher than father-child
Sallis et al.[23] (1988)	US	CS	33 children (mean age 4y, 39% male) and their parents	Child PA data, BMI, type A behaviour; parent PA data, BMI, family CVD risk	Parental vigorous activity was correlated with child moderate activity
Perusse et al.[24] (1989)	Canada	CS	893 youth (mean age 14.6y, 53.4% male); 717 parents	3d activity record for all subjects; BMI; PWC150; SES (father's occupation)	Transmission of PA b/w generations was significant; 29% genetic component for level of PA; 12% cultural component for exercise participation

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Table I. Contd

Study (year)	Country	Study type	Participants	Measures	Outcomes
Poest et al.[25] (1989)	US	CS	514 children (mean age not reported, 'preschool children', 52.3% male) and their parents	Parent questionnaire on their participation in PA and their child's large motor activities	Boys spent more time in large motor activities than girls; amount of time parents spent in PA correlated significantly with child PA patterns
Freedson and Evenson[26] (1991)	US	CS	30 children (aged 5–9y, 43.3% male); 30 mothers and 30 fathers	Each family member wore accelerometer and completed activity record; categorised into high or low activity group based on results	Correlation b/w: father-child frequency of PA in 67% of sample, amount of PA in 70% of sample, but no correlation in 28% of sample; mother-child frequency of PA in 73% of sample, amount of PA in 66% of sample; % age of inactive children highest with 2 inactive parents, lowest with 2 active parents
Moore et al.[16] (1991)	US	LO	102 children (ages 4–7y, no sex split), 99 mothers, 92 fathers	Accelerometer to assess PA levels (2 periods of 5 consecutive days, 6mo apart)	Children of active parents were 5.8 times as likely to be active (active mother: 2× more likely; father: 3.5×) than children of non-active parents
Anderssen and Wold[27] (1992)	Norway	CS	904 youth (mean age 13.3y, 55.1% male)	Questionnaire: (wrt parents and friends) perceived PA of friends/parents, perceived direct support, direct help from parents for PA, and perceived value of PA of friends and parents	All four measures correlated with child PA levels; none of the measures was significantly stronger than the other
Sallis et al.[28] (1992)	US	CS	297 children (mean age 9y, 50.2% male); 669 parents	Child PA: self-report, results of 1.6km (1 mile) run, accelerometer parent PA: questionnaire and self-report behaviours	Parental PA not associated with child PA; availability of transportation was significant predictor of PA; correlation b/w playing with children and PA, but not b/w verbal encouragement and PA
Dempsey et al.[29] (1993)	US	CS	71 children (ages 9–12y, 50.7% male); 69 parents	Questionnaire: PA value, PA expectancies, perceived competence, goal orientation and self-reported PA levels	Parents' perceptions of children's competence was only variable related to child PA participation

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Table I. Contd

Study (year)	Country	Study type	Participants	Measures	Outcomes
Sallis et al.[30] (1993)	US	CS	347 children (mean age 4y, no sex split); and one or both parents	Child PA behaviours assessed using BEACHES (direct observation technique); demographic questionnaire; mothers' PA 7-day recall; support assessed with Family Environment Scale; other social questionnaires	Prompts by parents not correlated with child PA; ethnicity and sex (child) but not SES were associated with child PA; mother's PA was not associated with child PA; family support environment not correlated with child PA
Stucky-Ropp and DiLorenzo[31] (1993)	US	CS	242 children (mean age 11y, 50% male); and their mothers	Physical Activity Interview, the Children's Physical Activity Questionnaire, and the Parental Physical Activity Questionnaire	PA predictors for boys: PA enjoyment, social support, mother's perceived barriers, mother's perceived support; for girls: PA enjoyment, no. of exercise-related equipment at home, mother's perceived support and barriers, and direct modelling of PA
Zakarian et al.[32] (1994)	US	CS	1634 youth (mean age 15.9y, 49.4% male)	Questionnaire: vigorous exercise performed outside of PE class, number of days per week they participated in PE class, sports team participation; independent variables were social, cognitive and physiological variables	Family support was a predictor of frequency of vigorous exercise and PE class in females only; males exercised more than females
Garcia et al.[33] (1995)	US	CS	286 children and youth (aged 10–12y or aged 13–14y, 48.3% male)	Health Promotion Model variables: background, health and behavioural factors	Sex and grade by sex differences found; predict 19% of variance in exercise behaviour
Biddle and Goudas[34] (1996)	England	CS	147 youth (aged 13–14y, no sex split)	Questionnaire: PA levels, intention to exercise, social-cognitive variables, adult encouragement	Frequency and intensity of adult encouragement was a significant predictor of children's PA and intentions to exercise; also indirectly predicted competence

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Table I. Contd

Study (year)	Country	Study type	Participants	Measures	Outcomes
Brustad[35] (1996)	US	CS	107 children (mean age 10.6y, 44.9% male)	Questionnaire: PA level, physical competence, perceptions of parental PA beliefs and behaviours	Significant relationship b/w parental socialisation and children's perceived competence; also sex differences wrt exertion in PA
Epstein et al.[36] (1996)	US	CS	59 children (mean age 10.5y, 33.9% male); 49 mothers, 10 fathers	Activity hedonics questionnaire, body composition, decisional balance questionnaire, and measures of psychological problems, submaximal fitness test, SES, recorded activity, wore accelerometer (parent and child completed all measures)	SES accounted for 6.8% of variance in model of child PA determinants, parent self-report activity accounted for 8.0%
Hovell et al.[37] (1996)	US	CS	486 children (aged 9–10y, 49.8% male); surveys completed by 88% of all parents	Parent PA and support for child PA survey; child PA assessed with accelerometer; used parent education as measure of SES	Girls had lower activity levels than boys; predictors of boys' activity = parent education, parent PA level, parent support; predictors of girls' activity = parent support
Yang et al.[38] (1996)	Finland	LO	Group 1: 635 children (mean age 9y, 49.8% male). Group 2: 648 children (mean age 12y, 49.5% male). Group 3: 598 youth (mean age 15y, 47.8% male)	Questionnaire (every 3y) PAI – assess PA variables (children and parents); SES; parental education	Father's PA related to child's PA; extent of child's sport participation higher in families with active parents than in families with inactive or single parents
Aarnio et al.[39] (1997)	Finland	CS	3254 youth (aged 16–18y, 47.8% males; all sets of twins); 1858 parents and grandparents	Questionnaire to assess leisure time PA; also, indices of PA to compare generations; SES	Intragenerational correlations, but no intergenerational. Significant differences b/w very active and inactive mothers and their daughters

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Table I. Contd

Study (year)	Country	Study type	Participants	Measures	Outcomes
Bungum and Vincent[40] (1997)	US	CS	852 youth (aged 14–18y, 0% male)	Survey: physiological, social, psychological, environmental, and demographic variables; parent modelling and support also assessed	Ethnicity correlated with EE
Pate et al.[41] (1997)	US	CS	361 children (mean age 10.7y, 48.8% male)	PA correlates questionnaire: psychosocial and environmental correlates; self-report PA questionnaire; classification of children as active or low-active	Ethnicity and perceived activity level of parents/ peers not significantly associated with activity status; sex not associated with moderate activity status
DiLorenzo et al.[42] (1998)	US	LO	Phase 1: 242 children (mean age 11.2y, 50% male) and 242 mothers. Phase 2: 111 youth (mean age 14y, 51.4% male), 111 mothers and 80 fathers	PA Interview, child's PA questionnaire, parent's PA questionnaire	In 5/6, enjoyment of PA was only contributor to PA behaviour In 8/9, parental PA levels and support/modelling predicted child's PA behaviour
Kimiecik and Horn[43] (1998)	US	CS	81 children (aged 11–15y; 67.9% male); 79 mothers, 63 fathers	Questionnaire: measures of parental beliefs and exercise behaviours (parent and child)	No relation b/w parents' PA behaviour and child's PA behaviour; correlation b/w parental PA beliefs and child's PA behaviour
Sallis et al.[44] (1999)	US	LO	732 children (mean age 9.4y at baseline, 49.5% male) and up to 3 adults per household	Child activity measures: 1d recall, accelerometer, parent questionnaire; measure of PA change over year; skinfolds, child-reported psychological variables, parent report of parent PA (baseline and 1y)	Girls less active at baseline than boys; parent transport of child predicted child behaviour change, parent PA predicted only boys' PA change
Raudsepp and Viira[45] (2000)	Estonia	CS	375 youth (aged 13–14y, 49.1% male) and their parents and siblings	7d physical activity recall (to assess PA levels)	Weak but significant familial aggregation of PA was found; fathers were stronger predictors of child PA than mothers

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Table I. Contd

Study (year)	Country	Study type	Participants	Measures	Outcomes
Campbell et al.[46] (2001)	Canada	LO	153 children and youth (mean age 13.5y at baseline [12y study], 50.3% male); and their parents	3d activity record that measured daily EE, inactive time and MVPA	Parental measures of PA levels did not add any predictive value, except daily EE in fathers (explained 8% of variance in young adult males)
McGuire et al.[47] (2002)	US	CS	900 youth (ages 13–18y; 47% male); 808 mothers, 92 fathers	Interview to collect info about their eating, exercising and weight-related behaviours (parents and adolescents)	Encouragement positively related to PA in White and Black boys and all girls; parent's concern about own fitness negatively related to television time in White girls, positively related in Black girls
Trost et al.[48] (2003)	US	CS	380 children (mean age 14y, 45% male) and their 2 parents	Parents: questionnaire (PA, support for child PA, importance of child PA, enjoyment of own PA). Child: questionnaire (PA, PA self-efficacy)	Parental PA behaviour, enjoyment of PA and perceived importance of PA were all positively associated with parental support; parental support related to child PA; parent PA not directly related to child PA
Davison et al.[49] (2003)	US	CS	180 children (mean age 9y, 0% male) and their mothers and fathers	Questionnaire: parents' support and modelling; PA measures for child: short version of Children's PA Scale and physical fitness test; anthropometric data (child)	Mothers more likely to provide support, fathers more likely to provide modelling, both of these increase PA levels in girls; if one parent provides support, more likely that the other parent also will; number of supportive parents predicts child PA
Welk et al.[50] (2003)	US	CS	994 children (mean age 10y, 51% male); 91 fathers, 440 mothers, 3 guardians	Survey: PA levels, attraction to PA, perceived competence, perceived parental influence	Parental influence accounted for 20%, 26% and 28% of variance in PA, attraction to PA, and perceived competence, respectively; also, children of active parents showed higher parental influence

BEACHES = Behaviours of Eating and Activity for Child Health Evaluation System; **BMI** = body mass index; **b/w** = between; **CS** = cross-sectional; **CVD** = cardiovascular disease; **EE** = energy expenditure; **LO** = longitudinal; **MVPA** = moderate-to-vigorous physical activity; **PA** = physical activity; **PAI** = Physical Activity Index; **PE** = physical education; **PWC150** = physical work capacity at a heart rate of 150 beats/min; **SES** = socioeconomic status; **wrt** = with respect to.

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concurrent validity information. This indicates that in 18 of 24 of the studies, the methods used to determine correlations between parents' and children's physical activity levels were not objective measures, and in 12 of 24 of the studies, the methods used had unreported validity.

Overall, there were mixed findings regarding whether parent physical activity is a correlate of child physical activity. Six of the 14 studies indicated that parental physical activity was a moderate predictor of children's physical activity,[16,18,22,23,31,50] but seven studies did not support these findings, reporting weak or no correlation between physical activity patterns of parents and children.[28,29,39,43,46-48] DiLorenzo et al.[42] were the only researchers to find an inverse relationship between parental modelling and children's physical activity levels (boys in the 8th and 9th grade). In terms of differences with age, Garcia et al.[33] found that older, compared with younger youth were significantly less likely to have parental exercise role models.

Of the six studies supporting a correlation in parent-child physical activity levels, three used measures that had been previously validated[22,23,50] and one was a longitudinal study that used a Caltrac accelerometer.[16] The latter was a very elegantly designed study in which it was found that children from families in which both parents were active were almost six times more likely to be active than children from families in which neither parent was active (sons were 7.2 times more likely, daughters were 4.5 times more likely). Also, the effect of parental activity was shown to be higher for boys than for girls.[16]

Seven of the eight studies that did not support the parent-child physical activity correlation used questionnaires or interviews that had not been previously validated, which makes this group of studies potentially confounded by measurement error when compared with the first seven. However, Sallis et al.[28] did show that parental physical activity was not related to children's physical activity using an accelerometer in conjunction with previously validated questionnaires and field tests.

In summary, it seems as though there is still much uncertainty with respect to this relationship. Although six studies showed a correlation between parent and child physical activity level, there were seven studies in the no-correlation group, and there was even one study that found a negative correlation between child and parent physical activity level.[42]

Common limitations of the studies were the general use of cross-sectional designs, the lack of standardisation, and validity in the measures used, and the potential lack of generalisability of the results to minority populations. Although some studies included participants that were representative of the average population,[16,18,46,47,50] the participants in the majority of the studies were usually of a higher socioeconomic status and were not ethnically diverse (usually, a higher percentage of Caucasians than what is seen in a typical North American population, i.e. 72% Caucasians in the US,[51] 87% Caucasians in Canada[52]).

For future studies, it may be important to consider both positive and negative forms of modelling and that one type may have a stronger influence than the other when it comes to physical activity habits.[50] It is also quite possible that children's physical activity levels influence parental patterns of activity.[39] Children who participate in sport tend to be independent and have their own expectations, which has a higher potential to change the parents' lifestyle.[38] Thus, the employment of experimental and longitudinal designs is needed. Finally, examining personality characteristics of active parents and children to determine a relationship in the aggregation of physical activity habits would also make for interesting future research.

2. Parental Support for Physical Activity

Of the 34 reviewed studies, 19 examined the relationship between parental support and child physical activity levels. These studies spanned from 1992 to 2003; 16 of the 19 were cross-sectional while three were longitudinal. Only three studies used an accelerometer for child activity measures,[28,37,44] while 16 employed questionnaires, interviews, or self-report log books as measures to assess support and/or physical activity.

All but one of the studies reviewed showed that there is a strong positive correlation between parental support and child physical activity level. In the study that did not support a correlation, it was re-

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ported that the measure of family support was not completely reliable.[30] Since the designs and methodologies of the 19 studies were all similar, the highlights of the significant findings are outlined below. Generally, the results showed that parental support can directly or indirectly (e.g. through self-efficacy) predict child's physical activity level. The studies also show that this effect tends to be more pronounced for younger children[28,33] and that the three most important forms of parental support are encouragement, involvement and facilitation.[28,34,35,37,42,47,50]

In support of a direct correlation, Anderssen and Wold[27] found a strong direct relationship between parental support in exercising vigorously and children's physical activity behaviours. Direct correlations have been reported in other studies, both cross-sectional[32,34,40,47,49] and longitudinal.[44] Parental encouragement has been shown to increase children's physical activity level.[34,47] Also, parental facilitation of physical activity (which can include transporting the child to various exercise or sporting venues or providing equipment, access, or opportunities to be active) has been strongly correlated with children's physical activity levels.[28,37,50] Conversely, indirect correlations can also be found between parental support and children's physical activity (mediated by psychosocial constructs).[31,34,43,48,50]

The remaining studies are not specific in their theorising as to whether parental support directly or indirectly predicts child physical activity patterns. For example, DiLorenzo et al.[42] found that family support in the form of encouragement correlated with physical activity levels of 5th and 6th grade boys. Parental involvement, a more overt form of support that can include coaching or playing with the child, has been found to be positively correlated with that child's physical activity behaviours.[28,37,50] Lastly, children whose parents have higher perceptions of their children's physical activity competence were more likely to be physically active.[29]

In terms of differences by age, Garcia et al.[33] found that older compared with younger children were significantly less likely to receive social support for exercise, and Sallis et al.[28] found that verbal prompts by parents were less effective for older children. Whether this is because parents play a more active support role when their children are young or whether it is because older children are not conducive to situations in which they are likely to receive parental support is not yet clear.

Considering the findings regarding parental physical activity and parental support together, one hypothesis for the split in findings with respect to parental modelling of physical activity is that parents who are physically active are more likely to support their children in physical activity.[50,53] Trost et al.[48] suggested that parental modelling alone does not remove important barriers to exercise (e.g. transportation to exercise venue), and therefore is an insufficient influence on children's physical activity habits. Thus, support may mediate any correlation between active parents and active children.[50] The important corollary of this hypothesis is that parental physical activity is not necessary, but is conducive to child physical activity levels. Of the present research conducted, only one of the seven studies that found significant correlations between parent and child physical activity controlled for parental support. In this study, the correlation between parent and child physical activity became trivial after controlling for support.[50] Thus, limited evidence exists to examine whether parental and child physical activity levels merely correlate due to a third variable of parental support, but this may be the case.

Overall, parental support in being active probably increases the likelihood of children engaging in physical activities.[54] Future studies should continue to determine whether the relationship between parental support and child physical activity is a direct correlation, or whether it is mediated by other variables (i.e. parental support may increase child self-efficacy for physical activity, which may increase child physical activity itself). Use of full social cognition models such as social cognitive theory[13] may help determine the causal structure of parental support. Also, because parents who are supportive tend to be physically active themselves, it would be helpful to establish the impact of genetics on the relationship between active parent (likely to be a supportive parent) and active child so that this effect, if it exists, can be controlled for in future research on parental support. At this point, studies employing experimental and longitudinal designs would be appropriate to further narrow in on the

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relationship between parental support and child physical activity.

3. Influence of One Parent versus Both Parents

Only five studies of the reviewed 34 examined differences between physical activity of two parents in each family and activity of one parent in each family. One study found that children from single parent families were more physically active,[28] while the other four found a strong correlation between number of active parents and child physical activity: having one active parent meant that children were less active than those from families in which there were two active parents, but were more active than those from families with no active parents.[16,26,38,49]

Three studies were cross-sectional and two were longitudinal. Two of the cross-sectional studies, conducted by Sallis et al.[28] and Freedson and Evenson[26] used accelerometers, while the other cross-sectional study, by Davison et al.,[49] used previously validated questionnaires to assess activity-related parenting practices and child physical activity. Moore et al.[16] conducted a longitudinal study using a Caltrac accelerometer to assess physical activity levels; this study also controlled for many confounding factors, such as the child's sex, weight, and parents' age(s). The second longitudinal study, carried out by Yang et al.,[38] used a questionnaire that had not been previously validated to assess physical activity. Of all the studies in this section, three examined the differences between having two, one, or no active parents,[16,26,49] while both Sallis et al.[28] and Yang et al.[38] examined the differences between single-parent and two-parent families.

Support for a positive relationship between child physical activity level and single-parent families was found in the study conducted by Sallis et al.[28] They showed that boys from single-parent families had higher physical activity levels (as measured by accelerometer) than boys from two-parent families.[28] Sallis et al.[28] suggest that this may be because boys from single parent families do not have as much supervision, or may have to rely on themselves for transportation (e.g. walking or biking).

The other four studies found that activity levels were highest in children with two active parents, slightly lower in children with one active parent, and lowest in children with no active parents.[16,26,38,49] Moore et al.[16] showed that children with only one active parent were still 3.5 times as likely to be active as children from families in which neither parent was active. Freedson and Evenson[26] found that when both parents were categorised as highly active, 93–97% of the children were also highly active. Lastly, Yang et al.[38] found that children with a single parent were significantly more active than children with a passive father, or even with a moderate-activity father in the case of boys. In summary, it appears as though having only one role model is better than two negative (inactive) role models of physical activity.[16,26,38,49] This may indicate the power of negative role modelling, or it may imply that the remaining parent tries to compensate for the lack of role models.[38]

Some limitations of these studies highlight the need for future research. The main limitations of the research of Yang et al.[38] were that the measures used had not been validated, and that it was not specified whether a single-parent family referred to a divorced, widowed, or never-married parent. It was implied that 'single-parent' meant mother only, but this was not stated explicitly. It is possible that these single-parent variations of family structure give rise to non-identical familial environments, so a distinction between these should be made in future research examining single-parent families. Although Sallis et al.[28] showed that children of single-parent families were more physically active, they emphasised that the effects were weak and that more studies are needed in this area. Lastly, since three of the studies used exclusively two-parent families,[16,26,49] their findings regarding one active parent in a family cannot be extrapolated to single-parent families, due to the possible confounding effects of negative modelling.

Most importantly, there is a great need for a larger volume of research in this area. There has been an increase in the number of single-parent families in recent decades,[51,52] and there is also evidence that these families may require different interventions and methods of support than two-parent families.[55] Issues that need to be addressed are

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the definition of a single-parent family, whether there is a difference between single-parent families and two-parent families (and if there is a difference, define the characteristics that typify those familial structures), the differences in environment with the different categories of single-parent families (e.g. divorced vs widowed), and the effect of modelling and the potential role of compensation by the existing parent in single-parent families.

4. Family Socioeconomic Status

Parents play a large role in determining which activities their children engage in and what resources they have available;[50] these decisions are often influenced by socioeconomic factors. Six studies of the 34 reviewed investigated socioeconomic relationships using measures of parental employment[18,30,36,38,39] and/or parental education.[28,30,36,38] Studies that examined these last two variables but did not make inferences regarding socioeconomic status were not included in this section. The studies were conducted between 1985 and 1997; five were cross-sectional and one was longitudinal. All six used questionnaires to establish physical activity levels (Sallis et al.[28] and Epstein et al.[36] also employed an accelerometer) and to determine socioeconomic status. With the exception of two studies,[28,30] all the measures used did not provide substantial information regarding their validities. When quantifying socioeconomic status, one of the studies used the father's occupation alone as the criterion.[18] Taken together, this information indicates that validity for this group of studies is potentially compromised and that caution should be used in interpreting these results. Still, it appears that family socioeconomic status may be positively correlated to child's physical activity pattern.

Epstein et al.[36] found that socioeconomic status predicted 6.8% of the variance in their model of physical activity. With respect to parental occupation, several results were found. Gottlieb and Chen[18] found that the father's occupation was significantly related to the frequency of exercise of youth. Yang et al.[38] showed that girls aged 9–12 years in the highest social status groups (based on paternal employment) were much more likely to continue training than girls in the other groups. In this same study, there were no differences found with respect to parental employment among boys and among girls aged 12–15 years.[38] Finally, considering parental education, Yang et al.[38] found that 9-year-old boys of fathers with a higher education were more likely to participate in sport than the children of less educated fathers.

Contrary to the aforementioned findings, Sallis et al.[30] found that socioeconomic status did not correlate with child physical activity, and similarly, Sallis et al.[28] were not able to show any significant correlation between parental education and child physical activity level. However, it should be noted that 80% of the parents in the latter study had a minimum of a college education, which may have limited the ability to detect any associations with this variable.

As mentioned in section 3, a major limitation of this group of studies was the lack of a standardised measure of family socioeconomic standing. In addition, the small number of studies in this section, coupled with many confounding factors (such as parental education, ethnicity and parental occupation) that were not controlled for in the majority of studies suggests that, without further evidence, no definite conclusion can be drawn. Thus, more research is needed. Still, since socioeconomic status may be a difficult variable to change, it may identify populations where interventions need to be focused, but not act as a focus of intervention itself. This last point should not be a rationale for complacency, since socioeconomic status and other non-modifiable correlates play a large role in targeting and directing intervention programmes.

5. Ethnicity

Seven studies of the 34 included in this review examined ethnicity as it relates to parent-child physical activity correlations. All seven were cross-sectional, conducted between 1985 and 2002. There is another caveat to this research: since socioeconomic status can vary by ethnic group[22] and no study included in this review examined the mechanisms underlying ethnic differences in physical activity patterns, it is possible that any differences in physical activity habits by ethnicity could be attributable to socioeconomic status.

The findings of the studies were inconsistent. Specifically, Sallis et al.[22] found that intrafamilial

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correlations were generally higher in Mexican Americans when compared with Anglos, yet McGuire et al.[47] found that the correlation between parental encouragement for exercise and boys' physical activity was the strongest in White and African-American boys, and weaker in boys of Asian, Hispanic and other ethnicity groups.

One study did not support a role for ethnicity: Pate et al.[41] showed that there was no correlation with child activity status. Conversely, two studies supported a direct correlation: Sallis et al.[30] found that Anglo Americans were more physically active than Mexican Americans, and Bungum and Vincent[40] found that Caucasian girls were more physically active than their African-American counterparts (controlled for socioeconomic status).

Relevant non-parental correlates should be mentioned, as these may underlie differences by ethnicity of parental correlates. Garcia et al.[33] found that African-American children reported greater access to exercise facilities than White children. Gottlieb and Chen[18] found that African Americans and Mexican Americans tended to be more involved in competitive team sports that Anglos, who in turn were more likely to participate in activities with more aerobic potential, in individual activities, and in non-competitive activities. This last finding on team sports versus non-competitive activities may mediate differences in interfamilial interactions by ethnic group. Due to the variations in results, the small number of studies, and the differences in the samples (i.e. different ethnic groups studied), no conclusions can be drawn from these findings.

Sallis et al.[22] speculate that ethnic minorities, being underrepresented in the majority culture, are more likely to turn to familial role models and are more susceptible to family influences than Anglos, who are well integrated in the social network. However, as previously implied, there is not enough evidence on the influence of ethnicity on parent-child correlates of physical activity to confirm or refute this hypothesis.

Limitations of the work in this area are the use of questionnaires with unreported validities found in the methodologies of four of the seven studies, and the general shortage of research on this particular topic. There are many studies examining the role of ethnicity in sport and physical activity, but unfortunately, a minority of these studies focus specifically on children and even fewer have identified relationships between parent and child physical activity patterns.

The role of ethnicity in the relationship between parent and child physical activity behaviours is another under-explored area in the search for the determinants of physical activity patterns in youth. It is possible that questionnaires and research designs used in generic studies of ethnicity and sport could be used as templates to develop proper methods of evaluation in the particular case of analysing parent-child interactions. Future studies should aim to further understand the impact of ethnicity in the parent-child physical activity relationship, and at this stage, this will require an accumulation of well conducted studies on this topic.

6. Sex Relations

Twenty-seven of the 34 reviewed studies examined either intragenerational (e.g. male children vs female children in the context of parents) or intergenerational (e.g. father-son vs mother-son) sex relationships, or both. Five were longitudinal while 22 were cross-sectional. Of the 27 studies, five used accelerometers, ten used questionnaires and self-report methods that had been previously validated, and 13 used questionnaires, interviews and self-report methods that were either created for the study, or did not state the validity or cite a validity study.

Results as to whether sex is a factor in parent-child physical activity were inconsistent, even when considering the most rigorous study designs.[16,19,22,26-28,30,32,33,37,41,44,45,49] Furthermore, of the better designed studies, eight included participants who were not representative of the general North American population (e.g. not ethnically or socioeconomically diverse); this is a limitation because the results cannot readily be generalised to larger groups.[22,27,28,30,32,41,45,49] Findings from the 27 studies have been separated by: (i) parental support differences by sex of child; (ii) maternal relationships; and (iii) paternal relationships for the purpose of discussion.

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6.1 Parental Support Differences by Sex

Nine of the 16 articles that focused on parental support differences by sex found that boys generally received more parental support than girls. Furthermore, 12 of these studies identified a strong correlation between sex and physical activity level, namely, that girls tend to have lower levels of physical activity than boys do.[16,25,27-30,32,33,36,37,44,50] Some studies found that boys receive more support to exercise from parents than do girls,[27,28,48] and parental support tended to explain more of the variance in boys' physical activity behaviours than in girls.[37,44,47,50] Additionally, two studies identified that boys receive more parental facilitation than girls.[28,50] Yang et al.[38] found that parental encouragement by parents to be active in competitive sports was higher for boys than for girls. Lastly, Trost et al.[48] showed that parents placed more importance on the physical activity of boys than that of girls.

Contrary to the above studies, Brustad[35] did not find sex differences for parental encouragement of physical activity levels. Similarly, Kimiecik and Horn[43] showed that parental beliefs for their children's physical activity was not dependent on the child's sex, while Garcia et al. [33] found that there were no sex differences with regard to social support for exercise and modelling of physical activity.

In summary, a majority of the studies found that there was a strong sex difference in physical activity levels or in support for physical activity: boys received more support and tended to be more active. Since parental support is correlated to child physical activity level, it may be presumed that sex-dependent differences in parental support are responsible for the sex variations in child physical activity levels. Future studies should attempt to examine differences in parental support due to sex, as this may be a source from which patterns of sex-related differences arise in children.

6.2 Maternal Relationship

The findings for mother-child relations in childhood and early adolescence are unclear, but it appears that mothers may have a more pronounced influence on their daughters than on their sons. Of the 11 studies that have focused on the maternal physical activity relationship, six supported a mother-daughter relationship while just three studies showed a significant mother-son relationship.

In a well designed study, Moore et al.[16] found that children of active mothers were twice as likely to be active as children of inactive mothers. Freedson and Evenson[26] showed that familial aggregation of physical activity occurred between mother and child in 73% of their sample; Perusse et al.[21] also supported a correlation between mother and child physical activity. Sallis et al.[22] found that mothers' energy expenditure (in Mexican Americans but not in Anglos) and hard leisure activity (in both Anglos and Mexican Americans) was significantly correlated with their 11-year-old children's. Similarly, they also found that mothers' energy expenditure (in both Anglos and Mexican Americans) and hard leisure activity (in Anglos but not in Mexican Americans) was significantly correlated with their 13-year-old children's.[22] Only one study found no association between mothers' and children's physical activity.[30]

In support of a mother-daughter relationship, a three-generation study conducted by Aarnio et al.[39] found a significant difference between very active mothers and inactive mothers and their daughters' physical activity (i.e. very active mothers more likely to have active daughters), but not between extreme classes of mothers and their sons. Similarly, Yang et al.[38] showed that mothers' physical activity correlated with girls' physical activity across age, but with only 12-year-old boys' physical activity, and Campbell et al.[46] found that mothers' physical activity did not predict their sons' physical activity. Davison et al.[49] found a strong association between mothers' support and their daughters physical activity. Lastly, in a study done by Raudsepp and Viira[45] using 13- and 14-year-olds, it was shown that mothers' physical activity levels were not related to boys' activities, but that girls' physical activity was related to mothers' moderate physical activity level.

These last five studies suggest that perhaps mothers' and boys' physical activity levels are not related; however, the findings are mixed. For example, DiLorenzo et al.[42] showed that mother's perceived negative family support was inversely related to 5th and 6th grade boys' physical activity levels, an indication that mothers may influence their sons'

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physical activity behaviours. The studies by DiLorenzo et al.[42] and Yang et al.[38] both showed a correlation between mothers' and sons' activity levels, and it is interesting to note that the boys were between 10 and 12 years old in both studies. It is possible that mothers' activity levels predict their sons' only when boys are at a certain age or developmental stage (i.e. late childhood). Furthermore, it must be stated that even the relationship between mothers' and daughters' physical activity behaviours has not been unanimously established: contrary to the above studies, DiLorenzo et al.[42] showed that mother's physical activity level was inversely related to 8th and 9th grade girls' physical activity levels. In summary, there is some evidence for a correlation between mother-daughter physical activity, but mother-son correlations are less consistent.

6.3 Paternal Relationship

Correlations between fathers' and older children's physical activity levels are unclear, although there appears to be a relationship between fathers' and sons' physical activity levels. Only one study, conducted by Aarnio et al.,[39] did not find any association between the physical activity levels of the fathers and those of their sons or daughters.

In two methodologically sound studies, Raudsepp and Viira[45] showed that boys' physical activity was significantly related to all levels of fathers' activity, while girls physical activity was correlated with fathers' total weekly activity and moderate activity, and Sallis et al.[22] found that fathers' energy expenditure (in both Anglos and Mexican Americans) was significantly correlated with their 13-year-old children's. Freedson and Evenson[26] found familial aggregation of physical activity between father and child in 67% of their sample, and similarly, both Davison et al.[49] and Perusse et al.[21] found positive correlations between father and child physical activity.

In another well conducted study, Moore et al.[16] found that children of active fathers were 3.5 times as likely to be active as children of inactive fathers. Yang et al.[38] found that children of active fathers were significantly more likely to persist in sport and also less likely to quit the sport than children of passive fathers; this finding may be due to the tendency for active fathers to offer more support to their children. Yang et al.[38] also found that lower status fathers (based on occupation) offered less encouragement and support to their daughters. Lastly, Campbell et al.[46] showed that fathers' daily energy expenditure explained 8% of the variance in sons' physical activity. These last two studies suggest that paternal activity and support may correlate more with sons' physical activity levels than with daughters'.

DiLorenzo et al.[42] found that fathers' enjoyment of physical activity and perception of social support were inversely related predictors of 8th and 9th grade girls' physical activity levels. In the same study, it was found that fathers' physical activity and self-efficacy for physical activity were important predictors of 8th and 9th grade boys' physical activity.[42] The findings of this study suggest that fathers may influence their sons more than their daughters. In summary, there is a strong correlation between father and child physical activity variables, particularly between father and son activity variables (although there were only four studies reporting any father-son findings).

7. Conclusions

The purpose of this article was to unite the existing research on parental influences on children's activity behaviours in order to establish direction for future research and provide target variables for existing child physical activity intervention programmes. With respect to parent-child physical activity levels, the results are equivocal. Since there is unanimous evidence, however, that active parents are more supportive of their children's physical activity than non-active parents,[48,50] the reported associations of child activity with parent activity may in fact be mediated by differences in support and encouragement, not modelling.

With respect to families with one active parent or single-parent families, it appeared as though having only one role model is better than two negative (inactive) role models of physical activity.[16,26,38,49] However, these results should be interpreted with caution as there were only five studies to examine this effect.

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It appears as though family socioeconomic status may be positively correlated to child's physical activity pattern. However, the small number of studies in this section coupled with the fact that there are many confounding factors (such as parental education, ethnicity and parental occupation) that have not been controlled for suggests that, without further evidence, no definite conclusion can be drawn. Similarly, the role of ethnicity in parent-child physical activity is not conclusive at this time.

Although there are many studies that have examined the inter- and intragenerational sex relationships, the results are still inconclusive. The findings for mother-child relationships in adolescence are unclear, although it appears that mothers have a more pronounced influence on their daughters than on their sons. Correlations between fathers' and older children's physical activity levels are also not unanimous, but there appears to be a relationship between fathers' and sons' physical activity levels.

Parental support and modelling are relatively well accepted as possible mechanisms for parent-child aggregation of physical activity, and were the primary mechanisms discussed in this review. However, some other possible interpretations, specifically, the concepts of shared activities, societal differences by generation, genetic heredity, and the implications of being in a minority are additional possibilities for parent-child physical activity relationships.

The hypothesis of shared activities is built on the assumption that parent and child share the same living environment and that most physical activities are done together as a family;[16] this concept supports familial similarity in energy expenditure and activity patterns. On the other hand, the belief that there are relevant societal differences by generation is an explanation for a discrepancy in the physical activity variables between parent and child. This model presents the idea that increases in both societal individualisation (leading to a rejection of traditional norms[38]) and health awareness (leading to an increase in opportunities for physical activity[39]) have contributed to decreased intergenerational correlations with respect to physical activity. Societal differences are accounted for in the exploration of the role of genetics in physical activity behaviours. The notion that genotype influences physical activity patterns has only been investigated in one study thus far,[24] warranting future research in this area. Finally, the implications of being in a minority group has been proposed as a potential source of variation in familial physical activity patterns between ethnic groups. It has been implied that individuals who are well integrated into the social network (i.e. majority groups) are less susceptible to family influence as they have much more support, opportunities, and non-familial role models than those who are less integrated.[22]

A key limitation of the research in this area is that none of the 34 studies reviewed were experimental studies (85% cross-sectional, 15% longitudinal). In under-explored areas, such as the role of socioeconomic status and ethnicity in parent-child physical activity patterns, correlational research seems appropriate. Also, some of these under-examined or emerging variables (e.g. one-parent families) cannot be easily manipulated for experimental conditions. On the other hand, future studies examining well established relationships, such as parental support and child physical activity levels, should begin to use experimental designs when possible in order to increase the certainty of results. Relevant findings from a well controlled experimental study will probably be translated into intervention efforts much more quickly and effectively than several correlational studies, and these efforts are essential for disease prevention through increased physical activity, the goal of research in this area.

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