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Review Article

The forgotten parent: Fathers' representation in family interventions to prevent childhood obesity

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ABSTRACT

Despite recognition that parents are critical stakeholders in childhood obesity prevention, obesity research has overwhelmingly focused on mothers. In a recent review, fathers represented only 17% of parent participants in > 600 observational studies on parenting and childhood obesity. The current study examined the representation of fathers in family interventions to prevent childhood obesity and characteristics of interventions that include fathers compared with those that only include mothers. Eligible studies included family-based interventions for childhood obesity prevention published between 2008 and 2015 identified in a recent systematic review. Data on intervention characteristics were extracted from the original review. Using a standardized coding scheme, these data were augmented with new data on the number of participating fathers/male caregivers and mothers/female caregivers. Out of 85 eligible interventions, 31 (37%) included mothers and fathers, 29 (34%) included only mothers, 1 (1%) included only fathers, and 24 (28%) did not provide information on parent gender. Of the interventions that included fathers, half included 10 or fewer fathers. Across all interventions, fathers represented a mere 6% of parent participants. Father inclusion was more common in interventions targeting families with elementary school-aged children (6–10 years) and those grounded in Ecological Systems Theory, and was less common in interventions focused on very young children (0–1 years) or the prenatal period and those targeting the sleep environment. This study emphasizes the lack of fathers in childhood obesity interventions and highlights a particular need to recruit and engage fathers of young children in prevention efforts.

1. Introduction

Childhood obesity is a pressing public health problem with short and long term health consequences (Reilly et al., 2003; Daniels, 2006). Given that children's diet and physical activity behaviors are established in the context of the family (Birch and Davison, 2001; Davison and Birch, 2001; Ventura and Birch, 2008; Trost and Loprinzi, 2011), engaging parents and families in the prevention of obesity is critical (Monasta et al., 2011; Waters et al., 2011). Despite widespread recognition of the pressing need to engage parents in childhood obesity interventions, research has overwhelmingly focused on mothers. In a 2016 systematic review and content analysis (Davison et al., 2016), our research team documented the inclusion of fathers in more than 600 observational studies on parenting and childhood obesity published since 2009. Results showed that fathers represented only 17% of all parent participants, with an average of 139 fathers per study compared with 672 mothers per study.

Father inclusion in parenting interventions is similarly low (Panter-Brick et al., 2014). This pattern is problematic given research illustrating improved child outcomes when parenting interventions include mothers and fathers compared with those that only include mothers (Lundahl et al., 2008). Research increasingly supports the need to include fathers in childhood obesity interventions. In a nationally representative US sample, over 70% of fathers with co-residential children aged 5 years or younger reported that they fed or ate a meal with their child every day over the previous 4 weeks (Jones, 2013). Similarly, fathers consider themselves responsible for feeding their children and helping with meal preparation including grocery shopping (Khandpur et al., 2014). Fathers' parenting approaches have in turn been linked with children's weight-related behaviors and outcomes. For

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example, research shows that higher paternal restriction of child access to food (Loth et al., 2013; Musher-Eizenman et al., 2009; Musher-Eizenman et al., 2007) and lower paternal pressure to eat (Loth et al., 2013; Tschann et al., 2013) are linked with higher body mass index (BMI) in children, a pattern that is consistent with what has been observed for mothers (Ventura and Birch, 2008).

Despite a documented need to include fathers in childhood obesity interventions, rates of father participation appear to be low. In a recent systematic review, Morgan and colleagues examined the inclusion of fathers in family interventions to treat and prevent childhood obesity. The authors found that in cases where one parent per family was recruited, only 6% were fathers (Morgan et al., 2017). The authors also reported that only 2 studies, from more than 200, explicitly reported using recruitment strategies targeted to fathers and only 4 studies reported low father involvement as a study limitation.

The current study examines the inclusion of fathers in family interventions to prevent childhood obesity and assesses differences in intervention content, child age, theories utilized, and the inclusion of underserved groups (low income, racial/ethnic minority) for interventions with and without fathers. This information will help identify characteristics of interventions that do not include fathers and particular subgroups of fathers who are excluded or missing from existing interventions. To guide future funding efforts, funding sources for interventions that include fathers are also characterized. While replicating elements of Morgan et al. (Morgan et al., 2017) this study is unique in its assessment of the theories utilized, sample size distributions, inclusion of underserved populations and funding sources.

2. Methods

This study utilized data from a recent systematic review and content analysis of family interventions for childhood obesity prevention (Ash et al., 2017) and was registered in PROSPERO (CRD42016041873) prior to its implementation and independent from the original review (CRD42016042009). Existing data for eligible interventions were augmented with new data on the inclusion of fathers/male caregivers and mothers/female caregivers. Methods from the original review are briefly summarized below followed by a description of the methods used to compile new data for this study. A detailed description of the original review methods, including the PRISMA reporting protocol, is provided in Ash et al. (Ash et al., 2017).

2.1. The original review

With the assistance of a research librarian, two researchers searched three research databases (PubMED, PsycINFO and CINAHL) using search terms that combined the concepts of family (e.g., family, father, mother), intervention (e.g., intervention, prevention, trial), children (e.g., child, infant, preschool), and obesity (obesity, body mass, overweight). The search was limited to articles published between January 1st 2008 and December 31st 2015. After removing duplicates, 8525 unique studies were identified and screened against eligibility criteria.

Eligible studies for the original review included family-based interventions for childhood obesity prevention published in English. The following studies were not eligible for inclusion: Studies that exclusively recruited children with overweight or obesity (i.e., treatment studies), studies that focused on specific clinical populations, dissertations and conference abstracts. In instances where multiple studies were published on the same intervention, the data extracted from each study were synthesized into a single entry resulting in a final sample of 119 unique eligible interventions. Two trained coders used conventional content analysis methodology (Berelson, 1952; Manganello and Blake, 2010) to code up to 90 intervention and participant characteristics for each study. Variables utilized in the current study from the original review include publication year, geographic region, age of the target child (prenatal, 0–1 year, 2–5 years, 6–10 years, 11–13 years, 14–17 years), intervention setting (home, community, clinic, school, childcare), theory utilized (none, Social Cognitive Theory, Ecological Systems Theory, Baumrind's parenting styles, Transtheoretical Model, other), racial/ethnic (White, Black/African American, Hispanic/Latino, other) and underserved (single parents, immigrant families, families with low socioeconomic status, SES) groups included, intervention delivery mode (in-person, technology based), factors targeted within the home environment (food parenting/environment, physical activity parenting/environment, media parenting/environment, sleep parenting/environment), and funding source.

2.2. New data coded for this study

Although the original review included intervention protocols, they were excluded from this study because they do not consistently report participant characteristics leaving 85 unique eligible interventions. To augment the data from the original review, two trained researchers coded new data on parent gender and sample size with a mean intercoder reliability (kappa) of 0.88. The coders recorded (a) whether the intervention included mothers/female caregivers, fathers/male caregivers, both, or if parent gender was unclear or not specified, and (b) the number of male and female parent participants at baseline using the following sample size categories (0, 1–10, 11–50, 51–100, 101–150, 151–200…401–450, 451–500, 501–1000, 1001–1500, 1501–2000). Sample size ranges were coded to facilitate consistent coding across coders (given variations in sample size numbers reported in a given paper) and to reduce coding burden.

2.3. Data synthesis and analysis

All missing data were reviewed. In most instances, missing data were the result of planned skip patterns. For example, when mothers or fathers were not included in a study, the coders were not prompted through the electronic coding form, to code the sample size for that group. In such cases, the number of participant mothers/fathers was coded as “0”. For missing data that were not the result of skip patterns, one of the authors returned to the original article and retrieved the missing information.

To address the first research question, the sum of participating fathers and mothers across all interventions and the average number of fathers and mothers per intervention were calculated. Prior to these calculations, each sample size category was converted to a continuous score using the mid-point of that range (e.g., the category 0–10 participants was coded as 5). Using data from a previous content analysis of father participation in observational studies (Davison et al., 2016; Gicevic et al., 2016) we verified that the mean score did not appreciably differ when calculated based on raw sample size scores (i.e., the actual number of individuals who participated) compared with midpoints of sample size ranges as utilized in this study. Thus, we do not anticipate that this approach interjected appreciable (and systematic) error into the data. Studies that did not include any fathers (or mothers) received a score of 0 for sample size. In cases where parents were included as participants but no information on parent gender was provided, the number of mothers and fathers was coded as missing. The midpoint scores were summed separately for mothers and fathers across all interventions. To calculate the average number of fathers and mothers per intervention, the total number of participants was divided by the number of interventions that contributed to the total score. For fathers, the denominator was 54 interventions. For mothers, the denominator was 55.

An independent *t*-test was used to test the difference in average sample size of fathers versus mothers. Cohen's d was calculated based on the results of the *t*-test (i.e., mean difference/pooled standard deviation) to provide a measure of effect size with 0.2, 0.5, and 0.8 interpreted as small, medium and large effect sizes respectively. To address the second research question, eligible interventions in which

Table 1
Characteristics of eligible interventions (N = 85)[a].

Characteristic	# interventions	% of interventions[b]
Year of publication		
2008	5	6%
2009	2	2%
2010	8	9%
2011	9	11%
2012	17	20%
2013	20	24%
2014	10	12%
2015	14	16%
Geographic region		
United States (US)	50	59%
Europe/UK	17	20%
Australia/New Zealand	8	9%
Canada	4	5%
Asia	0	0%
Mexico/Central America	2	2%
South America	1	1%
Middle East	1	1%
Other (includes Israel, Caribbean, Africa)	2	2%
Self-reported gender of parent participants		
Mother only	29	34%
Father only	1	1%
Mother and fathers	31	37%
Gender not specified	24	28%
Child age groups included at baseline[c,d]		
Prenatal	6	7%
0–1 year (infants)	20	24%
2–5 years (preschool)	35	41%
6–10 years (elementary school)	31	36%
11–13 years (middle school)	20	24%
14–17 years (high school)	7	8%

[a] In instances where multiple studies were published from one intervention, the data extracted were synthesized into one single entry.
[b] Denominator for % studies = all eligible studies (N = 85).
[c] Percentages may add to more than 100 because multiple categories could be selected.
[d] An age category was coded if the age range of participants fell predominantly in that category; additional categories were coded if the age range extended at least two years into that category.

parent gender was specified were categorized as including fathers versus only mothers. In all but one instance, interventions that included fathers also included mothers. Thus, the two categories were largely interventions with fathers and mothers versus interventions with only mothers. Chi-square analysis was used to examine differences in intervention (year, child age group, intervention setting, intervention delivery mode, parenting dimension targeted, theories utilized) and participant (race/ethnicity, immigrant status, SES) characteristics for interventions including fathers versus only mothers. The unit of analysis in all analyses was intervention, with the exception of group differences in average sample size which used participant as the unit of analysis. Analyses were performed in SAS 9.4 (Cary, NC) in August 2017.

3. Results

Shown in Table 1, the number of eligible interventions ranged from 2 to 20 per year. Interventions were primarily conducted in the United States (US; 59%), Europe/United Kingdom (20%) or Australia/New Zealand (9%), and most often targeted families with preschool (41%) or elementary school (36%) children. Approximately a third of interventions included mothers only (34%), a third included mothers and fathers (37%), and a third did not specify parent gender (28%); only 1% of interventions included fathers only. Eligible interventions were published in more than 90 journals with Childhood Obesity (N = 6), Obesity (N = 5) and Pediatrics (N = 5) being the most common publication outlets with at least five published studies each (data not shown).

Of the interventions that included fathers and reported father sample size (N = 30), 15 (50%) included 10 or fewer fathers and two (7%) included more than 100 fathers (see Fig. 1). In comparison, among interventions that included mothers and reported mother sample size (N = 55), no studies included 10 or fewer mothers and 31 (56%) included more than 100 mothers. The estimated number of participating fathers across all interventions was 990, with an average of 18.3 (sd = 34.7) fathers per intervention. The comparable figures for mothers were 14,405 mothers across all interventions and an average of 261.9 (sd = 288.3) mothers per intervention. A highly significant difference in the mean sample size of fathers versus mothers was observed ($t = 6.16$, df = 107, 95% CI = 165.3–321.9) with a large effect size ($d = 1.18$). Overall, fathers comprised 6% of parent participants in eligible interventions.

Compared with interventions that included mothers only, significantly fewer interventions that included fathers focused on the prenatal period ($\chi^2 = 7.34$, $p < 0.01$), targeted families with children ages 0–1 year ($\chi^2 = 8.40$, $p < 0.01$), or focused on sleep parenting ($\chi^2 = 5.05$, $p < 0.05$) and significantly more interventions with fathers focused on children ages 6–10 years ($\chi^2 = 7.23$, $p < 0.01$) and were grounded in Ecological Systems Theory ($\chi^2 = 4.64$, $p < 0.05$) (Table 2). No significant group differences in intervention setting were observed. For participant characteristics (Table 3), no significant differences in the inclusion of underserved or racial/ethnic groups were observed.

We also conducted a descriptive review of funding sources for interventions that included fathers. All but three interventions with fathers (i.e., 29 out of 32) reported at least one funding source. The majority of interventions with fathers received federal funding (N = 19,

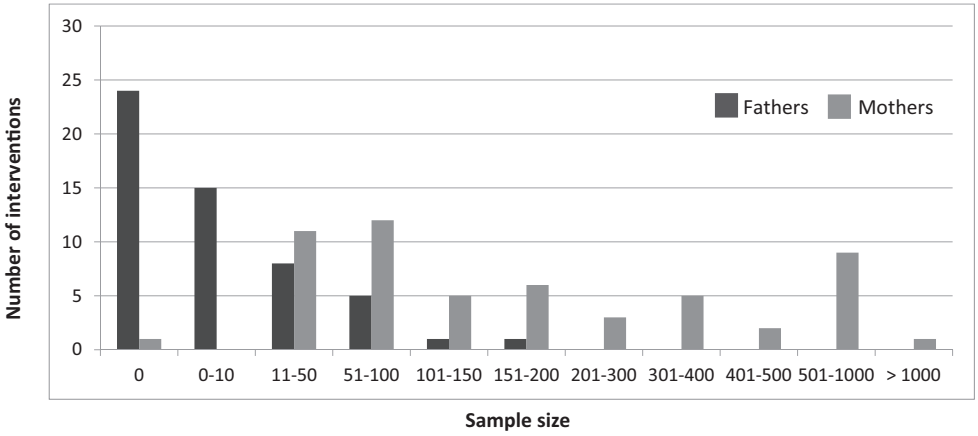

Fig. 1. Sample sizes for fathers and mothers for all eligible interventions where parent sample size was known (Fathers N = 54 interventions; Mothers N = 55 interventions)
Note: Using a sample size of 0 as an example, the interpretation of Fig. 1 is as follows: 24 studies included 0 fathers compared with 1 study that included 0 mothers. This can also be stated as 24 studies included only mothers and 1 study included only fathers.

Table 2
Intervention characteristics for interventions that included any fathers (N = 32) versus only mothers (N = 29)[a].

	Studies including only mothers (N = 29) # studies (%)[b]	Studies including any fathers (N = 32) # studies (%)[c]	Chi-square
Publication year			
2008	1 (3%)	3 (9%)	0.178[d]
2009	0 (0%)	1 (3%)	
2010	4 (14%)	3 (9%)	
2011	3 (10%)	4 (13%)	
2012	7 (24%)	5 (16%)	
2013	9 (31%)	7 (22%)	
2014	1 (3%)	3 (9%)	
2015	4 (14%)	6 (19%)	
Intervention setting			
Home	8 (28%)	11 (34%)	0.32
Community	9 (31%)	13 (41%)	0.61
Clinic	10 (34%)	6 (19%)	1.94
School	2 (7%)	7 (22%)	2.71*
Childcare	0 (0%)	3 (9%)	2.86*
Multi-setting	4 (14%)	7 (22%)	0.67
Child age group at baseline[e]			
Prenatal	6 (21%)	0 (0%)	7.34***
0–1 year (toddler)	12 (41%)	3 (9%)	8.40***
2–5 years (preschool)	11 (38%)	15 (47%)	0.49
6–10 years (elementary school)	5 (17%)	16 (50%)	7.23***
11–13 years (middle school)	5 (17%)	11 (34%)	2.31
14–17 years (high school)	3 (10%)	3 (9%)	0.01
Intervention delivery mode			
In person	25 (86%)	28 (89%)	0.02
Technology-based	2 (7%)	7 (22%)	2.71*
Parenting dimension targeted			
Food parenting	27 (93%)	30 (94%)	0.01
PA parenting	21 (72%)	26 (81%)	0.67
Media parenting	14 (48%)	19 (59%)	0.75
Sleep parenting	8 (28%)	2 (6%)	5.05**
Theories utilized			
None	18 (62%)	24 (75%)	1.18
Social cognitive theory	10 (34%)	16 (50%)	1.49
Ecological systems theory	2 (7%)	9 (28%)	4.64**
Parenting styles (Baumrind)	3 (10%)	7 (22%)	1.47
Transtheoretical model	3 (10)	4 (13%)	0.07

For all variables (except year), groups are not mutually exclusive and percentages may add to more than 100.

[a] Interventions that did not specify parent gender (N = 24) were excluded.

[b] Denominator for % of studies = 29.

[c] Denominator for % of studies = 32.

[d] z-score from χ^2 trend test.

[e] An age category was coded if the age range of participants fell predominantly in that category; additional categories were coded if the age range extended at least two years into that category.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

Table 3
Sample characteristics for interventions that included any fathers (N = 32) versus only mothers (N = 29).[a]

	Studies with only mothers (N = 29) # studies (%)	Studies including any fathers (N = 32) # studies (%)	Chi-square
Underserved parents included[b]			
Single parents	10 (31%)	8 (25%)	0.65
Immigrant	10 (34%)	7 (22%)	1.20
Low SES	21 (21%)	24(75%)	0.05
Racial/ethnic groups included[c]			
White	6 (37%)	12 (63%)	2.28
Black/African American	6 (37%)	10 (53%)	0.80
Hispanic/Latino	12 (75%)	16 (84%)	0.46
Asian	5 (31%)	7 (37%)	0.12

Percentages may add to more than 100 because the groups were not mutually exclusive.

No effects were statistically significant at $p < 0.10$, $p < 0.05$ and $p < 0.01$.

[a] Interventions that did not specify parent gender (N = 24) were excluded.

[b] Denominator for % of studies = 29 (only mothers) and 32 (any fathers).

[c] Denominator for % of studies = 16 (only mothers) and 19 (any fathers) due to missing race/ethnicity information for 15 studies.

59% for all interventions; N = 14, 70% of US interventions), 3 received international funding (i.e., from non-US agencies) and 5 reported the receipt of university seed grant funding. Federal funding for US interventions was predominantly from the National Institutes of Health (N = 11, 55%), with the United States Department of Agriculture (USDA) and Centers for Disease Control (CDC) each funding one intervention. Additional US funders included the American Cancer Society (ACA; N = 2 interventions) and the American Heart Association (AHA; N = 2 interventions). No interventions were funded by the Robert Wood Johnson Foundation (RWJF).

4. Discussion

Recent reports from authoritative national and international health organizations emphasize the need to engage parents in childhood obesity prevention (Institute of Medicine (IOM), 2012; World Health Organization (WHO), 2016). While "parent" engagement implies the engagement of mothers and fathers, this study demonstrates that fathers participate in childhood obesity interventions at much lower rates than mothers. Only 6% of parents who participated in family-based interventions for childhood obesity prevention published between 2008–2015 were fathers. Of the 30 interventions that included fathers, half included 10 or fewer fathers and only two included more than 100 fathers. Rates of father participation were particularly low in interventions targeting the prenatal period and families with infants. In contrast, fathers were most likely to participate in interventions targeting families with children ages 6–10 years and those grounded in Ecological Systems Theory.

Findings from this study expand our prior work on the inclusion of fathers in observational studies and replicate the findings of Morgan and colleagues (Morgan et al., 2014). Our finding that fathers represented 6% of parent participants matches that reported by Morgan et al., even though the studies used slightly different samples. Morgan et al. combined treatment and prevention studies and 6% father participation was in reference to interventions that sought to recruit one parent. This study focused on prevention studies and looked at the inclusion of fathers across all preventive interventions (i.e., regardless of recruitment strategy). Our goal was to profile the literature on family interventions to prevent obesity as a whole and to make statements about this body of work. In contrast, Morgan et al. focused on the recruitment strategy (i.e., limiting to one parent versus open to both parents) and implications for the inclusion of fathers. The overlapping finding, lends credibility to the results of both studies and suggests that the participation rates of fathers in prevention and treatment studies is similarly low.

Interventions focused on the early developmental years (prenatal period, birth – 1 year) were less likely to include fathers and those focused on families with elementary school-aged children (6–10 years) were more likely to include fathers. For example, of the 6 interventions that targeted the prenatal period, none included fathers. Similarly, of the 15 interventions focused on children ages 0–1 year, only 3 included fathers. In contrast, 16 out of 21 interventions for children ages 6–10 years included fathers. Counter to these findings, Morgan et al. found that child age did not predict father participation in interventions. However, their analysis was limited to 20 interventions that allowed participation from both parents. Morgan et al.'s approach tests a slightly different research question; that is, whether child age predicts father participation when they are directly considered in recruitment efforts. Our analysis sought to identify specific gaps in the literature on fathers and make recommendations for future research.

The lack of fathers in prenatal interventions targeting obesity is consistent with what is observed in prenatal care in general (Kotelchuck and Lu, 2017). Fathers relative absence from the prenatal setting may be explained by the emphasis placed on mothers during the prenatal period and the lack of consideration for the role of fathers on family health during this time (Kotelchuck and Lu, 2017). Low father involvement in prenatal programs, including obesity interventions, is problematic given research demonstrating that low paternal involvement is linked with low infant birthweight, suboptimal breastfeeding practices and accelerated infant weight gain (Alio et al., 2011a; Alio et al., 2010; Alio et al., 2011b; Martin et al., 2007). Furthermore, emerging research highlights the potential influence of fathers during early childhood on children's weight-related behaviors including diet and physical activity and media use (Khandpur et al., 2014; Loth et al., 2013; Tschann et al., 2013; Wong et al., 2017). Thus, it is critical to include fathers in obesity interventions targeting the prenatal and early developmental years. Fortunately, there is the potential to harness national efforts to achieve this objective. A multiagency national working group to improve paternal involvement in pregnancy and family health has been established (Bond et al., 2010) and rates of father involvement during pregnancy and the first year of life are increasing (Steen et al., 2012). In addition to including fathers in obesity interventions during the early developmental years, it is important to measure and report parent gender and present results separately for mothers and fathers to build a comprehensive knowledge base on the role of fathers in obesity prevention.

To our knowledge, no studies have examined whether obesity interventions that include fathers differ in their demographic composition to interventions including only mothers. In our prior assessment of observational studies, we found that studies that included fathers were significantly less likely to include participants from low income or racial/ethnic minority groups (Davison et al., 2016) than studies including only mothers. That is, when fathers were included it was generally in studies focusing on white, higher income families, possibly due to a tendency to recruit fathers via mothers or children enrolled in organized child care (Khandpur et al., 2014). In contrast, this study found no significant differences in the demographic composition of interventions with and without fathers. This finding suggests that the demographic bias seen in observational studies has not been carried forward to interventions themselves. It should be noted, however, that studies included limited information on single parents. There was generally insufficient information to determine the proportion of parent participants in a given study who were single parents. It is likely that studies with a large proportion of single parents include far fewer fathers than studies with predominantly two parent households. Given that approximately 1 in 4 US children live in single parent households (Kreider, 2007), the number and proportion of single parents (mothers and fathers) in family interventions should be reported. Studies should also report family structure and/or household composition in combination with relationship status given that multiple family structures could be reflected under a label such as "single parent" (i.e., single mother with live-in romantic male partner, single mother cohabiting with the child's biological father but who still classifiers herself as single, single father with no partner present), each of which may have implications for fathers' participation in obesity-related interventions.

This study also contributes to our understanding of the theories utilized in childhood obesity interventions including fathers and funding sources of this work. Interventions including fathers were more likely to be grounded in Ecological Systems Theory than interventions including mothers. No other differences in theoretical frameworks were identified. This finding likely reflects the fact that Ecological Systems Theory explicitly conceptualizes the family as a system with multiple members (Bronfenbrenner, 1979). Other examples of family theories that could support and guide research on fathers, but which have been used infrequently to date, include Family Systems Theory, Attachment Theory, Gender Theory and the Lifecourse Approach. Expanding the repertoire of family theories utilized beyond Ecological Systems Theory may bring new insight into strategies to engage fathers in obesity research and their role in obesity prevention.

Internal university grants and the National Institutes of Health were the predominant funders of interventions including fathers. Very few interventions with fathers were funded by the USDA or foundations

such as ACS and AHA, and no studies were funded by RWJF. This highlights future opportunities for these organizations to expand their funding portfolios to include interventions with appreciable numbers of fathers and which ideally present results for fathers separate from those for mothers.

This study makes a number of important contributions to the literature. First, it further emphasizes particularly low rates of father participation in family interventions to prevent obesity. When combined with our prior work and that of Morgan and colleagues, these studies convincingly illustrate the paucity of fathers in childhood obesity interventions and the need to adopt explicit strategies to recruit, engage, and retain fathers in future interventions. Second, this study shows that increasing father participation is particularly critical in studies focused on the early developmental years. These results, however, need to be weighed against study limitations. We drew on existing data from a recent systematic review. As a result, the quality of this study is confined by decisions made in the original review. For example, the original review focused on studies published since 2008 which may inflate estimates of father participation if earlier interventions included even fewer fathers. The fact that we included a similar number of preventive interventions as Morgan et al. and report the same results for the proportion of parent participants who were fathers suggests that the bias introduced was likely very low.

In summary, results from this study support recent research documenting low father participation in family interventions for child obesity (Morgan et al., 2014), highlight the need to target fathers of young children in particular, and suggest that theories referencing the family as an entire unit or system may help support father participation. Research that tests strategies to engage fathers, such as partnering with organizations trusted by fathers, targeting father-friendly venues (e.g., workplaces) and social media outlets (Davison et al., 2017) is also needed to identify the most effective approaches to engage fathers. The inclusion of both parents is likely to enhance the efficacy of programs (Lundahl et al., 2008) and will create the opportunity to examine the role of household-level factors involving both parents, such as coparenting, on child weight status. Finally, given that almost 30% of eligible interventions provided no information on parent gender, greater transparency in reporting is needed and the tendency to generalize the results of mother-only studies to “parents” should be avoided. Likewise, studies should measure and report information on household composition, father residential status and father relationship with the target child (i.e., biological father, step father, grandfather) given their implications for fathers' involvement in weight-related parenting and participation in obesity interventions.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Ethics

IRB approval was not required as no human subjects were included.

Authors' contributions

KD conceived the paper, designed the coding strategy, assisted with coding the data, and wrote the manuscript. NK coded the data, ran the analyses, generated the tables and graphs and assisted with drafting the paper. AAT designed the coding strategy, created the coding manual, reviewed the assisted with screening and coding training, and edited the manuscript. TA and AA developed the search strategy, performed the literature search, conducted article screening, and performed data extraction for the original review. MS performed the literature search and data extraction, NK, TA, AA, AAT, MS and JH assisted with data interpretation and edited this manuscript. All authors read and approved the final manuscript.

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References

Alio, A.P., Kornosky, J.L., Mbah, A.K., Marty, P.J., Salihu, H.M., 2010. The impact of paternal involvement on feto-infant morbidity among Whites, Blacks and Hispanics. Matern. Child Health J. 14 (5), 735–741.

Alio, A.P., Bond, M.J., Padilla, Y.C., Heidelbaugh, J.J., Lu, M., Parker, W.J., 2011a. Addressing policy barriers to paternal involvement during pregnancy. Matern. Child Health J. 15 (4), 425–430.

Alio, A.P., Mbah, A.K., Kornosky, J.L., Wathington, D., Marty, P.J., Salihu, H.M., 2011b. Assessing the impact of paternal involvement on racial/ethnic disparities in infant mortality rates. J. Community Health 36 (1), 63–68.

Ash, T., Agaronov, A., Young, T., Aftosmes-Tobio, A., Davison, K., 2017. Family-based childhood obesity prevention interventions: a systematic review and quantitative content analysis. Int. J. Behav. Nutr. Phys. Act. 14 (113). http://dx.doi.org/10.1186/s12966-12017-10571-12962.

Berelson, B., 1952. Content Analysis in Communication Research. Free Press, New York, NY.

Birch, L.L., Davison, K.K., 2001. Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. Pediatr. Clin. N. Am. 48 (4), 893–907.

Bond, M., Heidelbaugh, J., Robertson, A., Alio, A., Parker, W., 2010. Improving research, policy and practice to promote paternal involvement in pregnancy outcomes: the roles of obstetricians-gynecologists. Curr. Opin. Obstet. Gynecol. 22, 525–529.

Bronfenbrenner, U., 1979. The ecology of human development. In: Experiments by Nature and Design. Harvard University Press, Cambridge, MA.

Daniels, S., 2006. The consequences of childhood overweight and obesity. Futur. Child. 16 (1), 47–67.

Davison, K., Birch, L., 2001. Childhood overweight: a contextual model and recommendations for future research. Obes. Rev. 2, 159–171.

Davison, K., Gicevic, S., Aftosmes-Tobio, A., et al., 2016. Fathers' representation in observational studies on parenting and childhood obesity: a systematic review and content analysis. Am. J. Public Health 106 (11), e14-e21.

Davison, K., Charles, J., Khandpur, N., Nelson, T., 2017. Fathers' perceived reasons for their underrepresentation in child health research and strategies to increase their involvement. Matern. Child Health J. 21 (2), 267–274.

Gicevic, S.E., Aftosmes-Tobio, A., Manganello, J.A., Ganter, C., Simon, C.L., Newlan, S., Davison, K.K., 2016. Parenting and childhood obesity research: A quantitative content analysis of published research 2009-2015. Obes. Rev. 17 (8), 724–734.

Institute of Medicine (IOM), 2012. Accelerating progress in obesity prevention: Solving the weight of the nation. In: Washington, DC, Accessed on 1-16-17. https://www.nap.edu/read/13275/chapter/1.

Jones, J.M.W.D., 2013. Fathers' involvement with their children: United States, 2006–2010 report. In: National Helath Statistics Reports US Centers for Disease Control and Prevention. vol. 71.

Khandpur, N., Blaine, R.E., Fisher, J.O., Davison, K.K., 2014. Fathers' child feeding practices: a review of the evidence. Appetite 78, 110–121.

Kotelchuck, M., Lu, M., 2017. Father's role in preconception health. Matern. Child Health J. 21 (11), 2025–2039.

Kreider, R., 2007. Living Arrangements of Children: 2004. US Census Bureau, Washington, DC.

Loth, K.A., MacLehose, R.F., Fulkerson, J.A., Crow, S., Neumark-Sztainer, D., 2013. Food-related parenting practices and adolescent weight status: a population-based study. Pediatrics 131 (5), e1443–e1450.

Lundahl, B., Tollefson, D., Risser, H., Lovejoy, M., 2008. A meta-analysis of father involvement in parent training. Res. Soc. Work. Pract. 18 (2), 97–106.

Manganello, J., Blake, N., 2010. A study of quantitative content analysis of health messages in U.S. media from 1985 to 2005. Health Commun. 25 (5), 387–396.

Martin, L., McNamara, M., Milot, A., Halle, T., Hair, E., 2007. The effects of father involvement during pregnancy on receipt of prenatal care and maternal smoking. Matern. Child Health J. 11 (6), 595–602.

Monasta, L., Batty, G., Macaluso, A., et al., 2011. Interventions for the prevention of overweight and obesity in preschool children: a systematic review of randomized controlled trials. Obes. Rev. 12 (5), e107–118.
Morgan, P.J., Collins, C.E., Plotnikoff, R.C., et al., 2014. The 'Healthy Dads, Healthy Kids' community randomized controlled trial: a community-based healthy lifestyle program for fathers and their children. Prev. Med. 61, 90–99.
Morgan, P., Young, M., Lloyd, A., et al., 2017. Involvement of fathers in pediatric obesity treatment and prevention trials: a systematic review. Pediatrics 139 (2).
Musher-Eizenman, D.R., Holub, S.C., Hauser, J.C., Young, K.M., 2007. The relationship between parents' anti-fat attitudes and restrictive feeding. Obesity 15 (8), 2095–2102.
Musher-Eizenman, D.R., de Lauzon-Guillain, B., Holub, S.C., Leporc, E., Charles, M.A., 2009. Child and parent characteristics related to parental feeding practices. A cross-cultural examination in the US and France. Appetite 52 (1), 89–95.
Panter-Brick, C., Burgess, A., Eggerman, M., McAllister, F., Pruett, K., Leckman, J.F., 2014. 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 55 (11), 1187–1212.
Reilly, J.J., Methven, E., McDowell, Z.C., et al., 2003. Health consequences of obesity. Arch. Dis. Child. 88 (9), 748–752.
Steen, M., Downe, S., Bamford, N., Edozien, L., 2012. Not-patient and not-visitor: a metasynthesis fathers' encounters with pregnancy, birth, and maternity care. Midwifery 28 (4), 362–371.
The inclusion of fathers in family-based interventions for childhood obesity prevention. PROSPERO, 2016. CRD42016041873; 2016. Accessed Available from. http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016041873.
Trost, S., Loprinzi, P., 2011. Parental influences on physical activity behavior in children and adolescents: a brief review. Am. J. Lifestyle Med. 5 (2), 171–181.
Tschann, J.M., Gregorich, S.E., Penilla, C., et al., 2013. Parental feeding practices in Mexican American families: initial test of an expanded measure. Int. J. Behav. Nutr. Phys. Act. 10 (1), 6.
Ventura, A., Birch, L., 2008. Does parenting affect children's eating and weight status? Int. J. Behav. Nutr. Phys. Act. 5 (1), 15.
Waters, E., de Silva-Sanigorski, A., Hall, B., et al., 2011. Interventions for preventing obesity in children. Cochrane collaboration. 12 (1), 1–212.
Wong, M., Jones-Smith, J., Colantuoni, E., Thorpe, R., Bleich, S., Chan, K., 2017. The longitudinal association between early childhood obesity and fathers' involvement in caregiving and decision-making. Obesity 25 (10), 1754–1761.
World Health Organization (WHO), 2016. Report of the Commission on Ending Childood Obesity. WHO Document Production Services, Geneva, Switzerland Accessed on 1-16-17. http://apps.who.int/iris/bitstream/10665/204176/1/9789241510066_eng.pdf.