The impact of fathers on their children's physical activity and dietary behaviors

Philip J. Morgan[a,b], PhD, & Myles D. Young[a,b], PhD

Affiliations: [a] Priority Research Centre for Physical Activity and Nutrition, University of Newcastle, New South Wales, Australia; [b] Faculty of Education and Arts, University of Newcastle, New South Wales, Australia.

Address correspondence to: Philip J. Morgan, Priority Research Centre for Physical Activity and Nutrition, University of Newcastle, University Drive, Callaghan NSW, 2308, Australia. [philip.morgan@newcastle.edu.au], +612 49 217 265.

Keywords: fathers, dads, children, physical activity, diet, obesity prevention, parenting practices, modeling, co-physical activity

Abstract

Although fathers have an important influence on their children's wellbeing, their unique contribution on child lifestyle behaviors has been largely overlooked in the literature. To inform and encourage future research, this paper provides an overview of existing studies that have examined the influence of fathers on the physical activity and dietary behaviors of their children. While the available data indicate that fathers' behaviors and parenting practices likely play an important role in promoting healthy behaviors in children, the evidence-base is limited by a reliance on observational designs and small, ungeneralizable samples. This paper also provides a summary of the methods, research findings and experiential insights we have gained while conducting the '*Healthy Dads, Healthy Kids*' randomized controlled trials, which tested the efficacy and effectiveness of a socio-culturally targeted program that engages fathers to improve their own health and the health of their children.

INTRODUCTION

Childhood obesity is a global health concern. In developed countries, approximately 24% of boys and 23% of girls are overweight or obese [1]. Between 1980 and 2013, the prevalence of overweight and obesity also increased from 8% to 13% in both boys and girls from developing countries [1]. Compared to their healthy weight peers, these children are more likely to experience a range of negative biological, psychological and social health consequences during childhood [2] and are at a greater risk of physical and psychological morbidity and premature mortality in adulthood [3]. Childhood obesity is also very difficult to treat and reverse. Compared to their healthy weight peers, overweight children are much more likely to become obese adolescents [4], and overweight or obese adolescents are at much greater risk of becoming overweight or obese adults [5,6].

Parents play a key role in preventing childhood obesity by establishing healthy physical activity and dietary behaviors in their children from a very young age. In pursuit of effective strategies to reduce childhood obesity rates, the number of studies evaluating the impact of parent- or family-focused programs to improve children's health has steadily increased in recent years, though progress has been modest [7]. As such, novel approaches are urgently required to improve the effectiveness of these interventions.

Recently, two reviews of observational [8] and experimental [9] parenting and childhood obesity studies identified that mothers represent an overwhelming majority of research participants. Unfortunately, this reflects a broader trend where fathers have been underrepresented across multiple domains of pediatric research including child and adolescent psychology treatment [10] and general parenting programs [11,12]. As such, the unique contribution of fathers to fostering healthy lifestyle behaviors in their childhood has

been largely overlooked. This is likely due to a combination of low father response rates in research studies and researchers specifically targeting mothers, who are more likely to be the primary caregiver [13].

The lack of meaningful father representation in childhood obesity research is a major evidence gap, which has likely reduced our understanding of the factors that influence childhood obesity and hindered the effectiveness of family-based interventions. Indeed, recent research has shown that the weight status and parenting behaviors of fathers may be more important for predicting childhood obesity than mothers [14,15]. For example, a recent study of 3285 Australian families reported that children with an obese father and a healthy weight mother were 15 times more likely to be obese than children with healthy weight parents, respectively [14]. In contrast, children with an overweight or obese mother and a healthy weight father were not at significantly increased risk of obesity. Similarly, a longitudinal study of nearly 5000 children identified that the parenting styles of fathers were reflected in the weight related behaviors of their children. After controlling for multiple covariates including socio-economic position, child sex, parent education level and parent BMI status, children whose fathers were characterized as ‘permissive’ or ‘disengaged’ were at significantly increased risk of obesity compared to children with whose fathers displayed high levels of warmth and control (i.e., authoritative parenting) [15]. In this study, mothers parenting styles were not associated with child weight outcomes.

This research suggests that fathers may have a particularly important influence on the weight status of their children [14,15]. In addition, fathers are now spending more time with their children than ever before [13]. As such, much more high-quality research is warranted to

identify the specific mechanisms of this effect and determine how fathers can best be targeted to improve their children's health in future research and practice.

To inform and encourage future research in this area, this paper will provide an overview of existing studies that have examined the influence of fathers on the physical activity and dietary behaviors of their children. To begin, we will provide a summary of observational research findings, which represent the majority of evidence in the field to date. Following this, we will summarize the methods and results of our *Healthy Dads Healthy Kids* randomized controlled trials [18-20], which were recently identified as the only published studies evaluating father-focused programs on children's lifestyle behaviors [9]. Finally, we will provide a series of experiential recommendations for researchers and practitioners who are looking to engage fathers based on insights we have gained from our work in the field.

OBSERVATIONAL RESEARCH

Overview

Recently, Davison and colleagues conducted a systematic review to identify the inclusion of fathers as research participants in observational studies on parenting and childhood obesity [8]. The study included all articles published from 2009 to 2015 that examined parental influences on childhood obesity or obesity-related behaviors, including physical activity and diet. Notably, fathers represented only 17% of parents across the 667 eligible studies, 48% of which included no fathers at all. In the 52% of studies that included at least 1 father, the unique insights of fathers were merged with mothers in the analysis 84% of the time [8]. Overall, only 10% of studies reported father-specific data and only 1% of studies included fathers only [8].

By clearly demonstrating that fathers are underrepresented in observational research into parenting and childhood obesity, Davison and colleagues concluded that this evidence-gap has compromised the development of effective family-based obesity prevention interventions for children. The review also identified several notable biases in existing research; studies that included fathers were less likely to focus on children aged 0-5 years, more likely to focus on physical activity rather than diet, and less likely to represent fathers from underserved populations (e.g., ethnic minorities and fathers living in areas of low socio-economic position) [8].

In the following section, we will provide an overview of key findings from published observational studies exploring paternal associations with child physical activity and dietary behaviors. However, it is important to consider these findings as very preliminary insights given the overall dearth of research in this area [8]. While other behaviors such as sleep and sedentary behavior (e.g. screen-time) have also been linked to childhood obesity, these will not be covered due to the lack of studies focusing on these outcomes.

Physical activity

Although parents are influential in promoting children's physical activity behaviors, very little cross-sectional research has examined the unique influence of fathers [8,21]. However, two areas of paternal influence that have received some attention in the physical activity literature are physical activity modeling and father-child co-physical activity [21]. Other particularly important variables such including attitudes or family cohesion have not been explored in sufficient studies to generate meaningful insights at this stage [22].

Physical activity modeling

Although systematic reviews of parental correlates of physical activity have reported mixed evidence regarding the effect of parental physical activity modeling on child behavior [23,24], most studies have combined data from both parents without considering the unique paternal and maternal impacts and inter-parental dynamics. However, in a review of environmental correlates of youth physical activity [25], Ferreira and colleagues noted that while no associations in parent-child activity were identified in studies with merged parental data, paternal physical activity was significantly associated with child physical activity in 52% of cases, suggesting a modest, positive relationship. Neshteruk and colleagues supported this finding in their more recent review of the influence of fathers on child physical activity [21], which similarly identified that 52% of published father-child physical activity correlations were significant and positive. In contrast, maternal physical activity levels have been largely unrelated to child physical activity [25].

Although paternal physical activity levels have not predicted child physical activity in all circumstances, the apparent moderating effect of parent sex warrants further examination in future research. To advance the field, researchers should also consider the unique influence of fathers after controlling for maternal physical activity levels, which cannot be investigated when parental data are combined. For example, a recent longitudinal study with a nationally representative sample of 887 US children aged 10-18 years highlighted that fathers' vigorous physical activity levels were consistently and positively associated with children's vigorous physical activity, even after adjusting for possible confounders including maternal physical activity.[26].

Physical activity parenting

Another variable that is often identified as an important correlate of child physical activity is parental support [27], which can be conceptualized in a number of ways including logistic support (e.g., transport to sporting events), verbal encouragement and co-participation. A growing body of research has shown that while mothers often take the lead in providing logistical support, fathers are much more likely to initiate and drive co-participation in physical activity and sport with their children [28,29]. In a recent qualitative study, most mothers described fathers as the family's 'physical activity leaders' who were generally responsible for engaging the children in sports and physical activities at home and in the community [28]. Similarly, in another study where children were asked to write, draw and describe the factors that help them be more active, they were more likely to draw pictures where they were engaged in co-physical activity with their fathers compared to their mothers, who were sitting and watching in some instances [30].

These qualitative insights have also been supported by quantitative evidence. In a large observational study with 10,694 kindergarten-aged children, Beets et al. determined that the amount of time fathers spent with their children on weekdays and weekends significantly predicted child physical activity levels and this influence was mediated by time spent in family sporting activities [31]. A recent longitudinal analysis with accelerometer-measured physical activity also identified that a strong paternal influence may be particularly important to encourage sporting participation in young people from low socio-economic positions [32]

Despite the limited research in this area, these studies provide a good indication that father-child co-physical activity is a key ingredient in establishing and maintaining positive physical activity habits in children. Although the mechanisms for this effect are still somewhat unclear [32], , sociologists have noted that 'play' is often more central to fathers' parenting styles

than mothers' and this pattern emerges at a very early stage in child development [33]. Studies show that fathers typically play more often with their infants than mothers and with greater physicality [29] and, in general, fathers are also better models for fundamental movement skill development (e.g., catching, kicking, throwing) due to their increased opportunity to learn and practice these skills throughout life [34,35]. Aside from the health benefits of increased activity, the typical 'masculine interaction style' of fathers, characterized by unpredictable, stimulating, risky, vigorous and fun play is also thought to improve children's social-emotional wellbeing and help them develop the self-regulatory skills required to compete without aggression [33,36,37].

Father-child co-physical activity is also a key ingredient in nurturing the father-child relationship [29]. Indeed, scholars have conceptualized the father-child bond as an 'activation relationship', which primarily develops through physical, rough-and-tumble play [36]. Father-child co-physical activity continues to play a key role as children grow older. For example, in a study with 86 fathers and adult daughters (unrelated), both groups described father-daughter participation in sporting activities during the daughter's childhood as the most common 'turning point' in the quality of their relationship and emotional connection [38]. For this reason, sports and physical activity have been described as the dominant cultural contexts where fathers leave an enduring legacy with their children [39]. Finally, while some studies suggest that fathers spend more time being active with their sons than their daughters [23], a recent review identified inconclusive evidence on this topic [21]. However, the authors acknowledged that this was likely due to the dearth of published research and called for more studies to examine the potential moderating effect of child sex on fathers' physical activity parenting practices.

Diet

To date, fathers have been largely overlooked in research relating to child feeding [40]. However, the traditional gender roles of parents are changing over time and fathers now spend more time with their children than ever before [13,41]. Recent estimates suggest that over 96% of fathers who live with their children and 30% of fathers who live apart from their children share a meal with their children every day or several times a week [42]. In addition, most fathers now agree that they are responsible for child feeding and ensuring their children are receiving adequate nutrition at least half of the time [43]. In a recent qualitative study with a diverse range of fathers (n = 37), 62% reported sharing child-feeding responsibilities with the child's mother and 16% reported sole responsibility [44]. For the parents who shared child-feeding duties, some completed all tasks together, some were responsible for unique tasks and some were responsible for all child feeding tasks on alternating days. For these reasons, fathers likely have a considerable influence on their children's eating behavior. As with physical activity, two hypothesized areas of paternal influence on children's dietary behaviors are fathers' modeling and parenting practices.

Dietary modeling

To date, a growing body of research has investigated the role of parental modeling on child food intake. However, these studies have relied heavily on maternal data [45]. Despite this, the available evidence indicates that fathers' dietary habits have a unique and important influence on those of their children. Of the available data, independent studies have identified moderate correlations between father-child consumption of fruit for children aged 2-5 years [46], 5-12 years [47] and 12-18 years [48]. Independent of maternal intake, fathers' intake of sweet snacks during infancy has also predicted an increase in child intake of sweet snacks at

3.5 years [46]. In another recent study, McIntosh et al identified that one of the strongest predictors for the amount of time children spent in fast-food restaurants was the fathers' use of such restaurants, but not the mothers' use [49]. The effect of paternal modeling on other dietary variables such as vegetable intake currently remains unclear, largely due to a lack of published research.

Similar to the studies examining the role of fathers' parenting practices on child dietary behaviors, it is important to note that the impact of paternal modeling is also likely to be moderated by a number of factors. To provide a recent example, Walsh and colleagues determined that the dietary intake of younger, overweight fathers from low socio-economic backgrounds may have a particularly strong influence on their children's intake [50]. For this reason, much more research is required in this area before firm conclusions and insights can be drawn.

Dietary parenting

Recently, Khandpur and colleagues conducted a review of all research examining the role of fathers in child feeding, published up to February 2014 [51]. As expected, very little research was available. Of the 20 included studies, most recruited small, homogeneous samples of white, well-educated fathers with little representation of fathers from underserved groups and most insights were based on cross-sectional data collected with survey instruments that were not validated for use with fathers. As such, all findings in this area should be treated as preliminary and interpreted with caution.

Acknowledging these limitations, the authors were able to identify some emerging patterns. Of the available evidence, fathers appeared to be more likely than mothers to focus on their

child's overall food intake rather than the nutritional quality of the food [51]. In addition, fathers were often less likely than mothers to limit their child's access to food or monitor their food intake, but more likely employ strategies to pressure their child to eat (e.g., food as a rewards, physical prompts, praise) [52-54]. However, some research has demonstrated that paternal feeding practices are moderated by the child's weight status, with increased child BMI associated with greater paternal encouragement for healthy eating, lower pressure to eat and greater restriction of child food intake [51]. The impact of child sex of paternal feeding practices was inconsistent.

In the time since the previous review was published, the field appears to have progressed with more studies considering fathers' perspectives and targeting fathers from a broader range of backgrounds (e.g., [55-59]). Consequently, it has become evident that paternal feeding practices vary between fathers from different cultural groups and socio-economic positions. For example, Lora et al. identified that child sugar-sweetened beverage intake was associated with instrumental feeding (i.e., use of food as a reward) and emotional feeding (i.e., use of food to calm) in Hispanic, but not African-American fathers [58]. In contrast, father reports of their child's 'desire to drink' may be a stronger predictor of SSB consumption in African-American families. In another recent study, fathers who lived apart from their children and fathers without a college education were more likely than their counterparts to let their child dictate food preferences [59].

EXPERIMENTAL RESEARCH

Overview

To date, most studies exploring the influence of fathers on their children's physical activity and dietary habits have used cross-sectional or longitudinal designs [8,51]. While these

studies provide preliminary insights, observational data do not provide strong evidence for causality and should be supplemented with rigorous experimental data. However, progress in this area has been limited by a consistent lack of fathers in family-based programs targeting children's lifestyle behaviors [9].

Recently, we conducted a systematic review of father involvement in randomized controlled trials, which tested obesity prevention or treatment programs for children aged 0 – 18 years [9]. The review included 213 unique RCTs, all of which included a parental intervention component and were designed to improve children's physical activity, dietary habits or sedentary behavior. As observed in Davison et al.'s review of observational research studies [8], mothers also represented an overwhelming majority of parents in experimental research. Across the 213 RCTs, fathers represented less than 10% of parents. In trials where only one parent could participate, this proportion reduced to 6%. Notably, fathers were underrepresented regardless of study setting, delivery mode or targeted child age group. Of interest, a greater proportion of fathers participated in studies targeting child physical activity (17%) rather than child diet (9%), though the difference was not significant.

Although the number of publications increased steadily over time, the proportion of participating fathers remained small. Further, while 19 studies explicitly targeted mothers only, the *Healthy Dads Healthy Kids* (HDHK) program of work, which we have led from our research center, was the only program that specifically targeted fathers. In the following section, we will feature an overview of the HDHK program components, study findings, and insights we have gained from conducting this father-focused research project.

Healthy Dads Healthy Kids

With colleagues at the University of Newcastle, Australia, we developed and tested the first childhood obesity prevention program specifically targeting fathers [18-20]. The *Healthy Dads Healthy Kids* (HDHK) program engages fathers as agents-of-change to improve their own health and the health of their children with a range of strategies including increased co-physical activity, improved modeling of healthy eating behaviors and enhanced knowledge of effective parenting practices to optimize child physical activity, dietary and recreational screen time behaviors [20]. Importantly, the program also engages children to become healthy role models for their fathers. To date, HDHK has been tested in efficacy [19] and effectiveness [18] RCTs.

Given the clear lack of fathers in previous studies [9], the design and delivery elements of the HDHK program were socio-culturally targeted to appeal specifically to fathers. Based on considerable quantitative (e.g., process evaluation) and qualitative (e.g., focus groups, interviews) formative work [60], the HDHK program has been continually refined to ensure that the unique preferences, attributes, values, and motivators of fathers are integrated into the program recruitment methods, content, format (i.e., setting and mode of delivery), facilitator selection and pedagogy (i.e., teaching strategies) to ensure the program was appealing and engaging. For example, the recruitment materials strongly targeted unique paternal motivators including the opportunity to spend quality time with their children having fun and engaging in rough-and-tumble and sporting activities [60]. We also highlighted the father-only nature of the program, as many fathers are reluctant to participate in 'parenting' programs generally dominated by mothers [61] and the program was held after work hours to be more convenient for fathers [61].

Importantly, the core program messages were pitched as strategies to help fathers achieve outcomes they valued for their families. As many parents incorrectly believe their children are meeting physical activity and dietary recommendations [62,63] and fathers are generally less likely than mothers to consider excess weight as a problem for themselves [64] or their children [65], the program emphasized the importance of improving health behaviors for other purposes including optimizing children's social-emotional wellbeing, improving the quality of the father-child relationship and increasing social interaction, bonding and meaningful conversations [60]. The program also encouraged reciprocal reinforcement [18], where the children were motivated to improve their health and role-model healthy behaviors for the benefit of their father, and vice-versa. A recent systematic review and realist synthesis of family-based physical activity interventions [66], which included the HDHK studies, reported that targeting valued outcomes and encouraging children to become agents of change within their families were two of the most effective strategies to increase child physical activity levels.

The HDHK program was first tested in an efficacy RCT with 51 fathers and their 71 primary school-aged children (5-12 years) [19,67]. In this trial, the program was conducted in a University-environment and delivered by trained researchers with physical education backgrounds. Over eight consecutive weeks, the participants attended five father-only education sessions and three joint education and physical activity sessions for fathers and their children. At the 3-month post-intervention assessment, medium-to-large group-by-time effects in favor of the intervention group were detected for fathers' weight, waist circumference, blood pressure, resting heart rate and objectively-measured physical activity (all $p < 0.05$), but not dietary intake. Positive treatment effects were also detected for children's physical activity, dietary intake (daily kJ/kg) and resting heart rate. These effects

were all maintained at 6 months post-baseline. Importantly, the feasibility of the program was confirmed through high participant satisfaction, attendance and retention rates.

After establishing the efficacy of the HDHK program, we then tested the program's effectiveness in a larger-scale RCT [18], which included 93 fathers and 132 children living in rural areas with high-rates of mining and shift-work employment. In this trial, the program was delivered in community settings by trained, local facilitators. At post-test, a number of small-to-medium effects were identified for a range of health outcomes for both fathers (e.g., weight, waist circumference, physical activity, energy intake) and children (e.g., BMI z-score, physical activity) [18].

Following this, the program was rolled out in a non-randomized community translation trial with 190 families across five local government areas in NSW, Australia [68]. At 12-month follow-up, an intention-to-treat analysis identified significant treatment effects for fathers' weight and children's BMI z-score in addition to a range of health behaviours (e.g, physical activity, diet). Further, focus groups with fathers (n = 25), mothers (n = 15) and children (n = 41), revealed improvements in 'father-child bonding' and 'family bonding' as key themes in all groups. Other themes included 'positive family habits' (e.g. family walks, no TV during dinner) (fathers/mothers), 'positive changes in dad' (e.g. reducing screen time, playing more fun/active games) (children), and 'increases in dad's family involvement' (e.g. packing kids lunches, role in family) (mothers). Although the program effects in the effectiveness RCT and community translation trial were partially diluted compared to the efficacy trial, these studies provided additional support for our hypothesis that father-focused programs delivered in community settings were an effective and engaging strategy to improve family health outcomes.

After establishing the program's efficacy and effectiveness, Lloyd et al. conducted a series of mediation analyses in an attempt to identify the mechanisms of the programs effect on children's core food intake and physical activity [18]. With the HDHK effectiveness RCT data [18], the mediation analyses indicated that approximately 73% of the intervention effect on child core food intake was attributed to improvements in the fathers' beliefs about the benefits of healthy eating. Similarly, approximately 60% of the overall intervention effect on child steps/day could be attributed to increases in father-child co-physical activity [69]. This finding is particularly interesting considering that the majority of parent-child co-physical activity interventions evaluated to date have been unsuccessful [22]. To advance the field, further work is required to identify the optimal intensity, duration, purpose and nature of co-physical activity to elicit improvements in children's physical activity attitudes and behaviors. In HDHK, we teach fathers to provide one-on-one co-physical activity opportunities with their children that maximize opportunities for moving, laughing, talking and learning. These enhanced activities may result in superior outcomes for some children compared to more basic co-physical activities (e.g., passing a ball back and forth), though this hypothesis requires empirical validation in future research.

Compared to the control group, HDHK fathers in the effectiveness trial reported significant improvements for some physical activity and diet-related parenting practices including limit setting and reinforcement [70]. Although other parenting practices were specifically targeted in the intervention (e.g., pressure to eat, monitoring, reinforcement), no changes were detected in these variables. As the program targeted children aged 5-12 years, this may highlight the difficulty in changing some entrenched parenting behaviors in fathers and the importance of involving fathers in early childhood programs. However, our recent review

identified very low participation of fathers in obesity prevention RCTs targeting newborns/infants (0 – 1 years; 0%) and toddlers/preschoolers (2-4 years; 10%) [9], with no studies specifically targeting fathers.

Although HDHK predominantly targeted fathers, the mothers received specific program resources, were invited to one session of the program and participated in the family-based home tasks [19,20]. However, this intervention dose was not sufficient enough to generate changes in any maternal parenting practices at post-test [70]. Of interest, a similar effect was also observed recently in the InFANT trial [71], where an early-childhood obesity prevention program targeting mothers did not generate any flow-on health benefits in the corresponding fathers. As fathers have reported a preference for father-only programs [61], an interesting challenge for researchers will be to identify how to increase the intervention effect through meaningful mother involvement, without compromising levels of father engagement.

RECOMMENDATIONS

In addition to study outcome papers, scholars have recently called for researchers to report more experiential insights into effective recruitment strategies, engagement mechanisms and intervention components that may be linked to intervention efficacy [72]. As relatively little is currently known about how best to engage fathers in obesity prevention research, we have included a summary of practical suggestions for researchers and practitioners (see Table 1). These suggestions are based on insights from our experience in the field in combination with other published recommendations (e.g., [61,73,74]). Combined with high-quality, methodologically rigorous observational and experimental data, we hope that these suggestions may help researchers achieve a more meaningful representation of fathers in future studies exploring the link between parenting and childhood obesity.

CONCLUSION

A growing body of research has shown that fathers make a unique and valuable contribution to their children's development across social, cognitive, behavioral, emotional and academic domains [41]. Despite this, fathers have been notably absent in observational and experimental research exploring parental influences on child physical activity and nutrition [8,9,51]. While the available data indicate that fathers play an important role in this area, a reliance on cross-sectional designs and small, ungeneralizable samples confirm that much more works remains to be done. To advance the field, high quality longitudinal studies are required where the unique influences of fathers are considered independent of mothers. To improve the quality of childhood obesity prevention programs, a deliberate and sustained effort is also needed from researchers to greatly increase the meaningful engagement of fathers.

Table 1. Recommendations and research considerations for involving fathers in childhood obesity prevention and treatment studies.

Recruiting dads	• Research indicates that the most important valuable program features for fathers are demonstrated effectiveness, personal relevance, and the use of trained facilitators. Highlight these wherever possible. • Ensure recruitment materials focus on salient motivators for fathers. For example, feature opportunities for father-child co-physical activity, which is particularly important to the paternal parenting style. Fathers also highly value opportunities to enhance the father-child relationship and increase their children's self-esteem, confidence and social skills. • Include targeted recruitment strategies with explicit reference to fathers. Fathers often assume 'parent' is interchangeable with 'mother' in recruitment material. • Include children in the program wherever possible. The most common reason fathers signed up to our studies was to spend quality time with their children. • As fathers have expressed discomfort in participating in mother-dominated groups, target fathers exclusively via father-only programs or father-specific sessions, where possible. • Ensure face-to-face programs are held at convenient times for fathers (e.g., after work hours or on the weekend). • Ensure fathers are valued, recognized and have an enjoyable experience during the program to increase positive word of mouth.
Engaging dads	• Promote a strengths-based approach to fathering in all aspects of program delivery. Research shows that fathers want to be involved and care about their children's physical activity and dietary habits. • To increase the likelihood of sustainable behavior change, facilitate reciprocal reinforcement between fathers and their children (i.e., motivate each group to role model healthy behaviors for the benefit of the other). Encourage children to become leaders within the family unit. • Use humor to engage fathers and highlight key information. • As fathers may be less likely than mothers to view their child's weight as a problem, consider focusing on other motivators when encouraging behavior change (e.g., co-physical activity leads to improved social-emotional wellbeing in children and improved father-child bonding). • Include practical, evidence-based parenting tips and provide opportunities for social connectedness by allowing fathers to share their unique experience with other fathers. • Make time to talk to fathers before and after sessions for candid and immediate feedback on the program. • Where possible, select facilitators who fathers would perceive as credible, relatable and likeable sources of information.

Table 1. Recommendations and research considerations for involving fathers in childhood obesity prevention and treatment studies.

	• It can be particularly effective to choose fathers as program facilitators, provided they meet these desirable characteristics and have the required skills for effective program delivery. • Provide health information to fathers using a frank, clear and realistic approach. Identify key messages and report them clearly.
Future research considerations	• Endeavor to collect data on parenting practices, modeling and child health behaviors from both parent perspectives so the unique influence of fathers can be explored after controlling for maternal variables. • Additional insights into the unique and complementary roles of mothers and fathers on their children health could be gained through randomized controlled trials with interventions targeting fathers-only, mothers-only or both mothers and fathers. • Consider the use of innovative technologies (e.g., wearable cameras, digital recorders) to gain novel insights into the unique contributions of fathers (e.g., to assess the quality of father-child co-physical activity, co-parenting variables, the quality of father-child interaction, dinner table parenting practices). • Conduct mediation and moderator analyses to further our understanding of *how* fathers influence their children's health. What are the specific mechanisms of this effect and are they 'father-specific'? • Identify the effectiveness of internet-based or e-health interventions targeting fathers, as these may be more appealing due to increased accessibility and flexibility. • Implement strategies to increase the representation of fathers from ethnically diverse backgrounds, low socio-economic positions, and non-traditional family structures (e.g., fathers that live apart from their children) in both observational and experimental research. • Researchers and practitioners are strongly encouraged to develop and test childhood obesity prevention and treatment interventions that directly engage fathers. To date, less than 1% of published research trials have primarily targeted fathers as the agents of change within families.

REFERENCES

1. Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet.* 2014;384(9945):766-781.
2. Must A, Strauss RS. Risks and consequences of childhood and adolescent obesity. *Int J Obes Relat Metab Disord.* 1999;23 Suppl 2:S2-11.
3. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes.* 2011;35(7):891-898.
4. Cunningham SA, Kramer MR, Narayan KM. Incidence of childhood obesity in the United States. *N Engl J Med.* 2014;370(5):403-411.
5. Herman KM, Craig CL, Gauvin L, Katzmarzyk PT. Tracking of obesity and physical activity from childhood to adulthood: the Physical Activity Longitudinal Study. *Int J Pediatr Obes.* 2009;4(4):281-288.
6. Hulens M, Beunen G, Claessens AL, et al. Trends in BMI among Belgian children, adolescents and adults from 1969 to 1996. *Int J Obes Relat Metab Disord.* 2001;25(3):395-399.
7. Waters E, de Silva-Sanigorski A, Hall BJ, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev.* 2011(12): Art. No.: CD001871. DOI: 001870.001002/14651858.CD14001871.pub14651853.
8. Davison KK, Gicevic S, Aftosmes-Tobio A, et al. Fathers' Representation in Observational Studies on Parenting and Childhood Obesity: A Systematic Review and Content Analysis. *Am J Public Health.* 2016;106(11):1980-1980.

9. Morgan PJ, Young MD, Lloyd AB, et al. Involvement of fathers in pediatric obesity treatment and prevention trials: A systematic review. *Pediatrics.* 2017.

10. Phares V, Fields S, Binitie I. Getting fathers involved in child-related therapy. *Cognitive and Behavioral Practice.* 2006;13(1):42-52.

11. Panter-Brick C, Burgess A, Eggerman M, McAllister F, Pruett K, Leckman JF. Practitioner review: Engaging fathers--recommendations for a game change in parenting interventions based on a systematic review of the global evidence. *J Child Psychol Psychiatry.* 2014;55(11):1187-1212.

12. Lundahl BW, Tollefson D, Risser H, Lovejoy MC. A Meta-Analysis of Father Involvement in Parent Training. *Research on Social Work Practice.* 2008;18(2):97-106.

13. Pew Research Center. *Modern parenthood: Roles of moms and dads converge as they balance work and family.* Washington, D.C.: Pew Research Centre;2013.

14. Freeman E, Fletcher R, Collins CE, Morgan PJ, Burrows T, Callister R. Preventing and treating childhood obesity: time to target fathers. *Int J Obes.* 2012;36(1):12-15.

15. Wake M, Nicholson JM, Hardy P, Smith K. Preschooler obesity and parenting styles of mothers and fathers: Australian National Population Study. *Pediatrics.* 2007;120(6):E1520-E1527.

16. Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. *Obes Rev.* 2001;2:159-171.

17. Golan M, Weizman A. Familial approach to the treatment of childhood obesity. A conceptual model. *Journal of Nutrition Education.* 2001;33:102-107.

18. Morgan PJ, Collins CE, Plotnikoff RC, et al. The 'Healthy Dads, Healthy Kids' community randomized controlled trial: a community-based healthy lifestyle program for fathers and their children. *Prev Med.* 2014;61:90-99.

19. Morgan PJ, Lubans DR, Callister R, et al. The 'Healthy Dads, Healthy Kids' randomized controlled trial: efficacy of a healthy lifestyle program for overweight fathers and their children. *Int J Obes.* 2011;35(3):436-447.

20. Morgan PJ, Lubans DR, Plotnikoff RC, et al. The 'Healthy Dads, Healthy Kids' community effectiveness trial: study protocol of a community-based healthy lifestyle program for fathers and their children. *BMC Public Health.* 2011;11:876.

21. Neshteruk CD, Nezami BT, Nino-Tapias G, Davison KK, Ward DS. The influence of fathers on children's physical activity: A review of the literature from 2009 to 2015. *Prev Med.* 2017;102:12-19.

22. Rhodes RE, Lim C. Promoting Parent and Child Physical Activity Together: Elicitation of Potential Intervention Targets and Preferences. *Health Educ Behav.* 2017:1090198117704266.

23. Gustafson SL, Rhodes RE. Parental correlates of physical activity in children and early adolescents. *Sports Med.* 2006;36(1):79-97.

24. Pugliese J, Tinsley B. Parental Socialization of child and adolescent physical activity: A meta-analysis. *J Fam Psychol.* 2007;21(3):331-343.

25. Ferreira I, van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J. Environmental correlates of physical activity in youth - a review and update. *Obes Rev.* 2007;8(2):129-154.

26. Isgor Z, Powell LM, Wang YF. Multivariable analysis of the association between fathers' and youths' physical activity in the United States. *BMC Public Health.* 2013;13.

27. Trost SG, Loprinzi PD. Parental influences on physical activity behavior in children and adolescents: A brief review. *American Journal of Lifestyle Medicine.* 2011;5(2):171-181.

28. Zahra J, Sebire SJ, Jago R. "He's probably more Mr. sport than me" - a qualitative exploration of mothers' perceptions of fathers' role in their children's physical activity. *BMC Pediatr.* 2015;15.

29. Lamb ME. *The role of the father in child development* 5th ed. New York: Wiley; 2010.

30. Noonan RJ, Boddy LM, Fairclough SJ, Knowles ZR. Write, draw, show, and tell: a child-centred dual methodology to explore perceptions of out-of-school physical activity. *BMC Public Health.* 2016;16.

31. Beets MW, Foley JT. Association of father involvement and neighborhood quality with kindergartners' physical activity: a multilevel structural equation model. *Am J Health Promot.* 2008;22(3):195-203.

32. Kwon S, Janz KF, Letuchy EM, Burns TL, Levy SM. Parental characteristic patterns associated with maintaining healthy physical activity behavior during childhood and adolescence. *Int J Behav Nutr Phys Act.* 2016;13.

33. Fletcher R, May C, St George J, Morgan PJ, Lubans DR. Fathers' perceptions of rough-and-tumble play: Implications for early childhood services. *Australiasian Journal of Early Childhood.* 2011;36(4):131-138.

34. Hardy LL, King L, Espinel P, Cosgrove C, Bauman A. NSW Schools Physical Activity and Nutrition Survey (SPANS) 2010: Full Report. Sydney: NSW Ministry of Health; 2010.

35. Telford RM, Telford RD, Olive LS, Cochrane T, Davey R. Why Are Girls Less Physically Active than Boys? Findings from the LOOK Longitudinal Study. *PLoS ONE.* 2016;11(3).

36. Paquette D. Theorizing the father-child relationship:mechanisms and developmental outcomes. *Hum Dev.* 2004;47(4):193-219.

37. Lindsey EW, Cremeens PR, Caldera YM. Mother-Child and Father-Child Mutuality in Two Contexts: Consequences for Young Children's Peer Relationships. *Infant and Child Development.* 2010;19(2):142-160.

38. Barrett EL, Morman MT. Turning Points of Closeness in the Father/Daughter Relationship. *Human Communication.* 2013;15(4):241-259.

39. Harrington M. Sport and leisure as contexts for fathering in Australian families. *Leisure studies.* 2006;25(2):165-183.

40. Adamson M, Blight EJ. Bringing dads to the table: Comparing mother and father reports of child behaviour and parenting at mealtimes. *Journal of Family Studies.* 2014;20(2):118-127.

41. Yogman M, Garfield CF, Committee On Psychosocial Aspects Of C, Family H. Fathers' Roles in the Care and Development of Their Children: The Role of Pediatricians. *Pediatrics.* 2016;138(1).

42. Jones J, Mosher WD. *Fathers' involvement with their children: United States, 2006-2010. National health statistics reports; no 71.* Hyattsville, MD: National Center for Health Statistics;2013.

43. Mallan KM, Nothard M, Thorpe K, et al. The role of fathers in child feeding: perceived responsibility and predictors of participation. *Child Care Health Dev.* 2014;40(5):715-722.

44. Khandpur N, Charles J, Davison KK. Fathers' Perspectives on Coparenting in the Context of Child Feeding. *Child Obes.* 2016;12(6):455-462.

45. Wang Y, Beydoun MA, Li J, Liu Y, Moreno LA. Do children and their parents eat a similar diet? Resemblance in child and parental dietary intake: systematic review and meta-analysis. *J Epidemiol Community Health.* 2011;65(2):177-189.

46. Walsh AD, Cameron AJ, Crawford D, Hesketh KD, Campbell KJ. Dietary associations of fathers and their children between the ages of 20 months and 5 years. *Public Health Nutr.* 2016;19(11):2033-2039.

47. Hall L, Collins CE, Morgan PJ, Burrows TL, Lubans DR, Callister R. Children's intake of fruit and selected energy-dense nutrient-poor foods is associated with fathers' intake. *J Am Diet Assoc.* 2011;111(7):1039-1044.

48. Beydoun MA, Wang Y. Parent-child dietary intake resemblance in the United States: evidence from a large representative survey. *Soc Sci Med.* 2009;68(12):2137-2144.

49. McIntosh A, Kubena KS, Tolle G, et al. Determinants of Children's Use of and Time Spent in Fast-food and Full-service Restaurants. *J Nutr Educ Behav.* 2011;43(3):142-149.

50. Walsh AD, Cameron AJ, Hesketh KD, Crawford D, Campbell KJ. Associations between dietary intakes of first-time fathers and their 20-month-old children are moderated by fathers' BMI, education and age. *Br J Nutr.* 2015;114(6):988-994.

51. Khandpur N, Blaine RE, Fisher JO, Davison KK. Fathers' child feeding practices: A review of the evidence. *Appetite.* 2014;78:110-121.

52. Tschann JM, Gregorich SE, Penilla C, et al. Parental feeding practices in Mexican American families: initial test of an expanded measure. *Int J Behav Nutr Phys Act.* 2013;10:6.

53. Loth KA, MacLehose RF, Fulkerson JA, Crow S, Neumark-Sztainer D. Food-related parenting practices and adolescent weight status: a population-based study. *Pediatrics.* 2013;131(5):e1443-1450.

54. Hendy HM, Williams KE, Camise TS, Eckman N, Hedemann A. The Parent Mealtime Action Scale (PMAS). Development and association with children's diet and weight. *Appetite.* 2009;52(2):328-339.

55. Parada H, Ayala GX, Horton LA, Ibarra L, Arredondo EM. Latino fathers' feeding-related parenting strategies on children's eating. *Ecol Food Nutr.* 2016;55(3):292-307.

56. Vollmer RL, Adamsons K, Foster JS, Mobley AR. Association of fathers' feeding practices and feeding style on preschool age children's diet quality, eating behavior and body mass index. *Appetite.* 2015;89:274-281.

57. Pratt M, Hoffmann D, Taylor M, Musher-Eizenman D. Structure, coercive control, and autonomy promotion: A comparison of fathers' and mothers' food parenting practices. *J Health Psych.* In press.

58. Lora KR, Hubbs-Tait L, Ferris AM, Wakefield D. African-American and Hispanic children's beverage intake: Differences in associations with desire to drink, fathers' feeding practices, and weight concerns. *Appetite.* 2016;107:558-567.

59. Khandpur N, Charles J, Blaine RE, Blake C, Davison K. Diversity in fathers' food parenting practices: A qualitative exploration within a heterogeneous sample. *Appetite.* 2016;101:134-145.

60. Morgan PJ, Young MD, Smith JJ, Lubans DR. Targeted Health Behavior Interventions Promoting Physical Activity: A Conceptual Model. *Exerc Sport Sci Rev.* 2016;44(2):71-80.

61. Bayley J, Wallace LM, Choudhry K. Fathers and parenting programmes: Barriers and best practice. *Community Pract.* 2009;82(4):28-31.

62. Corder K, Crespo NC, van Sluijs EM, Lopez NV, Elder JP. Parent awareness of young children's physical activity. *Prev Med.* 2012;55(3):201-205.

63. Briefel RR, Deming DM, Reidy KC. Parents' Perceptions and Adherence to Children's Diet and Activity Recommendations: the 2008 Feeding Infants and Toddlers Study. *Prev Chronic Dis.* 2015;12:E159.

64. Tsai SA, Lv N, Xiao L, Ma J. Gender Differences in Weight-Related Attitudes and Behaviors Among Overweight and Obese Adults in the United States. *American Journal of Men's Health.* 2015.

65. Anti E, Laurent JS, Tompkins C. The Health Care Provider's Experience With Fathers of Overweight and Obese Children: A Qualitative Analysis. *Journal of pediatric health care : official publication of National Association of Pediatric Nurse Associates & Practitioners.* 2016;30(2):99-107.

66. Brown HE, Atkin AJ, Panter J, Wong G, Chinapaw MJ, van Sluijs EM. Family-based interventions to increase physical activity in children: a systematic review, meta-analysis and realist synthesis. *Obes Rev.* 2016.

67. Lubans DR, Morgan PJ, Collins CE, Okely AD, Burrows T, Callister R. Mediators of weight loss in the 'Healthy Dads, Healthy Kids' pilot study for overweight fathers. *Int J Behav Nutr Phys Act.* 2012;9.

68. Morgan PJ, Lloyd A, Barnes A, et al. Engaging fathers to improve family physical and mental health: The impact of the 'Healthy Dads, Healthy Kids' community program. Paper presented at: International Society for Behavioral Nutrition and Physical Activity 2015; Edinburgh, U.K.

69. Lloyd AB, Lubans DR, Plotnikoff RC, Morgan PJ. Paternal Lifestyle-Related Parenting Practices Mediate Changes in Children's Dietary and Physical Activity Behaviors: Findings From the Healthy Dads, Healthy Kids Community Randomized Controlled Trial. *J Phys Act Health.* 2015;12(9):1327-1335.

70. Lloyd AB, Lubans DR, Plotnikoff RC, Morgan PJ. Impact of the 'Healthy Dads, Healthy Kids' lifestyle programme on the activity- and diet-related parenting practices of fathers and mothers. *Pediatr Obes.* 2014;9(6):e149-155.

71. Walsh AD, Lioret S, Cameron AJ, et al. The effect of an early childhood obesity intervention on father's obesity risk behaviors: the Melbourne InFANT Program. *Int J Behav Nutr Phys Act.* 2014;11:18.

72. Diep CS, Chen TA, Davies VF, Baranowski JC, Baranowski T. Influence of behavioral theory on fruit and vegetable intervention effectiveness among children: a meta-analysis. *J Nutr Educ Behav.* 2014;46(6):506-546.

73. Tully LA, Piotrowska PJ, Collins DAJ, et al. Optimising child outcomes from parenting interventions: fathers' experiences, preferences and barriers to participation. *BMC Public Health.* 2017;17(1):550.

74. Morgan PJ, Jones RA, Collins CE, et al. Practicalities and Research Considerations for Conducting Childhood Obesity Prevention Interventions with Families. *Children (Basel).* 2016;3(4).

Annotated references	
**** Of outstanding importance**	
Davison KK, Gicevic S, Aftosmes-Tobio A, et al. Fathers' Representation in Observational Studies on Parenting and Childhood Obesity: A Systematic Review and Content Analysis. Am J Public Health. 2016;106(11):1980-1980.	*This was the first systematic review to quantify the involvement of fathers in observational parenting and childhood obesity studies. Results indicated fathers were greatly underrepresented.*
Morgan PJ, Young MD, Lloyd AB, et al. Involvement of fathers in pediatric obesity treatment and prevention trials: A systematic review. Pediatrics. 2017.	*This was the first systematic review to quantify the involvement of fathers in pediatric obesity treatment and prevention programs. Overall fathers represented less than 10% of participating parents.*
Morgan PJ, Collins CE, Plotnikoff RC, et al. The 'Healthy Dads, Healthy Kids' community randomized controlled trial: a community-based healthy lifestyle program for fathers and their children. Prev Med. 2014;61:90-99.	*This paper reports the outcomes of the Healthy Dads Healthy Kids effectiveness randomized controlled trial, which tested the effect of a socio-culturally targeted healthy lifestyles program specifically for fathers and children.*
Khandpur N, Blaine RE, Fisher JO, Davison KK. Fathers' child feeding practices: A review of the evidence. Appetite. 2014;78:110-121.	*This review provides an overall summary of the evidence relating to fathers child feeding practices. The paper also includes a road map to inform future research in this area.*
Neshteruk, C.D., Nezami, B.T., Nino-Tapias, G., Davison, K.K., & Ward, D.S. The influence of fathers on children's physical activity: A review of the literature from 2009-2015. Preventive Medicine. 2017; 102:12-19.	*This review provided the first summary of observational studies examining the influence of fathers on children's physical activity habits. The authors also provide a number of recommendations to advance the field.*
*** Of importance**	
Panter-Brick C, Burgess A, Eggerman M, McAllister F, Pruett K, Leckman JF. Practitioner review: Engaging fathers--recommendations for a game change in parenting interventions based on a systematic review of the global evidence. J Child Psychol Psychiatry. 2014;55(11):1187-1212.	*This paper provides an important summary of the global literature on general parenting interventions and the underrepresentation of fathers.*
Yogman M, Garfield CF, Committee On Psychosocial Aspects Of C, Family H. Fathers' Roles in the Care and Development of Their Children: The Role of Pediatricians. Pediatrics. 2016;138(1).	*This paper represents the position statement of the American Academy of Pediatrics regarding the important role of fathers in child wellbeing across multiple domains.*
Lloyd AB, Lubans DR, Plotnikoff RC, Morgan PJ. Paternal Lifestyle-Related Parenting Practices Mediate Changes in Children's Dietary and Physical Activity Behaviors: Findings From the Healthy Dads, Healthy Kids Community Randomized Controlled Trial. J Phys Act Health. 2015;12(9):1327-1335.	*This mediation paper presents the first experimental evidence directly linking changes in fathers parenting practices to changes in children's physical activity and dietary behaviors.*