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Maternal and paternal parenting practices and their influence on children's adiposity, screen-time, diet and physical activity

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Abstract

The primary aim of this study was to examine a range of potential behavioral and maternal/paternal correlates of adiposity in children. Secondary aims were to examine (a) correlates of screen-time, diet and objectively measured physical activity and (b) if there were differences in maternal and paternal physical activity- and dietary-related parenting practices. Cross-sectional analysis was conducted using a sample of 70 families with children (59% boys (41/70), mean age 8.4 (+/-2.4) years). Parenting practices were measured using the *Parenting Strategies for Eating and Activity Scale*. Children's outcomes included: 7-day pedometry (physical activity), screen-time, percent energy from core foods (Food frequency questionnaire) and BMI *z*-score. Multiple regression models were generated to examine the associations between maternal and paternal parenting practices and childrens' variables. In the regression analyses, fathers' BMI ($p<.01$) and mothers' control ($p<.001$) were significantly associated with child weight status. Fathers' reinforcement ($p<.01$) was significantly associated with child physical activity. For screen-time, mothers' monitoring ($p<.001$) and child characteristics [age ($p=.01$), sex ($p=.01$), BMI *z*-score ($p=.03$)] were significant predictors. Mothers' parenting practices [limit setting ($p=.01$), reinforcement ($p=.02$)] and child screen-time ($p=.02$) were significantly associated with intake of core foods. Despite some similarities within families, three out of five eating and physical activity parenting constructs were significantly different between mothers and fathers. Mothers and fathers have different parental influences on their children's weight status and lifestyle behaviors and both should be included in lifestyle interventions targeting children. A focus on maternal parenting specifically relating to screen-time and diet, and father's physical activity parenting and weight status may support their children in developing more healthy behaviors.

Keywords: Obesity, children, parenting, diet, physical activity, screen-time

Introduction

Pediatric obesity is associated with a range of adverse physiological and psychological health consequences (Dietz, 1998; Lobstein, Baur, & Uauy, 2004) and studies have shown that excess weight in childhood is likely to track into adulthood (Biro & Wien, 2010). During the past three decades, childhood overweight/obesity rates have increased substantially in developed nations (Han, Lawlor, & Kimm, 2010) and prevalence is 21-25% in Australia (Olds, Tomkinson, Ferrar, & Maher, 2009). Modifiable obesity-related risk factors include high levels of screen-time, low levels of physical activity, low fruit and vegetable intake and high intakes of energy-dense, nutrient-poor foods (Birch & Ventura, 2009). However, internationally, studies have reported only a small percentage of children meeting guidelines for physical activity (Colley et al., 2011; Currie et al., 2008; Kohl et al., 2012; Nelson, Neumark-Stzainer, Hannan, Sirard, & Story, 2006; Sallis & Saelens, 2000), fruit & vegetable intake (Currie et al., 2008; Lock, Pomerleau, Causer, Altmann, & McKee, 2005; Magarey, Daniels, & Smith, 2001) and screen-time (Martin, 2011; Matthews et al., 2008; Salmon, Timperio, Telford, Carver, & Crawford, 2005; Sigman, 2012). In Australia; just under 50% of 5- to 10-year olds meet physical activity (PA) guidelines (Hardy, 2011) while dietary data indicate low levels of adherence to the Australian Dietary Guidelines for children (CSIRO, 2008). In the 9-13 years group, 51% meet the fruit recommendations and only 2% meet the serving recommendations for vegetables (≥2-4 serves/day excluding potato) (CSIRO, 2008). In addition, the majority of children are exceeding the two hours recommended screen-time per day (Martin, 2011) which has been associated with increased BMI (Jago, Baranowski, Baranowski, Thompson, & Greaves, 2005) and the consumption of energy dense nutrient poor foods (Pearson & Biddle, 2011).

The importance of family and the household in shaping children's physical activity and dietary behaviors and weight status has been well established (Swanson, Studts, Bardach, Bersamin, & Schoenberg, 2011). Children are influenced by both their home physical and social environment which includes: their parents' modeling of specific behaviors, parenting style, parenting practices and beliefs, and social norms (Rhee, 2008). Furthermore, the family is critical to health behavior change (Gruber & Haldeman, 2009) with parents playing a major role in preventing and treating obesity in children, through their influence on their children's physical activity, eating behaviors (Patrick & Nicklas, 2005) and screen-time (Jago et al., 2011). In addition, there is evidence from systematic reviews to suggest lifestyle intervention effectiveness can be enhanced by including parents (Dellert & Johnson, 2013; Golley, Hendrie, Slater, & Corsini, 2011; Kitzmann et al., 2010; McLean, Griffin, Toney, & Hardeman, 2003; Niemeier, Hektner, & Enger, 2012; van der Kruk, Kortekaas, Lucas, & Jager-Wittenaar, 2013); however, there is uncertainty around who and how to involve family members (Faith et al., 2012; Hingle, O'Connor, Dave, & Baranowski, 2010; O'Connor, Jago, & Baranowski, 2009; Van Lippevelde et al., 2012; Waters et al., 2011).

Parenting practices generally refer to the specific acts of parents when attempting to socialize their children (Patrick, Hennessy, McSpadden, & Oh, 2013), and can include social support and household rules concerning physical activity, screen-time and dietary intake. The association between parenting practices and child physical activity levels (Edwardson & Gorely, 2010b; Ferreira et al., 2007; Gustafson & Rhodes, 2006; Pugliese & Tinsley, 2007; Sallis & Saelens, 2000), diet (Pearson, Biddle, & Gorely, 2009; Rasmussen et al., 2006; van der Horst et al., 2007; Ventura & Birch, 2008) and screen-time (Cillero & Jago, 2010) has been a focus of a number of systematic reviews. In a systematic review of parental influences on physical activity, Edwardson and Gorley (2010b) found that parents influence their children's physical activity through direct involvement, role modelling, encouragement and providing transport for organised physical activity. A positive association has also been demonstrated between child fruit and/or vegetable consumption and parenting practices through parental support for healthy eating (Rasmussen et al., 2006), family rules, home availability and parental encouragement (Pearson et al., 2009). In their review of screen-viewing, Cillero and Jago (2010) found that young children living with less parental screen-rules, more media access, or with parents with higher body mass indexes were more likely to have higher screen-viewing. Demographic variables (ethnicity/non-white, age and lower socioeconomic status) were also consistently correlated with children's higher levels of screen viewing (Cillero & Jago, 2010).

Moreover, behavioral associations between parents and children lifestyle behaviors also have been found for parents' and children's physical activity levels (Biddle, Atkin, Cavill, & Foster, 2011; Gustafson & Rhodes, 2006). In addition, consistent evidence exists for the association between parental fruit, vegetable and fat intake and that of their children (van der Horst et al., 2007).

Despite advances in our understanding of the parental correlates of children's lifestyle behaviors, previous research has mostly been from the mothers' perspective (Nicholson & Rempel, 2004; Rodenburg, Oenema, Kremers, & van de Mheen, 2013; Sleddens, Gerards, Thijs, de Vries, & Kremers, 2011). The lack of studies exploring paternal associations with children's behaviors is of concern given recent evidence highlighting the unique role of fathers in shaping children's dietary and physical activity habits (Biddle et al., 2011; FaHCSIA, 2009; Freeman et al., 2012; McIntosh et al., 2011; Morgan, Lubans, Callister, et al., 2011) and recommendations from a recent systematic review to examine both mothers and fathers (Sleddens et al., 2012). There is limited research that has compared maternal and paternal activity related parenting practices (Davison, Cutting, & Birch, 2003; Edwardson &

Gorely, 2010a), feeding practices (Blissett, Meyer, & Haycraft, 2006; Haycraft & Blissett, 2008; Loth, MacLehose, Fulkerson, Crow, & Neumark-Sztainer, 2013) or general parenting (Baxter & Smart, 2010).

There have also been recent calls in the literature for more research to examine potential differences in the influence of mothers' and fathers' parenting practices and behaviors on children's activity and dietary behaviors (Rodenburg et al., 2013). Including paternal and maternal variables in the same regression models allows researchers to assess if there is an 'independent' effect of fathers that is separate from the effect of mothers (Pleck, 2010). In a systematic review of the relationship between general parenting and children's weight status and lifestyle behaviors, it was recommended that larger samples of fathers were needed in studies to allow comparisons between mothers and fathers and examination of differences in associations in child lifestyle behaviors, given the paucity of work in this area (Sleddens et al., 2011). These are problematic issues as fathers rarely participate in interventions or complete study measures and questionnaires (Sleddens et al., 2011).

To develop effective obesity prevention interventions for children, it is important to improve our understanding of how both parents influence their children's physical activity, dietary patterns and screen-time. Therefore, the primary aim of this study was to examine a range of potential behavioral and maternal/paternal correlates of children's adiposity. The secondary aims were (a) to examine correlates of children's screen-time, diet and objectively measured physical activity and (b) to examine if there were differences in maternal and paternal physical activity- and dietary-related parenting practices.

Methods

Study Design

A cross-sectional analysis of baseline data from the Healthy Dads, Healthy Kids (HDHK) community effectiveness randomized controlled trial (RCT) (Morgan, Lubans, Plotnikoff, et al., 2011) was conducted. Briefly, HDHK targets overweight fathers to lose weight and role model/positively influence their children's physical activity and dietary habits (Morgan, Lubans, Callister, et al., 2011). The Human Research Ethics Committee of the University of Newcastle, Callaghan, New South Wales, Australia approved the study, and written informed father/mother consents and child assents were obtained for all participants.

Participants: A total of 93 men (aged 18-65 years) with children aged between 5 and 12 years were recruited for the RCT from two Local Government Areas (Singleton and Maitland) in New South Wales, Australia. The study protocol has been reported elsewhere (Morgan, Lubans, Plotnikoff, et al., 2011). The inclusion criteria for the community RCT were: fathers' body mass index 25-40kg/m^2; no participation in other weight loss programs during the study; passing a health-screen (based on a questionnaire); and access to a computer with Internet facilities. Participants were recruited through a range of strategies including school newsletters, school-based presentations, advertisements on community notice-boards, and the local press. For the present study, families (n=70) that had responses from both mother and father in relation to their parenting practices were included. In addition, only data pertaining to the eldest participating child in each respective family were used in this study.

Demographic characteristics: Background details and socio-demographic variables including age and post code were collected by questionnaire. SES was based on postal code of residence using the Index of Relative Socioeconomic Advantage and Disadvantage from the Australian Bureau of Statistics census-based Socio-Economic Indexes for Areas (SEIFA) (Australian Bureau of Statistics, 2008).

Body weight of the fathers and children was measured, without shoes and wearing light clothing, on a digital scale to .1kg (model CH-150kp, A&D Mercury Pty Ltd, Australia). Measures were taken 1-2 weeks before program commencement.

BMI was calculated using the standard equation (weight [kg]/height $[m]^2$) and standardized methods. For children, height and weight was used to calculate BMI (kg/m^2) and age- and sex-adjusted standardized scores (*z*-scores) based upon the UK reference data (Cole, Freeman, & Preece, 1995) and LMS methods (Cole & Pan, 2002) were used. International Obesity Task Force cut points were used to determine overweight or obesity (Cole, Bellizzi, Flegal, & Dietz, 2000).

Physical activity: Yamax 200 pedometers (Yamax Corporation, Kumamoto City, Japan) were used to objectively measure physical activity. These pedometers are reliable (Le Masurier, Lee, & Tudor-Locke, 2004) and have been validated in children (Eston, Rowlands, & Ingledew, 1998) and adults (Steeves, Silcott, Bassett, Thompson, & Fitzhugh, 2011). Both fathers and their children were asked to wear the pedometers for 7 consecutive days and maintain their normal routine. Participants were instructed to attach the pedometers (at the waist on the right hand side) and asked to remove the pedometers only when sleeping, during contact sports or when the pedometer might get wet (e.g. swimming, showering). Participants were instructed to record their steps and reset their pedometers to zero at the end of each day. Participants were included in the analyses if they had completed at least 4 weekdays of pedometer monitoring and 1 weekend day (Trost, Pate, Freedson, Sallis, & Taylor, 2000). Counts were converted to average steps per day. For children in the sample population, step count guidelines are 13000-15000 for boys and 11000-12000 for girls (Tudor-Locke, Craig, Beets, et al., 2011) and for the fathers, 10000 steps a day for healthy adults (Tudor-Locke, Craig, Brown, et al., 2011).

Sedentary behavior: A modified version of the Children's Leisure Activities Study Survey (CLASS) (Telford, Salmon, Jolley, & Crawford, 2004) was completed by mothers with reference to their eldest child participating in the study. Mothers were chosen to complete the survey as it was validated in a sample of mostly mothers (Telford et al., 2004). Mothers are also more likely to be present at times of the day when children are engaged in screen-time. In addition, we believe the reporting by mothers is likely to have reduced reporting bias, compared with father proxy. The CLASS has been validated in children (Telford et al., 2004) and has acceptable test retest reliability (Salmon et al., 2005). For this study, the screen behaviors subscale of the CLASS survey was used to determine time spent in small screen recreation (SSR) in a typical week. Fathers completed an adaptation of the Sitting Questionnaire, which has been shown to be both a valid and reliable measure of sitting time in various domains (Marshall, Miller, Burton, & Brown, 2010; Miller & Brown, 2004). For this study, we added two items (Watching TV and Using a computer at home) to come up with a SSR scale to assess fathers' screen behaviors on a work and nonwork day.

Parenting practices (strategies): were assessed using the Parenting Strategies for Eating and Activity Scale (PEAS), which has been shown to be a valid measure of parenting strategies related to children's obesity-related behaviors in Latino communities (Larios, Ayala, Arredondo, Baquero, & Elder, 2009). Eight items of the PEAS scale are originally from the Child Feeding Questionnaire (CFQ) (Birch et al., 2001) and were included in its development to complement the physical activity items of the PEAS scale (Larios et al., 2009). In our study, both parents completed the PEAS to allow the comparison of parenting strategies within family groups for the same child (eldest participating child). Examples of the items used to assess the parenting strategies (control, monitoring, limit setting, reinforcement and discipline) and the corresponding Cronbach's alphas are listed in Table 1. The internal consistency for the PEAS subscales in previous studies was moderately strong and ranged from .73 to .87 (Ayala et al., 2010), and .70 for the control (pressure to eat) subscale (Birch et al., 2001). Similarly, in our sample the alphas ranged from .70 to .87 for mothers and .73-.88 for fathers. Following factor analysis, two items were removed from the original control scale reducing it to a four item measure, which corresponded with four items originally from the Child Feeding Questionnaire (CFQ) (Birch et al., 2001) where it formed the ‘pressure to eat’ subscale. The two items removed related to using unhealthy rewards for good behavior. A pilot study in the community was conducted in May 2010 (Singleton, NSW 2010). Recruiting 12 parents, PEAS was pretested for suitability when filled in by both mothers and fathers.

Dietary intake was assessed for fathers and children using the adult and child versions of Australian Eating Survey (AES). AES is a 120-item semiquantitative Food Frequency Questionnaire (FFQ), previously validated in adults (Collins et al., 2011; Collins et al., 2013) and in children and adolescents up to 16 years old (Collins et al., 2013). Individual FFQ questions were combined into nutrient-dense (core) food groups and energy-dense, nutrient-poor (noncore) food groups, defined according to the Australian Guide to Healthy Eating (Kellet, Smith, & Schmerlaib, 1998) and used to calculate the percentage of total energy intake derived from core and noncore foods. For this study, we calculated and reported on the percentage of kJ intake that was from core foods (i.e. foods providing essential nutrients for health).

Analyses

Analysis was performed using IBM SPSS Statistics for Windows, Version 19.0 (2010 SPSS Inc., IBM Company Armonk, NY). Descriptive statistics were used to verify normality of the data. Means and standard deviations were calculated for all normally distributed variables. Internal consistency of the *Parenting Strategies for Eating and Activity Scale(s)* was calculated separately for mothers and fathers (see Table 1). In addition, factor analysis was performed to examine how each item loaded in the respective scale. To address the primary and secondary (a) aims, multiple regression models for the dependent variables (children's BMI *z*-score, screen-time, percent energy from core foods and physical activity) were generated. Bivariate correlations were used in the first instance to establish any associations with a p value $< .2$. Correlations between explanatory variables were checked to investigate potential problems of collinearity in the multiple variable model(s). If any explanatory (predictor) variables were highly correlated, then a decision was made regarding which items to drop from the model(s), based on the variance inflation factor, level of correlation and theoretical considerations. Variables from the univariate search ($p<.2$) were then entered into multiple regression model(s) to determine any significant predictors and calculate the total variance explained. Nonsignificant variables were then dropped, one at a time, least significant first, while controlling for covariates that were significantly associated with the outcome variable. When more than one explanatory variable was found, all two way interactions between significant variables were tested in the base model. As a final check, variables identified in the original bivariate correlation investigation ($p < .2$) that were excluded from the model(s) were added to the final model (one at a time) to determine if any were significant. In addition, statistical assumptions were checked again using residuals. A multilevel approach was not required for the regression analysis as the experimental unit was the child and we did not have multiple outcome measurements for the same child characteristic. To address the secondary aim (b) differences between mothers' and fathers' eating and activity parenting practices were investigated using paired sample t-tests. Paired samples t-tests were used because of the way the data were gathered. The mother and father in each family unit completed their own questionnaire and as such are linked and represent the household as the experimental unit. This mode of collection does not guarantee that the mother/father results will be strongly correlated. However, if this is the case, then this makes the paired t-test more sensitive than an independent t-test. Often when data are collected in this way, they will often be correlated, hence the choice of the paired t-test. In all analyses, statistical significance was set at .05.

Results

Fathers' and children's characteristics are presented in Table 2. Of those with valid physical activity data, 12% of fathers (n=8) and 21% of children (n=13) met current step count guidelines (Tudor-Locke, Craig, Beets, et al., 2011; Tudor-Locke, Craig, Brown, et al., 2011). For this study, data were used for those families who had complete responses from both the mother and father (n=70). SES for families based on SEIFA, where 10 is highest and 1 lowest, indicated 55.7% were at the higher end of the scale (7-8), 41.4% were mid-scale (5-6) and 2.9% (3-4) were at the lower end.

Behavioral and parental correlates of children's adiposity

The univariate analysis identified child BMI *z*-score was negatively associated with maternal ($p<.01$) and paternal control ($p<.01$), and positively associated with paternal BMI ($p<.001$) and paternal workday screen-time ($p<.05$) (Table 3). Results of the regression analysis are displayed in Table 4. In generating the regression model, no significant interactions between explanatory variables were found. For children's BMI *z*-score, fathers' BMI and mothers' control were significant variables in the final model ($p<.001$), which explained 34% of the variance.

Behavioral and parental correlates of children's screen-time, diet and physical activity

In the univariate analysis, several parent-related outcomes were significantly associated with child-level lifestyle behaviors (Table 3). Children's screen-time was negatively associated with mothers' monitoring (p<.001) and discipline (p<.05) and negatively associated with fathers' limit setting (p<.01), discipline (p<.01) and higher paternal BMI (p<.05). In addition, BMI *z*-score (p<.05) was positively associated with screen-time, with boys engaged in more screen-time than girls (p<.05). Children's energy intake (%) from core foods was positively associated with maternal limit setting (p<.01), monitoring (p<.001) and negatively associated with reinforcement (p<.05). Similarly, children's energy intake (%) from core foods was associated with paternal limit setting (p<.05) and paternal energy intake (%) from core foods (p<.01). Children's steps per day were negatively associated with mothers' control (p<.05) and fathers' reinforcement (p<.01).

Multiple regression analysis was conducted for the three child lifestyle behaviors (screen-time, diet and physical activity) as dependent variables (Table 4). For the screen-time model, a child's age, BMI *z*-score, sex (being male) and mother's monitoring (inverse) were significant predictors (p<.001), explaining 41% of the variance. For the model of children's energy intake (%) from core foods, children's screen-time, mothers' limit setting and reinforcement (inverse) were significant predictors (p<.001), explaining 33% of the variance. The model predicting children's steps per day explained 18% of the variance, with an inverse association for reinforcement from fathers identified as a significant variable (p=.001).

Differences between mothers' and fathers' physical activity and dietary-related parenting practices

Mothers reported significantly higher use of limit setting (p<.01) and monitoring (p<.001) and significantly lower use of control (p<.001), compared with fathers (Table 5). Mothers and fathers did not differ significantly for the discipline and reinforcement subscales (p>.05). Correlations between mothers' and fathers' parenting practices within families were examined (see Table 6). Significant moderate strength associations (r=.54, p <.001) were found between maternal-paternal control, and maternal-paternal monitoring ($r=.31$, $p<.05$). There was no significant maternal - paternal associations for any of the other PEAS subscales ($p >.05$).

Discussion

The primary aim of this study was to examine a range of potential behavioral and maternal/paternal correlates of children's adiposity. Secondary aims were to examine (a) correlates of children's screen-time, diet and objectively measured physical activity and (b) if there were differences between maternal and paternal physical activity- and dietary-related parenting practices. The novel contribution of this study was the examination of the relative influence of maternal and paternal parenting practices for each child behavior. We found the maternal parenting practice of control and paternal BMI to be associated with child adiposity. We also found a number of maternal parenting and child-related variables were associated with core food intake and screen-time. Interestingly, we found that paternal parenting practice of reinforcement (praise) was negatively associated with children's physical activity. Mothers and fathers reported significantly different parenting practices for three of the five constructs.

The regression model addressing our primary aim for children's BMI z-score identified both maternal control ($\beta = -.42$) and paternal BMI ($\beta = .35$) as significant variables in the final model, explaining over a third of the variance. Our finding for maternal control is consistent with previous research, which has found that mothers' use of controlling strategies (e.g. making sure children always finish the food on their plate) was inversely associated with child BMI (Francis, Hofer, & Birch, 2001; Galloway, Fiorito, Francis, & Birch, 2006; Larios et al., 2009). It could be that parents of children who have lower BMIs might be concerned about their child not eating enough and hence may pressure them to eat. Similarly if a child is overweight, parents may be less likely to pressure the child to eat in an attempt to reduce the child's energy intake. In view of our findings, which suggest maternal parenting has a greater influence on child adiposity than paternal parenting; future work should include both parents to further elucidate sex-specific parenting practices. This is important as we also found that fathers' BMI was a significant predictor of child weight status, which supports recent research (Brophy, Rees, Knox, Baker, & Thomas, 2012; Freeman et al., 2012). This may be attributed to genetic characteristics (Ng et al., 2010) and/or a father's influence on their children's physical activity and diet (Biddle et al., 2011; Hall et al., 2011; Morgan et al., 2014; Morgan, Lubans, Callister, et al., 2011). This adds support to recent findings suggesting interventions should consider targeting overweight fathers as a potential strategy to treat/prevent childhood obesity (Freeman et al., 2012). However, the lack of data available for mothers' BMI and behaviors in our analysis means our findings should be interpreted with some caution.

Addressing our secondary aim (a), the findings indicated that specific maternal and paternal parenting practices, in addition to some child characteristics, were significantly associated with child behaviors. However, the nature of the association varied depending on the children's lifestyle-related behavior, namely screen-time, diet or physical activity. Mothers' monitoring, child age, sex, and BMI z-score were significantly associated with children's screen-time. Our finding of a negative association for monitoring is supported by a review of family and environmental correlates of health behaviors in high-risk youth that identified three studies with strong negative associations between parental monitoring and sedentary behavior (Lawman & Wilson, 2012). However, the review did not distinguish between maternal and paternal monitoring. Our findings for maternal/paternal differences in parenting practices showed that mothers monitored more (significantly higher mean score, $p<.001$) than fathers and our regression model findings suggest that mothers' monitoring is more influential than fathers' monitoring. Blisset et al. (2006) also found that mothers' monitoring of child food intake (the monitoring scale in the current study had five of seven items relating to food intake) was greater compared with fathers and suggested this could be due to greater perceived maternal responsibility for feeding. We also found that boys participated in more screen-time than girls and screen-time time increased with age. A recent systematic review on correlates of screen-viewing in young children found that age was consistently associated with higher screen-time (Cillero & Jago, 2010). In the current study, child BMI z-score was also positively associated with screen-time, as previously established (Van Zutphen, Bell, Kremer, & Swinburn, 2007). Fuller-Tyszkiewicz et al. (2012) suggest, the relationship between TV viewing and BMI is bidirectional, which we are unable to determine from our cross-sectional analysis.

Maternal limit setting, maternal reinforcement and child screen-time explained 30% of the variance in children's intake of healthful or core foods. Maternal limit setting explained most of the variation in children's intake of core foods. This finding may be due to the lower level of paternal involvement in purchasing food and meal preparation (Baxter & Smart, 2010; Blissett et al., 2006). In addition, we also found (see Table 5) a significant ($p=.003$) difference in limit setting with mothers more likely to set limits on screen-time, snacking and soft drink consumption than fathers. A possible explanation for this may be in the relative awareness that parents have of their children's food intake and screen-time, as mothers typically spend more time with their children than fathers (Baxter & Smart, 2010) and therefore may be more likely to impose limits. We also found mothers' use of reinforcement (negative association) was a significant predictor of core food intake. Davison and Campbell (2005) suggest it could be ineffective and counterproductive for parents to emphasize the benefits of certain foods, children may resent being praised for something if it is not warranted or be possibly interpreted as coercion. Child screen-time was also negatively associated with core food intake. This is supported by previous research in children where sedentary behavior, typically assessed as screen-time and largely TV viewing, has been associated with a less healthy diet (Pearson & Biddle, 2011). For example Temple et al. (2007) found children tend to consume energy-dense, nutrient-poor foods when watching television.

No studies to date have investigated the relationship between maternal and paternal parenting strategies and multiple lifestyle behaviors using objectively measured child and father physical activity. The model for child physical activity explained about one-fifth of the variance with paternal reinforcement the sole explanatory variable, but interestingly, was negatively associated with children's physical activity. While this is a somewhat counter-intuitive finding, our findings are supported in the general parenting literature where there is evidence that too much praise can be detrimental to child outcomes (Grosz, 2013). Bayat (2010) suggested that children who are praised when little effort has been applied to the particular task might doubt the authenticity of the praise. Another plausible explanation for our findings for paternal reinforcement is that a higher than average proportion of the children in this study were either overweight or obese (42%) and well-intentioned parents may encourage and promote physical activity differently depending on the weight status of their child. This may have an unintended adverse effect on physical activity, as children may interpret the encouragement as coercion (Davison & Campbell, 2005). Similarly, for children who are least active, it is possible they receive more praise from their parents as a mechanism to try and motivate them to be more active. In contrast to our findings, Hennessy and colleagues found a positive association between reinforcement and objectively measured physical activity. However the authors only found a significant association for parents who exhibited a permissive parenting style (Hennessy, Hughes, Goldberg, Hyatt, & Economos, 2010). Further research is warranted to investigate the potential moderating role of parenting style and the mediating effect of parenting practices on children's physical activity. However, our findings suggest that it is the influence of the father in respect to physical activity and praise that is more influential than the mother.

Supporting our hypotheses and addressing our final aim, to examine if there were differences in maternal and paternal physical activity- and dietary-related parenting practices, we found significant differences between three of the five subscales (i.e., control, monitoring and limit setting). This is supported by other studies that have examined either activity- or diet-related parenting practices and identified significant differences between maternal and paternal reports of control (pressure-to-eat) (Brann & Skinner, 2005; Loth et al., 2013), monitoring (Blissett et al., 2006) and limiting sedentary behavior (Edwardson & Gorely, 2010a). In the current study, fathers reported significantly ($p<.001$) higher use of control in relation to child eating than mothers. This is consistent with some previous research (Brann & Skinner, 2005; Loth et al., 2013) but not all (Blissett et al., 2006). The authors suggested potential inaccuracies in paternal reporting of child eating due to lower rates of perceived responsibility and monitoring of feeding their children, with the fathers recruited from primarily higher SES areas (Blissett et al., 2006). Most of the families in our study were not from low SES areas and hence similar issues may have influenced our results. Fathers may also take on more traditional feeding practices than mothers, such as encouraging young children to eat everything on their plate (Savage, Fisher, & Birch, 2007). Our findings suggest future research to explore sex-differences in parental use of control, relative to child food intake, is warranted.

When examining both mothers' and fathers' parenting practices within the same family, our findings suggest that parents within the same household exhibit similar levels of control (pressure-to-eat) and monitoring. However, similar patterns were not observed across all parenting practices, suggesting that parents are not consistent in regard to managing their children's physical activities and eating behaviors. If the mother reported using pressure-to-eat (control), then the father was likely to also report this ($r=.54$, $p<.001$). Similarly, if a mother reported a high level of monitoring, the father was also likely to report high levels ($r=.31$, $p<.05$). Other studies have found similarities across couples in relation to parenting practices (Baxter & Smart, 2010; Blissett et al., 2006; Davison et al., 2003; Pleck, 2010).

Overall, our findings may be used to inform future research and particularly interventions aimed at preventing obesity in children. Mothers' monitoring of child screen-time may be an important parenting practice to target. Interventions that target parents and are designed to increase children's physical activity and healthy food consumption need to ensure parents are informed of the possible negative impact on behavior change resulting from excessive praise, particularly when the children are either overweight or obese. Specifically, for child physical activity, fathers' use of praise should be targeted and for mothers, a focus on promoting child healthy food consumption. In addition, parents should be made aware of the links between children's screen-time and the type of food children consume. It would be fruitful to educate parents on their role in optimizing child dietary patterns through setting limits in relation to screen-time and noncore food groups. Programs designed to enhance children's diets and physical activity may benefit from engaging both fathers and mothers. Emphasis should be placed on fathers' behavior and parenting for physical activity and mothers' parenting practices for healthy eating and screen-time. Future research needs to incorporate both mothers and fathers in high quality RCTs.

The strengths of our study include the inclusion of parenting measures for both parents, which allowed simultaneous exploration of paternal and maternal variables in the multiple regression models and to examine differences in maternal and paternal activity- and diet-related parenting practices, which addresses recent calls in the literature (Rodenburg et al., 2013). Other strengths were the examination of multiple domains of parenting practice and the use of objective measures of physical activity and anthropometry. However, there are limitations in the current study that should be considered when interpreting the results. The reinforcement subscale of the Parenting Strategies for Eating and Activity Scale was composed of only two items, one item related to physical activity and one relevant to diet. The cross-sectional nature of this study meant it was not possible to determine causality and we collected fathers' anthropometric and behavior measures but not mothers. The physical activity measure (pedometers), are not able to capture intensity of activity and are problematic for certain activities (e.g. cycling) and not to be worn in water and contact sports. A final limitation was only using the PEAS scale to measure parenting practices, when more comprehensive physical activity and diet related parenting measures would give a more in depth understanding of the differences between maternal and paternal parenting practices.

Conclusion

This study supports research indicating that paternal BMI is associated with children's weight status. We have established that fathers and mothers differ in their use of specific physical activity- and diet-related parenting practices. However, within couples, some parenting constructs are correlated. Parents should be informed of the potential relationship between greater screen-time and lower intakes of healthy foods. Lifestyle interventions targeting children need to engage mothers, particularly in terms of child screen-time and dietary behavior, they also need to target fathers' weight status and parenting in relation to physical activity. Further research is needed to examine the utility of teaching parents to use reinforcement for physical activity and healthy eating within interventions targeting them, particularly when the child is overweight or obese.

Competing Interests

The authors declare that they have no competing interests.

Authors' contributions

Recruiting participants and/or study implementation: AL, PM and DL. Analysis and interpretation of data: AL. Drafting of manuscript: AL. Critical revision of the manuscript: PM, DRL, RP and CC. Statistical analysis: AL and PM. Obtained funding: PM, DRL, CC and RP. All authors read and approved the final manuscript.

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Table 1 Parenting strategies for eating and activity scale: Scale descriptions and reliability scores for mothers and fathers

Scale	Description	No. of items	Mothers Cronbach's α	Fathers Cronbach's α
Control	Response options ranged from (1) disagree to (5) agree. e.g. *'How much do you agree or disagree with each statement? My child should always eat all the food on his/her plate'.*	4	.70	.75
Limit setting	Response options ranged from (1) disagree to (5) agree. e.g. *'I limit the amount of time my child watches TV or videos during the week (Mon – Fri)'*	6	.84	.86
Monitoring	Response options ranged from (1) never to (5) always. e.g. '*How much do you keep track of the Exercise your child is getting?'*	7	.87	.88
Discipline	Response options ranged from (1) never to (5) always. e.g. '*How often to you discipline your child for doing the following without your permission watching TV or videos?'*	5	.87	.87
Reinforcement	Response options ranged from (1) never to (5) always. e.g. *'How often do you praise your child for being physically active?'*	2	.86	.73

Table 2 Baseline characteristics of fathers and their children

Characteristics	Fathers (n = 70)		Eldest Child (n = 70)	
	Mean	(SD)	Mean	(SD)
Age (years)	39.9	5.2	8.4	2.4
Sex (% male)	100	-	58.6	-
Weight (kg)	103.6	15.4	33.9	12.1
Height (m)	176.7	6.3	131.4	15.0
BMI (kg/m^2)	33.3	4.2	19.0	3.6
BMI *z*-score	n/a	n/a	1.0	1.1
BMI Category				
Overweight, (%)	25.7	-	27.5	-
Obese, (%)	74.3	-	14.5	-
Physical activity (steps/day)[a]	6768	2538	9858	2915
Energy from core foods (%)[b]	56.3	11.4	62.7	9.4
Screen-time/day (min)[c]	-	-	161.7	83.3
Workday	137.8	90.7	-	-
Nonworkday	228.4	125.1	-	-

Abbreviations: HDHK = Healthy Dads, Healthy Kids; BMI = Body Mass Index;
[a] n = 65 fathers, n = 63 children
[b] n = 69 fathers, n = 62 children
[c] n = 68 fathers, n = 65 children

Table 3 Bivariate correlations between fathers' characteristics, mother and father parenting practices and children's behaviors and outcomes

	Child behaviors and outcomes			
Mothers	**BMI *z*-score**	**Screen-time** *(Min/day)*	**Core foods** *(% energy)*	**Steps** *(per day)*
Control	-.47**	.04	-.19	-.25*
Limit setting	.11	-.15	.39**	.09
Monitoring	-.09	-.44***	.48***	.07
Discipline	.05	-.30*	.20	.12
Reinforcement	.13	-.00	-.25*	.11
Fathers				
Control	-.31**	-.04	-.09	.02
Limit setting	-.03	-.33**	.30*	.13
Monitoring	-.05	-.24	.10	-.13
Discipline	-.07	-.34**	.19	-.18
Reinforcement	-.03	.05	-.08	-.42**
BMI	.41***	.31*	-.18	.12
Age	.14	.14	-.12	-.10
SES	-.14	-.00	.00	-.04
Steps	-.07	-.24	.04	.22
Core foods (%)	-.11	-.18	.37**	-.25
Workday screen-time	.28*	.13	.25	.19
Non-workday screen-time	.04	-.06	.15	.17
Eldest Child				
Age	.12	.39***	-.22	.04
Sex	-.04	-.28*	.14	-.20
BMI z-score	-	.27*	-.16	-.01

*$p < .05$, **$p < .01$, ***$p < .001$

Table 4 Regression analysis results for children's BMI *z*-score, screen-time, core foods and physical activity

Variables in final model(s)	Standard β	p value	Part R^2	Variance explained
BMI *z*-score				**Model R^2 = .34**
Mothers' control	-.42	<.001	-.41	
Fathers' BMI	.35	.001	.35	
				$F(2,66) = 16.87, p < .001$
Screen-time				**Model R^2 = .41**
Mothers' monitoring	-.34	.002	-.33	
Child age	.27	.010	.27	
Child sex	-.30	.006	-.29	
Child BMI *z*-score	.23	.029	.22	
				$F(4,59) = 10.35, p < .001$
Core foods (% energy)				**Model R^2 = .33**
Mothers' limit setting	.39	.001	.38	
Mothers' reinforcement	-.28	.016	-.28	
Child screen-time	-.28	.015	-.28	
				$F(3,54) = 8.77, p < .001$
Child steps (per day)				**Model R^2 = .18**
Fathers' reinforcement	-.42	.001	-.42	
				$F(1,61) = 13.13, p = .001$

Non-significant covariates were omitted from the final model(s)

Table 5 Paired samples t-test comparing maternal and paternal scores on the Parenting Strategies for Eating and Activity Scale.

Scale	**Mothers** *(n = 70)*		**Fathers** *(n = 70)*		**Sig**	**Paired**	**95% CI**	
	Mean	**SD**	**Mean**	**SD**	*(2 – tailed)*	**Diff.**	*L*	*U*
Control	2.55	.96	3.13	1.03	.000	.58	.35	.81
Limit setting	4.48	.60	4.15	.75	.003	-.32	-.53	-.12
Monitoring	4.20	.58	3.77	.68	.000	-.42	-.60	-.25
Discipline	3.55	1.09	3.51	.90	.787	-.04	-.35	.27
Reinforcement	3.85	.87	3.66	.94	.219	-.19	-.50	.12

CI, Confidence intervals; L, Lower; U, Upper; Sig, Significance.

Table 6 Paired samples correlations between maternal and paternal parenting practices

Pair	n	Correlation
Maternal control and paternal control	70	.54**
Maternal limit setting and paternal limit setting	70	.19
Maternal monitoring and paternal monitoring	70	.31*
Maternal discipline and paternal discipline	70	.17
Maternal reinforcement and paternal reinforcement	70	-.03

*$p < .05$, **$p < .001$