INTRODUCTION

Family meals have been identified as a key factor in the home environment to promote positive health behaviors in children and adolescents. Family meals have been positively associated with healthy eating behaviors[1,2], improved dietary quality[3], psychosocial outcomes[4-6] and reduced engagement in high-risk behaviors.[7-9] Due to these relationships, family meals are hypothesized to play a protective role for children and often recommended for health promotion.[10-12] The Expert Committee Recommendations Regarding the Prevention, Assessment, and Treatment of Child and Adolescent Overweight and Obesity specifically encourage family meals where the parent and child eat together, as a target behavior for obesity prevention.[12]

Due to the presence of food at family meals, outcomes naturally have often focused on dietary intake or nutrition-related outcomes. Results of a systematic review examining the influence of family meals on dietary intake in adolescents suggested family meals may improve dietary intake and quality, but cautioned about the complexity of today's families (such as family structures, living arrangements, and employment demands), and the need for inclusion of mediating/confounding factors.[13] The first study to use meta-analytic methods to examine the association between family meal frequency (≥3 meals/ week to <3 meals/week) and nutrition health outcomes found there to be a 20% reduction of odds of eating unhealthy foods and a 24% increased odds of eating heathy foods in children and adolescents when families shared at least 3 meals per week.[1] The definitions used to define a family meal varied across studies. Besides the study by Hammons and colleagues[1] that reported on unhealthy and healthy eating there has not been a meta-analysis conducted to understand the association between family meal frequency

and specific dietary outcomes (e.g. fruits and vegetables [FVs], sugar sweetened beverages [SSBs]) commonly targeted as part of dietary interventions.

While family meals are believed to be important, there has been less of a focus on possible underlying mechanisms for the relationship between family meals and positive health behaviors. It is well-documented that family-based interventions are associated with improvements in child and parent health behaviors.[14] Many of these interventions target components of family functioning, which include dimensions of family connectedness or cohesion, communication, expressiveness, and conflict/problem-solving. Studies have shown that improvements in family functioning have been associated with psychosocial wellbeing among children and adolescents with chronic medical conditions and psychiatric conditions.[15-18] Family functioning can be assessed through observations of a family meal because the way a family responds to a family meal is indicative of the family's overall family functioning, indicating family meals could be hypothesized to be a proxy for family functioning.[19,20] To date no systematic reviews or meta-analyses have examined the relationship between family meal frequency and family functioning outcomes.

While numerous individual studies have examined family meal frequency and various outcomes there is a need for a more comprehensive understanding. Thus, to expand upon previous reviews and literature about family meal frequency and dietary outcomes that have often been limited to a single dietary outcome (e.g. FV intake), and the limited understanding of the connection between family meal frequency and family functioning outcomes, the primary purpose of this systematic review and meta-analysis was to explore the direction and magnitude of exposure to family meals and dietary and family functioning outcomes in children. Meta-analyses were performed only when adequate data existed. It was hypothesized that more

frequent family meals would be associated with better dietary outcomes and family functioning outcomes.

METHODS

The meta-analysis of observational studies in epidemiology (MOOSE) reporting guidelines have been adhered to in preparation of this manuscript.[21]

Search Strategy

Our search strategy was guided by the Cochrane handbook.[22] Two separate searches, one for each outcome of interest, were conducted across 5 databases including PubMed, CINAHL, Web of Science, Scopus and PsycINFO. The key search terms used included ("family meals" or "shared meals" or "family mealtime") and ("family functioning" or "family cohesion" or "family relations" or "nuclear family" or "communication" or "interpersonal") or "dietary intake." Each search was established in PubMed by a Senior Assistant Librarian and translated to each of the subsequent search engines utilized. An example of the complex search strategy used for PubMed is available in a supplementary file online.

Study Selection Criteria

Studies selected were full length manuscripts published in a peer reviewed journal in English prior to December 2018 and met the following inclusion criteria: participants were children (2-18 years-old); interventions/exposures of family meal frequency; outcomes included dietary intake or family functioning; had a study design that was cross-sectional, longitudinal cohort, or randomized. Case studies, commentaries, methods or questionnaire development, narrative or systematic reviews, and feeding studies were excluded. Dissertations and theses were also not included due to the lack of peer review and potential lack of rigor. Only studies conducted in the

United States were included (due to the nationally-focused promotion of family meals through organizations such as the American Academy of Pediatrics, and examining cultural differences was not within the scope of this review).

Data Extraction

The titles and abstracts of all studies were screened by 2 independent reviewers with expertise in nutrition and psychology (SMR, MBM) using the established eligibility criteria. Disagreements were resolved through discussion. If inadequate information was provided by the title and/or abstract the article was included for full-text review. Data were independently extracted by 2 authors for dietary (SMR, SR) and family functioning (SMR, MBM) outcomes and discrepancies were resolved by consensus. Extracted data included first author, primary data source, study design, exposure and outcome variables, location, participant characteristics and outcomes. Authors were contacted for 4 studies to obtain additional data.

Frequency of family meals (defined as a minimum of a child eating a meal with a least 1 other individual at home) was captured in many different ways across studies. Response options were often indicative of a week time frame and include an absolute number (0-7) or category (such as 'never' '1-2 times' '3-6 times' '7 or more times'). Several studies focused on regular or frequent family meals but definitions varied from ≥3 meals per week, ≥5 meal per week, or ≥6 meals per week. Fewer studies individually assessed family meal frequency by meal type (breakfast, lunch, dinner).

Dietary outcomes were considered across 8 categories including fruits, vegetables, fruits and vegetables (FVs), diet quality (as measured by the Healthy Eating Index [HEI]), sugar sweetened beverages (SSBs), snack foods, fast food, or desserts. Definitions of dietary outcomes varied greatly depending upon the measure used and cutoffs established. Most often frequency of

consumption (per day or per week) was measured by a food frequency-type questionnaire. Only one study[4] assessed dietary outcomes with 24-hour recalls. Given the diversity of dietary assessment methods, there were not criteria for exclusion related to assessment method of dietary outcomes.

Outcome measures of family functioning had to have at least 1 dimension of family functioning (family connectedness/cohesion, communication, expressiveness, or conflict/problem-solving) to be included.

Methodological Quality Assessment

Two authors independently (SMR, SR) assessed study quality using the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies from the National Heart, Lung, and Blood Institute of the National Institutes of Health.[23] The Quality Assessment Tool was used to assess each study based upon the research question, study population, sample size justification, exposure measurement and timing, outcome measurement, blinding of outcome assessors, follow-up rate, and statistical analyses. Studies were assigned an overall quality score of "good" (indicating the least risk of bias), "fair" (the study is susceptible to some bias not sufficient to invalidate its results), or "poor" (indicating significant bias).[23] Authors discussed any divergence in ratings and reached an agreement on the final rating.

Data Analysis

Studies' effect estimates were pooled only where there were 3 or more studies that provided adequate data for meta-analysis, were of the same study design (i.e., longitudinal or cross sectional) and had comparably defined exposures and outcome variables to ensure that bias could be reduced when measuring heterogeneity using I^2.[24,25] Effect estimates were pooled to result in the standardized mean difference for cross-sectional studies, and the standardized mean

difference in change from baseline to final follow-up for longitudinal or cohort studies. No randomized trials were included as none were identified in the published literature. Where studies only reported odds ratios and 95% confidence intervals (i.e., or other measure of variation), these data were converted using a standard formula to Cohen's d to allow inclusion in the meta-analysis.[22] Where there were an adequate number of studies (determined after a request to authors for unpublished data), effect estimates were pooled using a random effects model in Stata 15 MP using the DerSimonian & Laird method[26], with the estimate of heterogeneity (I^2) being taken from the inverse-variance fixed-effect model. Interpretation of I^2 used the following ranges: 0-40% might not be important, 30-60% may represent moderate, 50-90% may represent substantial, and 75-100% is considerable, as outlined in the Cochrane Handbook.[22] The higher the I^2 the more variability in the results. Funnel plot asymmetry and small study bias were not assessed due to an inadequate number of studies.[22,27]

RESULTS

Overview of Included Studies

A total of 1,241 studies were identified for dietary outcomes; 890 were reviewed after 349 duplicates were removed, and 87 were selected for full-review. Thirty-one articles[3,4,28-56] met study inclusion criteria, were included in the systematic review (supplementary material, Table 1), and of those articles 8[3,4,51-56] in the meta-analysis (Figure 1a). For family functioning outcomes 1,982 articles were identified; 1,433 were reviewed after 549 duplicates were removed, and 83 were selected for full-review. Twelve articles[4,51,52,57-65] met all study inclusion criteria, were included in the systematic review (supplementary material, Table 2), and of those articles 4[4,51,64,65] in the meta-analysis (Figure 1b).

Across all studies 81.4% had a cross-sectional design and 18.6% used a longitudinal design. All studies included in meta-analyses had a cross-sectional design. Baseline sample sizes ranged from 50 to 99,426 with the majority having a similar proportion of females and males when reported, except for 1 study by Bauer et al.[36] that was all female. Of studies included 62.8% included potential confounding variables as adjustments in models. Within each dietary outcome results from all studies included in the systematic reviews are first described based upon study design (cross-sectional, longitudinal) followed by studies only included in the meta-analysis when applicable. Given studies with family functioning outcomes were all cross-sectional, results are presented as all studies included in the systematic review followed by meta-analysis results.

Dietary Outcomes

Many of the selected articles included more than 1 dietary outcome in relationship to family meal frequency. Of the 31 articles included in the systematic review the majority reported outcomes for fruits[29-35,37,38,40-42,49,51,54] (n = 15, 48.4%), vegetables[29-35,37,38,40-42,49,51,54] (n = 15, 48.4%) and/or FVs[4,28,29,33,36,39,42,44,48,52,53,55,56] (n = 13, 31.9%). SSBs[4,28,30,32,34,36,40-44,49,51,54] (e.g., soft drinks, soda) was an outcome in 14 (45.2%) articles. Fewer articles investigated the relationship of family meal frequency to snack foods[28,29,33,40,43,44,49-51] (n = 9, 29.0%), diet quality[3,4,45-47] (n = 5, 16.1%), fast food[33,41,56] (n = 3, 9.7%) or desserts[28] (n = 1, 3.2%).

Fruits, Vegetables, and FVs

Overwhelmingly, studies showed a positive relationship between family meal frequency and fruit and vegetable intake when examined separately, but also when FV intake were combined. Within each type of study fruit and vegetable outcomes are first presented separately followed by FV outcomes.

Cross-sectional. Correlations showed family meal frequency was positively related to fruit intake[35,41] (r = 0.15 to 0.25, *P*s ≤ .05); however, only 1 of the 2 studies found this relationship for vegetable[41] intake (r = 0.32, *P* < .05). When looking at trends in fruit intake and vegetable intake across varying levels of frequency of family meals, the majority of data support a positive relationship whereby as frequency of family meals increased so did intake of both fruits and vegetables.[29,31,38,42,49] In contrast, Welsh and colleagues[51] did not find evidence of association between family meal frequency and fruit or vegetable intake in adolescents. Feldman and colleagues[40] also did not find evidence of an adjusted association in vegetable intake, but did in fruit intake. Examination of the association between family meal frequency and fruit and vegetable intake within age groups (0-5 years, 6-11 years, 12-17 years) using adjusted models found no evidence in 0-5 year-olds, an association with vegetables only in 6-11 year-olds and an association for both fruits and vegetables in 12-17 year-olds.[54]

Several studies focused on the frequency of a specific meal (breakfast, lunch or dinner) and fruit and vegetable intake. When examining breakfast family meal frequency, 2 studies[30,37] found evidence of a relationship with fruit intake, but not vegetable intake. These same findings were shown for lunch family meal frequency.[37] Examination of only the dinner family meal showed inconsistent findings. Dinner family meal frequency examined by Fulkerson and colleauges[42] found a difference in daily servings of fruit intake when examining 5-7 family dinner meals per week compared to no family dinner meals per week (5-7 days/week: 2.4 ± 0.26 vs. Never: 1.2 ± 0.37, *P* < .05); however, there was no clear statistical evidence for this when examining daily servings of vegetable intake. Another study examining family dinner frequency found the odds of eating fruits (≥ 2 times/day) and vegetables (≥ 3 times/day) increased with regular family dinner meals (5-7 dinners/week) in adolescent females; however, in males this

relationship was only seen in fruit intake not vegetable intake.[32] Similarly, in adolescents the odds of not eating 2+ vegetables and 2+ fruits decreased as the number of evening family meals increased.[38] Based upon a food frequency questionnaire completed by the oldest school age child in limited resource families, dinner family meal frequency was not related to either fruit intake or vegetable intake.[37]

Fruits and vegetables were also combined as an outcome. One study[28] reported a correlation between the number of family meals in the past week and FV intake ($r = 0.18$, $P < .05$). Intake of FVs was shown to increase as family meal frequency inceased[29] and there was evidence of an association between regular family meal (≥5 times/week) consumption and FV intake.[52] Berge and colleagues[56] found family meal frequency to be associated with FV intake in girls ($\beta = 0.14$. $P < .001$) and boys ($\beta = 0.14$. $P < .001$); however, in a study[36] examining only adolescent girls ($\beta = 0.08$. $P = .69$) frequency of family meals was not found to be associated with FV intake. In contrast Watts and colleagues found no evidence of association between family meal frequency and FV intake.

The frequency of individual meals (breakfast, lunch, dinner) were also examined with FV intake. One study by Andaya and colleagues[48] examined breakfast and lunch and found evidence of an association for consumption of a breakfast family meal (≥4 times/week) and FV intake ($P = .04$), but not for lunch. Of the 5 studies that focused on dinner family meal frequency and the relationship to FV intake, 3 studies[4,53,55] found evidence of a positive relationship, whereby more frequent dinner family meals were associated with higher intakes of FV; however, 2[42,48] studies showed no evidence for this relationship.

Longitudinal. When looking at trends in fruit intake and vegetable intake separately across varying levels of family meal frequency Larson and colleagues[31] found a positive linear trend

across categories of family meal frequency (never to 7+ times) for both fruits and vegetables, even after adjustments that included Time 1. Examination of family meal frequency defined as regular family meals (≥ 5 meals/week), was associated with vegetable servings in male and female adolescents, but with fruit servings in males only.[34]

Frequency of family meals was shown to be associated with combined FV intake (βest = 0.33 ± 0.05, $P = < .001$)[44] and a vegetable and fruit dietary pattern (β = 0.06, p < 0.0001)[33] at Time 2 in adolescents. When looking at the relationship between family meal frequency and combined FV intake by racial/ethnic groups, family meal frequency declined from kindergarten to eighth grade for Non-Hispanic White, Non-Hispanic Black and Hispanic children, and this change was associated with fruit and vegetable intake in eighth grade (Non-Hispanic White: β = 0.14 ± 0.05, $P < .01$; Non-Hispanic Black: β = 0.43 ± 0.20, $P < .05$; Hispanic: β = 0.20 ± 0.11, $P < .10$).[39] This association was not found in Asian children.[39]

Meta-analysis. Meta-analyses indicated little evidence for an association between frequency of family meals and fruit consumption in cross-sectional studies[51,54] (Figure 2). The estimate was imprecise (standardized mean difference (SMD) 0.19, 95% CI: -0.02 to 0.40, N= 4), with substantial between-study heterogeneity ($I^2 = 69.4\%$). For vegetable intake, higher frequency of family meals was weakly associated with higher vegetable consumption in cross-sectional studies[51,54] (Figure 2) (SMD 0.29, 95% CI: 0.14 to 0.43, N = 4), with no between-study heterogeneity ($I^2 = 0.0\%$). More frequent family meals[52,55,56] (Figure 2) and more frequent dinner family meals[4,53] (Figure 2) were weakly associated with higher fruit and vegetable consumption in cross-sectional studies. These studies showed substantial between-study heterogeneity for family meal frequency ($I^2 = 40.9\%$), but no between-study heterogeneity for family dinner frequency ($I^2 = 0.0\%$).

SSBs

Cross-sectional. Of the 14 studies assessing SSB outcomes 12 were cross-sectional and show mixed results. Two studies[28,41] found negative correlations between family meal frequency and SSB intake (r = -0.05 to -0.24, *P*s < .05) while Fulkerson and colleauges[42] and Erinosho and colleagues[49] found no difference in regular soda intake and soft drinks, respectively by family meal frequency. Four studies[4,36,43,51] using regression analysis found no association between family meal frequency and SSB intake. Larson and colleagues[30] found an inverse association between breakfast frequency and SSBs in adolescents only when the adjusted model included total energy intake. Fink and colleagues[54] reported adjusted associations between family meal frequency and no SSBs in young children ([0-5 years] OR = 2.04, 95% CI: 1.06, 393, *P* = .033) and older children ([6-11 years], OR = 2.12, 95% CI 1.27, 3.55, *P* = .026), but not in adolescents (12-17 years). Feldman and colleauges[40] showed higher consumption of SSBs (median daily serving) in girls with no family meals as compared to family meals (both with and without TV), while in boys SSB intake (median daily servings) did not differ between family meals (with TV) and no family meals. SSB intake in both of these categories did differ from SSB intake in family meals (with no TV). Demissie and colleauges[32] also investigated females and males separately and found that eating dinner 5-7 times per week with a parent or guardian was associated with a lower odds of consuming SSBs (≥3 times/day) in U.S. female high school students (OR = 0.77, 95% CI: 0.63, 0.94), but not U.S. male high school students (OR = 1.02, 95% CI: 0.83, 1.25).

Longitudinal. Both Burgess-Champoux and colleauges[34] and Lipsky and colleagues[44], who conducted longitudinal studies found family meal frequency was not associated with SSB consumption.

Meta-analysis. Meta-analysis indicated little evidence for an association between frequency of family meals and SSB consumption in cross-sectional studies[51,54] (Figure 2). The estimate was imprecise (SMD -0.21, 95% CI: -0.41 to -0.01, N = 4), with substantial between-study heterogeneity (I^2=57.7%).

Snack Foods

Cross-sectional. Four[28,29,43,51] of the 7 cross-sectional studies investigating family meal frequency and snack foods as a dietary outcome found there was a lack of statistical evidence for a relationship. Two studies that examined this relationship by sex. Feldman and colleagues[40] found clear evidence of higher intake of snack foods (in median daily servings) in girls who had no family meals as compared to family meals (no family meals: 2.4 vs. family meals: 2.2, $P \leq$ .05), but there was no clear evidence of an association in boys. In contrast, Larson and colleagues[50] found frequency of family meals was associated with energy-dense snack food intake in the mutually-adjusted model ($\beta = 0.10$, $P = .04$); however, there was no clear evidence of association in models by sex. A study by Erinosho and colleagues[49] showed a decrease in the odds of a child consuming snack foods ≥3 times/week as compared to ≤2 times/week when family meals frequency was ≤6 days per week; however, statistical significance was not reported.

Longitudinal. Cutler and colleagues[33] report a negative association between family meal frequency and a sweet and salty snack food pattern ($\beta = -0.03$, $P = .02$) at Time 1, but not Time 2. Lipsky and colleagues[44] did not find clear evidence of association between family meal frequency and snack intake.

Diet Quality

Cross-sectional. All studies examining diet quality, measured by HEI, as an outcome were cross-sectional. Regular family meals when defined as ≥3 (as compared to < 3 family meals/week) were not associated with HEI (β = 0.13, 95%CI: -0.82 to 1.07, *P* = .79)[47]; however, in children with Type 1 diabetes, regular family meals defined as ≥5 (as compared to < 5 family meals/ week) found weak evidence of a relationship with HEI (54.5 vs. 51.7, *P* = .047).[46] Berge and colleagues[3] examined associations for breakfast, lunch and dinner frequency and preschool child HEI score in Hispanic and Non-Hispanic households. Only breakfast frequency was associated with preschool child HEI total score (β = 1.3 *P* = .001) in Non-Hispanic households. Total meal frequency was also found to be associated (β = 0.38, *P* = .01). In contrast to these findings of Berge and colleagues[3], when focused only on family breakfast frequency there was no clear evidence that HEI score differed by family breakfast frequency among boys (mean ± SE); never: 52.3 ± 1.6 vs. 1-2 times/week: 50.5 ± 1.7 vs. 3-7 times/week: 52.0 ± 1.7, *P* = .44) or girls (mean ± SE); never: 53.8 ± 1.4 vs. 1-2 times/week: 54.0 ± 1.6 vs. 3-7 times/week: 54.0 ± 1.8, *P* = .99).[45] When only dinner family frequency was examined it was found to be associated with a higher HEI score (β = 0.77, *P* <0.05). Taken together there are inconsistent findings for the relationship between family meal frequency and HEI.[4]

Meta-analysis. There was weak evidence for an association between frequency of family dinner and HEI in cross-sectional studies[3,4] (Figure 2). The estimate was imprecise (SMD 0.72, 95% CI: 0.06 to 1.38, N=3), with substantial between-study heterogeneity (I^2 = 69.9%).

Fast Food

Cross-sectional. Two cross-sectional studies demonstrated no clear statistical evidence for a relationship between family meal frequency and fast food consumption.[41,56]

Longitudinal. Only 1 study[33] found clear evidence of an inverse relationship between family meal frequency at Time 2 and fast food (β = -0.07, $P < .001$).

Desserts

Cross-sectional. There was no clear evidence of a correlation between number of family meals in the past week and dessert consumption.[28]

Family Functioning Outcomes

Nearly all the studies included in the systematic review and meta-analysis demonstrated a positive relationship between family meal frequency and measures of family functioning.

Cross-sectional studies. Two studies found positive correlations between family meal frequency and family connectedness (r = 0.27, $P <.001$)[64] and family cohesion (r = 0.41, $P <.01$).[51] Children who had family meals more frequently (defined as ≥5 times/week or usually/always) had higher scores related to parent communication as compared to children who had infrequent family meals (<2 times/week or never/almost never)[52]. When comparing family functioning scores by family meal frequency, adolescent girls with family functioning scores at the 95th percentile had more family meals per week as compared to those who had family functioning scores at the 5th percentile (95th: 5.12 vs. 5th: 2.62, $P < .001$).[61] The same relationship was also shown for adolescent boys.[61] High family cohesion was shown to predict frequent family meals (β = 0.87, $P < .10$), while low family cohesion predicted less frequent family meals (β = -3.38, $P < .01$).[63] Family functioning was also found to moderate the relationship between family meal frequency and disordered eating behavior outcomes in a study by Loth and colleagues.[57]

Three studies specifically examined only dinner family meal frequency. Lawrence and colleagues[62] found a positive correlation between dinner family meal frequency and family communication (r = 0.25, $P = <.05$). Two of the studies[4,65] demonstrated evidence for a positive

association between dinner family meal frequency and family functioning (family communication and family connectedness).

Longitudinal. Of the 3 longitudinal studies 1 study[60] examined the relationship between overall family meal frequency and family functioning outcomes, while 2 studies[58,59] specifically focused on dinner family meal frequency. All 3 studies found evidence of an association between family meal/dinner frequency and family functioning outcomes (family cohesion, parent-child communication, parent-child relationship).

Meta-analysis. Meta-analysis results (Figure 3) showed that more frequent family meals were moderately associated with higher family functioning in cross-sectional studies[51,64] (SMD 0.56, 95% CI: 0.50 to 0.62, I^2 = 0%, N = 3), and when dinner family meals were examined they were also more frequent dinner family meals were moderately associated with higher family functioning in cross-sectional[4,65] studies (SMD 0.46, 95% CI: 0.27 to 0.65, N = 3), with substantial between-study heterogeneity (I^2 = 59%).

DISCUSSION

In nutrition, family meals have often been promoted due to the relationship between more frequent family meals and a healthier dietary intake. This study systematically reviewed the literature to examine the direction and magnitude of the association between family meal frequency, multiple dietary outcomes, and family functioning outcomes in children. Once duplicates were removed of the 892 and 1,433 articles related to dietary outcomes and family functioning outcomes respectively, only 8 were included in the meta-analysis for dietary outcomes and 4 articles for family functioning.

Similar to a previous systematic review[66], in general family meal frequency was most often positively related to FV consumption. When FVs were examined separately, findings were not always consistent between fruit intake and vegetable intake. As dietary intake is typically reflective of a child's overall diet it would be important to further assess if greater consumption of fruits or vegetables is occurring because parents are more likely to offer fruits or vegetables at family meals resulting in an increase in intake. When combined, FV intake only showed a weak correlation; however, being more specific about the meal (e.g., family dinner frequency) reduced the between-study heterogeneity, which may be expected. Horning and colleagues[4] had demonstrated that when family dinner frequency was specified, despite differences in 9 assessment measures of family dinner frequency, results consistently showed family dinner frequency to be positively correlated with FV intake. Perhaps, these findings underscore the importance of assessing family meal frequency by meal type.

In addition to FVs, SSBs are often a dietary behavior targeted for change in children likely due to their inclusion in obesity prevention and treatment recommendations.[12] Studies included in the systematic review demonstrated mixed results while the meta-analysis indicated positive relationships between family meal frequency and dietary outcomes (FV, SSBs) and family functioning outcomes, but confidence intervals were wide indicating a need for a greater number of large, high quality studies to determine if there is a true association and sufficient magnitude to be of public health importance. SSBs were defined diversely (e.g. some defined as soft drinks, soda) likely contributing to the between study heterogeneity.

Very few studies included in this systematic review and meta-analysis examined other food categories (e.g., snack foods, fast food, desserts) or overall diet quality. These findings in combination with the mixed results of this systematic review indicate a need for stronger

evaluation of the family meal frequency literature and specifically the impact or lack of impact on dietary outcomes.

To better elucidate the relationship between family meal frequency and dietary outcomes identifying possible underlying mechanisms, such as family functioning, are needed.[7] The positive relationship between greater family meal frequency and higher family functioning indicates that family meal frequency may serve as a proxy for family functioning. Several studies have noted the independent effects of family functioning measures (e.g., family connectedness) on psychosocial outcomes.[67] In addition many studies[5,8,30,62,68,69] have adjusted for family functioning during analyses, limiting the ability to identify the effect. Furthermore, a mealtime observation using an assessment tool such as the McMaster Mealtime Interaction Coding System[70] is often used to assess family functioning, indicating the interrelated nature of these two factors. Studies from Project EAT have provided the foundation for much of the work in family meals.[8,10,20,29,52,69,71-73] A review of what has been learned published in 2010 raised the question, if family meals are a marker for better family functioning or some other familiar characteristic.[72] To date this question has yet to be sufficiently answered.

Potential Bias in Review Reporting

This study may suffer from publication bias given this systematic review focused on peer reviewed published data. While funnel plots can aid in the detection of publication bias there were a limited number of studies with the same study design, exposure and/or outcome variables. Given this few studies were available for meta-analysis and thus were unable to conduct funnel plots to examine small study bias (i.e. at least 10 studies are needed for funnel plots[22]).

Study Quality

Findings should be considered within the quality of studies used as part of the systematic review and meta-analyses. Based upon the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies 3 studies received a "good" rating, 1 a "poor" rating, and the rest received a "fair" rating. A "fair" rating most commonly resulted due to lack of sample size justification, exposure and outcome variables being measured at the same time point, limited number of exposure measurements, lack of information regarding assessor blinding and lack of applicability of follow-up rate. This was not surprising given the predominant use of a cross-sectional study design.

Strengths and Weaknesses

This study expands the literature on family meals given the number of dietary outcomes included and the use of meta-analysis when statistically appropriate. A comprehensive search was conducted across 5 databases; however, the findings should be interpreted within the context of the study's limitations. This study reviewed full texts of studies whereby the primary aim was not similar, thereby including studies that may have been excluded at the title/abstract screening stages. Standard and complex formulas as outlined in the Cochrane handbook[22] were used to convert effect estimates that were not obviously appropriate for meta-analysis. Where data were not available authors of studies were contacted, and unpublished data were obtained, overcoming some possible publication bias. Due to specific eligibility criteria (e.g., conducted in the United States) the generalizability to populations in other countries may be limited. Eligibility criteria were also established based upon the research question perhaps limiting the number of articles included in this systematic review and meta-analysis.

Guidelines for Future Research

The methodological diversity across studies indicates a need to standardize measures in regards to cut-offs and reporting of family meal frequency and dietary and family functioning-related outcomes. These findings related to methodological diversity have been well cited in previously published review papers.[2,7] The variation of family meal definitions, and the need for validated procedures has been well described by Martin-Biggers and colleagues.[66] Furthermore, research using experimental study designs, especially randomized controlled trials are warranted to better evaluate the magnitude and causality of family meal frequency on outcomes like diet.[2] Standardization of family meal measures will also allow for more robust analyses in the future.

IMPLICATIONS FOR RESEARCH AND PRACTICE

There is a positive relationship between family meal frequency and dietary outcomes specifically when examining fruit and vegetable intake. The direction and magnitude of the relationship to additional dietary outcomes such as SSBs, snack foods, fast food, desserts, and diet quality has been investigated less. Family meal frequency may serve as a proxy for family functioning, but research is needed to confirm this finding. To continue to move the family meal literature forward, standardized measures of family meals and associated outcomes in addition to interventions examining the effect of family meals are warranted.

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Figure Captions

Figure 1. Consort Diagrams for Family Meal Frequency and Dietary Outcomes (Figure 1a) and Family Functioning Outcomes (Figure 1b).

Figure 2. Pooled standardized mean differences and 95% confidence intervals for cross-sectional associations between family meals and dietary outcomes.*

Note: *Berge, 2014a Boys, Berge, 2014b Girls, Fink, 2014a Younger Children (Birth to 5 Years), Fink, 2014b Older Children (6-11 years), Fink, 2014c Adolescents (12-17 years), Horning, 2016a Parent-reported, Horning 2016b Child-reported

Figure 3. Pooled standardized mean differences and 95% confidence intervals for cross-sectional associations between family meals and family connectedness.*

Note: *Horning, 2016a Parent-reported, Horning 2016b Child-reported, Welsh, 2011a Adolescent-reported, Welsh, 2011b Parent-reported