

# Family Functioning and Medical Adherence Across Children and Adolescents With Chronic Health Conditions: A Meta-Analysis

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## Abstract

**Objectives** A meta-analysis examined family functioning and medical adherence in children and adolescents with chronic health conditions. Family functioning was evaluated at the level of the family unit, as well as parent–child interactions. **Methods** We conducted literature searches using PubMed, PsycINFO, SCOPUS, Web of Science, and Cochrane. After reviewing 764 articles, 62 studies met eligibility criteria. Pearson's *r* correlations were the effect size of interest. We conducted both omnibus and domain-specific (e.g., family conflict, cohesion) meta-analyses. Meta-regressions examined whether relevant covariates related to the magnitude of the effect. **Results** The omnibus meta-analysis showed that family functioning was significantly related to medical adherence across a variety of pediatric chronic health conditions. Lower family conflict, greater family cohesion, greater family flexibility, more positive communication, and better family problem-solving were each associated with better adherence. There were no significant differences in the magnitude of the omnibus effect based on child age, measurement features (subjective vs. objective or bioassay adherence; family unit vs. parent–child interactions), or study quality. **Conclusions** Consistent with social–ecological frameworks, findings supported links between family functioning and medical adherence. This study highlights several limitations of the extant research, including absence of a guiding theoretical framework and several methodological weaknesses. We offer clinical and research recommendations for enhancing scientific understanding and promotion of adherence within the family context.

**Key words:** adherence; family functioning; meta-analysis.

Medical adherence is a necessary component of effective pediatric disease self-management but is exceptionally difficult to achieve. Medical adherence refers to the correspondence between a patient's or caregiver's behavior with medical provider prescription (Haynes, 1979) and involves a triadic partnership between patients, family members, and medical providers (De Civita & Dobkin, 2004). Across childhood diseases, patients and families are required to adhere

to multifaceted and complex treatment regimens, involving routine administration of medications, regular clinic attendance, monitoring for symptoms, and other necessary lifestyle recommendations (e.g., dietary modifications, physical activity, and skin/wound care). Nonadherence remains a ubiquitous yet perplexing challenge across disease groups and regimens, with documented rates of nonadherence averaging at approximately 50% and even higher rates (up to

75%) observed among adolescents (Rapoff, 2009). Nonadherence can result in numerous poor outcomes, including poor disease control, preventable complications, poor health-related quality of life, increased health-care utilization, and health care spending >\$300 billion across all nonadherent patients (McGrady & Hommel, 2016). Recognizing the role of family in addressing this complex pediatric behavioral health issue, research has examined relationships between family functioning and adherence, as well as intervened at the family level (Wysocki et al., 2007). To optimize such family-based intervention approaches, we sought to rigorously evaluate components of family functioning that correlate with pediatric medical adherence by conducting a meta-analytic review.

Family functioning refers to the structural and relational aspects of a family environment and encompasses several conceptual dimensions of family life (Alderfer et al., 2008; Herzer et al., 2010; Miller, Ryan, Keitner, Bishop, & Epstein, 2000; Moos & Moos, 1994; Olson, 2000). Assessment of family functioning may be at the family unit level (e.g., family environment), as well as at the dyadic level (e.g., parent-child interaction; Hayden et al., 1998; Palermo & Chambers, 2005), and includes components of healthy family functioning (e.g., clear communication, collaborative problem-solving) and poor family functioning (e.g., conflict, disorganization). For children with and without chronic health conditions, family functioning is dynamic over the course of development. Increased family conflict during early adolescence is normative, usually temporary, and plays an important role in negotiating family roles such as greater adolescent independence (Holmbeck, 1996; Smetana, Campione-Barr, & Metzger, 2006). For example, family conflict surrounding an adolescent's nonadherence may promote developmentally appropriate realignments in the allocation of treatment responsibilities (i.e., parents become more involved and adherence improves). On the other hand, chronically high or unresolved levels of family conflict result in poorer medical adherence (Anderson et al., 2009; Butner et al., 2009; Psihogios & Holmbeck, 2013).

There are many ways in which family functioning is theoretically and empirically important to consider in relation to child adaptation to chronic illness, including adherence. Models of family functioning, including the McMaster Approach to Families (Miller et al., 2000) and the Circumplex Model of Marital and Family Systems (Olson, 2000), each propose specific components of family functioning that impact child adjustment, including conflict, cohesion, flexibility, communication, and problem-solving. Relatedly, social-ecological theories of family adaptation to chronic health conditions (e.g., the Pediatric Psychosocial Preventative Health Model; Kazak,

2006) and pediatric disease self-management (e.g., The Pediatric Self-Management Model; Modi et al., 2012) posit that managing a chronic illness while maneuvering broader developmental issues not only impacts the child with a chronic health condition but also affects individual members of the family (e.g., a parent or sibling) and the family as a whole. At the same time, family plays a reciprocal role in child adjustment, including a child's adherence to the medical regimen and their development of self-management skills.

Across the many investigations evaluating family functioning and adherence, adherence appears to be maximized when there are low levels of family conflict (Hilliard, Mann, Peugh, & Hood, 2013; Hood et al., 2007; Stepansky, Roache, Holmbeck, & Schultz, 2010) and high levels of family cohesion (DeLambo, Ievers-Landis, Drotar, & Quittner, 2004), adaptive problem-solving (Modi, Guilfoyle, Mann, & Rausch, 2016; Wysocki et al., 2008), and positive communication (Iskander, Rohan, Pendley, Delamater, & Drotar, 2015; Loiselle, Rausch, & Modi, 2015). In pediatric populations, family functioning surrounding disease management is also important to consider, with evidence to suggest that family conflict regarding adherence behaviors accounts for substantial variance in adherence (Hood, Butler, Anderson, & Laffel, 2007). A supportive and collaborative family environment is also an important prerequisite for the development of other relevant self-management skills and beliefs, such as youth self-efficacy for disease management (Noser, Huffhines, Clements, & Patton, 2017). Nevertheless, further delineation of the family functioning components that most closely relate to adherence is strongly needed to maximize the effectiveness and efficiency of adherence interventions. For example, it is possible that some components of family functioning are critical for adherence, while others play a smaller role.

While various reviews summarized the impact of broad social support on adherence (e.g., practical and social support and family cohesion and conflict; DiMatteo, 2004), the efficacy of adherence interventions (Kahana, Drotar, & Frazier, 2008; Pai & McGrady, 2014), and the role of family functioning on general child adjustment (Leeman et al., 2016; Van Schoors et al., 2017), there are no known meta-analyses that summarize empirical evidence investigating associations between family functioning and pediatric medical adherence. Leeman and colleagues (2016) conducted a sub-analysis of family functioning and adherence, although their search was restricted to four generic measures of family functioning and yielded only four studies (all related to type 1 diabetes). They ultimately did not find significance, which may be owed to the narrow scope of their search and few studies included. Meta-analyses examining adherence interventions have confirmed the impact of

behavioral and multicomponent interventions, many of which involve family-based approaches, on improving adherence (Kahana et al., 2008). Nonetheless, the essential family functioning components that most closely relate to nonadherence remain unknown (McGrady, Ryan, Brown, & Cushing, 2015). A Comprehensive Meta-Analysis (CMA) is needed to summarize and evaluate the current state of the research, with attention to a broad range of pediatric populations, family functioning components, levels of family assessment (family functioning as a unit vs. dyadic functioning), and multifaceted adherence demands.

Thus, guided by social-ecological theories and previous literature stressing the importance of examining family functioning in relation to adherence, the primary aim of this article was to conduct a meta-analysis and commentary on the current state of evidence related to family functioning and pediatric adherence across pediatric populations. Specifically, we sought to examine the magnitude of the overall effect of family functioning on adherence, as well as the strength of specific core family functioning components described by family functioning theoretical models: family conflict, cohesion, communication, flexibility, and problem-solving. In addition, we examined the relationships of various study characteristics and methods, such as child age, measurement approaches, and article quality, on effect sizes. This meta-analysis advances adherence science by comprehensively summarizing and examining relationships between family functioning and pediatric adherence across disease groups and methodological approaches.

## Method

### Literature Search and Inclusion Criteria

The first author (A. M. P.) conducted literature searches of the following databases: PubMed, PsycINFO, SCOPUS, Web of Science, and Cochrane. Search terms were (chronic disease\* OR diabetes OR asthma OR cancer OR sickle cell disease OR transplant OR spina bifida OR cystic fibrosis OR obesity OR HIV or arthritis OR inflammatory bowel disease) AND (pediatric\* OR child OR adolescent) AND (medical adherence) AND (family functioning\* OR family conflict OR family cohesion OR family communication OR family flexibility OR family problem-solving). We conducted a parallel search to capture relationships between parent-child interaction and adherence (parent-child interaction\* OR parent-child relationship quality OR parent-child conflict OR parent-child communication OR parent-child problem-solving). Our intention was to include any pediatric chronic condition or treatment (e.g., solid organ recipient) that requires adherence to one or more treatment demands. We specified several specific disease groups

to increase the reach of our search. Selection of these disease search terms was informed by similar adherence meta-analyses/systematic reviews (Kahana et al., 2008; Pai & McGrady, 2014). We also screened reference lists of included articles and the online table of contents of the *Journal of Pediatric Psychology*, which contributed more articles than any other publication (approximately 30% articles). To ensure studies were peer-reviewed, gray literature, such as conference abstracts and dissertations, was not included (Schmucker et al., 2013).

### Inclusion Criteria

Inclusion criteria were (1) focus on global family functioning of the unit or parent-child interaction, (2) assess adherence, (3) relate to any pediatric chronic health condition or treatment (e.g., solid organ recipient) that requires ongoing adherence to one or more treatment demands, and (4) provide empirical research with correlation coefficient(s) reported or provided to compare the magnitude of effect size(s) across studies. Exclusion criteria included: (1) focus on the individual (e.g., parenting style; parent or child adjustment), (2) age of the sample extended outside the scope of children and adolescents (i.e., an adult sample, defined by  $M$  age  $>18$  years), (3) focus on acute disease (e.g., pneumonia) or routine preventative health behaviors (e.g., adherence to scheduled vaccinations), (4) literature reviews or summaries, consensus, and opinion papers, and (5) qualitative research. As no known meta-analyses examined associations between family functioning and medical adherence across pediatric chronic diseases, we did not restrict our search to a specific time frame.

### Study Definitions

The primary outcome was *adherence*, defined as “the extent to which a person’s behavior coincides with medical or health advice” (Haynes, 1979, pp. 1, 2). Measures of adherence may be objective (electronic monitors, pill count, clinic attendance via chart review), subjective (self-, parent-, and provider-reported questionnaires, daily diary assessments, or semi-structured interviews), or bioassays (e.g., hemoglobin A1C; HbA1C or tacrolimus blood levels). Based on theoretical models of family functioning (Olson, 2000; Miller et al., 2000), we defined *family conflict* as disagreements, openly expressed anger or negativity, and relationship difficulties. *Family cohesion* included the emotional bond family members have with one another, including affective responsiveness, warmth, and relationship quality. We defined *family communication* by how information is exchanged within a family, including listening and speaking skills, reciprocity, and respect and regard. *Family flexibility* included how the family balances structure (e.g. clearly defined

roles, rules, and organization) with adaptability (e.g., modifying roles when needed). *Family problem-solving* described a family's ability to resolve problems that threaten the integrity or functioning of the family. Family functioning may have been assessed at the level of the family unit (e.g., family conflict) or parent-child interactions (e.g., parent-child conflict).

### Study Selection

The original literature search (February 2017) yielded 559 total articles; 373 articles were unique papers (186 duplicates were removed; see [Figure 1](#)). The first author (A. M. P.) screened the 373 titles and abstracts and identified 85 potentially relevant abstracts for further review. Of the 85 full texts that were screened, 46 were subsequently excluded. The most common reason for exclusion was lacking necessary statistical information for inclusion in the meta-analysis ( $n=38$ ; i.e., missing bivariate correlation(s) for family functioning and medical adherence variables). Of the 38 studies that lacked necessary statistical information, 11 were already accounted for in the meta-analysis by papers that published on the same data set. We attempted to contact the remaining 27 authors to obtain necessary statistics. Total 5 author groups provided information, 6 authors indicated that they no longer had access to the relevant data, 11 did not respond, and valid contact information was unavailable for authors of the remaining 5 studies.

In October 2017, we conducted an update of this procedure, yielding an additional 25 papers, and of those, 2 articles met eligibility criteria. In February 2018, we conducted a third update by expanding search terms to include parent-child interactions. Our parent-child interactions search yielded 160 articles, 8 of which met eligibility criteria. Screening references lists and the *Journal of Pediatric Psychology* online table of contents yielded an additional 20 articles. Thus, the final number of studies included in the meta-analysis was 62 studies across 69 publications (four data sets were published more than once; see [Figure 1](#) for PRISMA diagram).

### Data Extraction

The first and second authors conducted data extraction using a standardized template that summarized basic study information (e.g., year of publication, sample size and characteristics, and study design), theoretical framework (if provided), methodology (e.g., family functioning and adherence measures, including coding level of family assessment and objective/subjective adherence measures), statistical information (e.g., bivariate correlation(s) between family functioning and medical adherence; *Ms*, *SDs*, and reliability coefficients of family functioning and adherence variables), and the study abstract. The first author (A. M. P.) then checked for accuracy and completeness.

We synthesized and described this information in [Supplementary Table S1](#).

### Quality Assessment

We adopted [Alderfer et al. \(2010\)](#) method for rating the scientific merit and potential bias of each included study. This system evaluates nine aspects of correlational studies on a three-point scale (1 = no or little evidence in fulfilling the criterion/low quality to 3 = good evidence/high quality): (1) explicit scientific context and purpose, (2) methodological design and analysis, (3) measurement reliability and statistical interpretation, (4) statistical power, (5) internal validity, (6) measurement validity and generalizability, (7) external validity, (8) appropriate discussion and limitations, and (9) contribution of knowledge (see [Supplementary Table S1](#) for further information). The first and second author rated each article using these criteria. When ratings were >1 point apart, the raters convened and reached a consensus rating; this occurred once. As recommended by [Alderfer and colleagues \(2010\)](#), individual scores within each article, across both raters, were averaged to obtain an overall rating for each paper (see [Supplementary Table S1](#)). The average intraclass correlation coefficient was .84 across the two raters, demonstrating good interrater reliability.

### Data Analyses

The statistical information extracted from each study or provided by authors was entered into CMA 3.0 statistical software. Pearson's  $r$  values were transformed into Fisher's  $Z$  correlations with calculation of the corresponding standard error from sample size for meta-analysis, and then (back) transformed to Pearson's  $r$  for interpretation and creation of forest plots. When authors indicated nonsignificant findings but did not provide a bivariate correlation,  $r=0$  was used ([Rosenthal, 1995](#)). One study did not provide correlation coefficients but provided the sample size and  $p$ -values; thus, we estimated correlation coefficients based on the sample size and  $p$ -values. We standardized the sign of the correlation, so that a positive value indicated a positive association between family functioning (e.g., more cohesion, better problem-solving, and less conflict) and better adherence (e.g., higher self-reported adherence and lower HbA1C).

The first analysis took an omnibus approach to summarize statistical data across all domains of family functioning and medical adherence. We evaluated the  $Q$  statistic to determine the heterogeneity of the effect. If the  $Q$  statistic indicated significant random error, we used random-effects models to account for nonnormal distribution of effect sizes and methodology heterogeneity across studies. For fixed- and random-effects models, relative weights are assigned to each

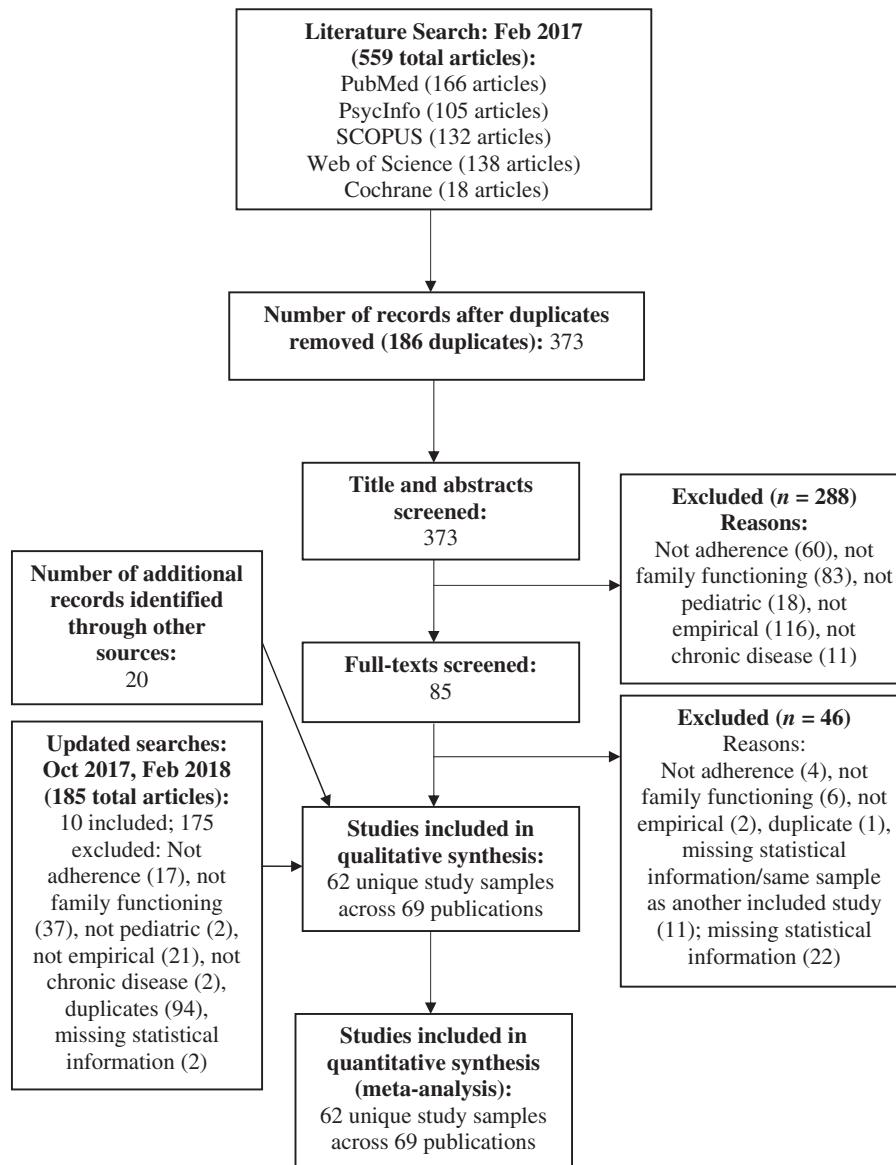


Figure 1. PRISMA diagram.

study based on sample size (Borenstein, Hedges, & Rothstein, 2007). For the omnibus meta-analysis, we averaged multiple effect sizes within studies (e.g., multiple measures of family functioning, multiple measures of adherence, and multiple reporters) and samples (e.g., multiple time points) for this analysis. When separate publications reported on the same data set, these publications were treated as dependent and combined. This technique is preferable to treating dependent findings as independent, which distorts standard error estimates (Hedges, Tipton, & Johnson, 2010; Olkin & Gleser, 2009). To assess and adjust for the possibility of publication bias, we created a funnel plot of the standard error and used the “trim and fill” algorithm (Duval & Tweedie, 2000). Using methods derived from symmetry assumptions, this approach estimates the number of missing studies and then imputes the missing values to

estimate an overall adjusted effect. The second set of analyses involved subgroup meta-analyses to better estimate the size of the associations between specific family functioning components and adherence. Associations between relevant covariates (child age, subjective vs. objective or bioassay adherence: subjective as the reference group, family unit vs. parent–child family functioning assessment, and article quality) were examined via meta-regression analyses.

## Results

### Qualitative Synthesis

#### Sample Characteristics

For the 62 unique studies, we provided descriptive information regarding each study design, guiding theoretical model, sample, measures, and correlational

findings in [Supplementary Table S1](#). The cumulative sample size across the 62 studies was 6,427 participants. The average sample size was 104 ( $SD = 72$ , range = 13–338). There were nine unique disease groups, including asthma ( $n = 4$  studies), cystic fibrosis ( $n = 5$  studies), epilepsy ( $n = 2$  studies), inflammatory bowel disease ( $n = 2$  studies), juvenile rheumatoid arthritis ( $n = 1$ ), sickle cell disease ( $n = 3$  studies), spina bifida ( $n = 2$  studies), solid organ transplantation ( $n = 4$  studies), and type 1 diabetes ( $n = 38$  studies). One study included two disease groups (type 1 diabetes and cystic fibrosis). The mean age of patients was 12 years ( $SD = 3$ , range = 1–15). **Study design.** In terms of the study design, 51 of the 62 studies were cross-sectional (82.3%) and the remaining 11 were longitudinal (17.7%). Twenty-seven studies described a theoretical model as guiding their research question (43.5%). Of note, across these studies, 29 different theoretical frameworks were cited. The most common theoretical frameworks were: (1) McMaster Model of Family Functioning ( $n = 3$  studies; [Epstein, Baldwin, & Bishop, 1983](#)) and (2) Family Systems Theory ( $n = 3$  studies; [Minuchin, 1988](#)).

### Measurement

Regarding measurement of family functioning, 57 studies included a questionnaire measure of family functioning (91.9%), while 9 studies included an observational measure of family functioning (14.5%). The most commonly used questionnaires were the Diabetes Family Conflict Scale ([Rubin, Young-Hyman, & Peyrot, 1989](#))/the Revised Diabetes Conflict Scale ( $n = 12$  studies; [Hood et al., 2007](#)), followed by the Family Environment Scale ( $n = 9$  studies; [Moos & Moos, 1994](#)) and the Family Adaptability and Cohesion Evaluation Scale ( $n = 8$  studies; [Gorall, Tiesel, & Olson, 2004](#)). Nearly half of studies (45.2%) assessed family functioning at the parent-child interactions level, while 41.9% of studies assessed family functioning at the level of the family unit and 12.9% assessed family functioning at both levels. Most studies included only one measure of family functioning (71.0%). Of the 57 studies that included a questionnaire measure of family functioning, 57.9% included child- and parent-report ( $n = 33$  studies), 22.8% included parent-report only ( $n = 13$  studies), and 12.3% of studies included child-report only ( $n = 7$ ). Four studies did not specify the informant (7.0%).

In terms of adherence measurement, 44 studies used a subjective measure of adherence (e.g., interview, daily diary, or questionnaire; 71.0%), 33 studies used a bioassay (e.g., HbA1C or tacrolimus blood levels; 53.2%), and 17 studies used an objective measure (e.g., electronic monitor, clinic attendance documented in the health record; 27.4%). Over half of the

studies (54.8%) included a single measure of adherence. Of those that included a subjective measure of adherence, the majority assessed adherence using multiple informants (parent, patient, and/or medical provider; 61.4%,  $n = 27$ ).

### Quality Ratings

On average, the quality rating across studies fell in the “good” range. The mean quality rating was 2.39 ( $SD = 0.25$ ), with ratings ranging from 1.83 to 2.83 on a three-point scale (1 = poor evidence/low quality, 3 = good evidence/high quality; [Alderfer et al., 2010](#)). Six of the studies fell below 2.0 (see [Supplementary Table S1](#)). The most common weaknesses were insufficient statistical power, threats to internal validity (e.g., risks for common method variance given single-informant, measuring predictor(s) and outcome(s) at the same time point), and threats to external validity (e.g., findings not generalizable to the target population).

### Meta-Analysis: Overall Association Between Family Functioning and Adherence

Across the 62 studies, spanning 69 publications, there were 695 correlations of interest. Within the omnibus meta-analysis, we did not find significant heterogeneity beyond the sampling error, validating the use of the fixed-effects model,  $Q(61) = 58.83$ ,  $p > .05$ . With the fixed-effects model, the point estimate of the correlation between family functioning and medical adherence was .18, with a 95% confidence interval (CI) [.15, .20]. The point estimate was significantly different from 0 ( $Z = 13.60$ ,  $p < .00001$ ), suggesting that the overall association of family functioning and adherence was significant. The trim and fill approach suggested that publication bias resulted in 20 missing effects, resulting in an adjusted point estimate of .13, 95% CI [.11, .15]. Meta-regression analyses indicated that there were not significant differences in the magnitude of the effect size depending on child age,  $Q(1) = .22$ ,  $p > .05$ , level of family assessment (unit vs. parent-child;  $Q(1) = .03$ ,  $p > .05$ , type of adherence assessment (subjective vs. objective or bioassay;  $Q(2) = 2.72$ ,  $p > .05$ , or article quality,  $Q(1) = 1.46$ ,  $p > .05$ ).

### Meta-Analysis: Components of Family Functioning

#### Family Conflict

Thirty-two studies evaluated family conflict (operationalized as conflict, negativity, negative reciprocity/communication, and relationship difficulties). The  $Q$  statistic did not indicate significant random error,  $Q(31) = 38.63$ ,  $p > .05$ . With the fixed-effects model, the point estimate of the correlation between family functioning and medical adherence was  $-.18$ , with a 95% CI of  $-.21$  to  $-.15$  (see [Supplementary Figure S1](#)).

The point estimate was significantly different from 0 ( $Z = -10.51, p < .00001$ ), suggesting a significant negative association between family conflict and adherence. The trim and fill approach showed that three studies needed to be imputed to account for probable publication bias. The adjusted coefficient for the fixed-effects model was  $-.16, 95\% \text{ CI } [-.19, -.13]$ . There were no significant differences in the effect size based on child age,  $Q(1) = 1.41, p > .05$ , level of family assessment,  $Q(1) = 1.53, p > .05$ , type of adherence assessment,  $Q(2) = 3.78, p > .05$ , or article quality,  $Q(1) = .25, p > .05$ .

### Family Cohesion

Twenty-eight studies evaluated family cohesion (operationalized as family cohesion, affective involvement/responsiveness, warmth/caring, emotional support, relatedness, and relationship quality). The  $Q$  statistic did not indicate significant random error,  $Q(27) = 28.41, p > .05$ . With the fixed-effects model, the point estimate of the correlation between family functioning and medical adherence was  $.18$ , with a  $95\% \text{ CI}$  of  $.14$  to  $.21$  (see [Supplementary Figure S2](#)). The point estimate was significantly different from 0 ( $Z = 8.97, p < .00001$ ), suggesting a significant positive association between family cohesion and adherence. Per the trim and fill approach, publication bias did not result in missing effects. Again, there were no significant differences in the magnitude of the effect size depending on child age,  $Q(1) = 2.53, p > .05$ , level of family assessment,  $Q(1) = .92, p > .05$ , type of adherence assessment,  $Q(2) = 1.71, p > .05$ , or article quality,  $Q(1) = 1.23, p > .05$ .

### Family Flexibility

Twelve studies evaluated aspects of family flexibility (operationalized as roles, organization, rules about behavior, and adaptability). The  $Q$  statistic did not indicate significant random error,  $Q(11) = 4.99, p > .05$ . With the fixed-effects model, the point estimate of the correlation between family functioning and medical adherence was  $.13$ , with a  $95\% \text{ CI}$  of  $.07$  to  $.19$  (see [Supplementary Figure S3](#)), which was significantly different from 0 ( $Z = 4.03, p = .0001$ ). That is, family flexibility positively related to adherence. Publication bias resulted in one missing effect, with the adjusted point estimate remaining  $.13, 95\% \text{ CI } [.07, .19]$ . The magnitude of the effect size did not depend on child age,  $Q(1) = .13, p > .05$ , level of family assessment,  $Q(1) = .13, p > .05$ , type of adherence assessment,  $Q(2) = 1.95, p > .05$ , or article quality,  $Q(1) = .12, p > .05$ . As all studies measured family flexibility at the family level, we were unable to test level of family assessment as a moderator.

### Family Communication

Eleven studies evaluated aspects of family communication (operationalized as communication and positive reciprocity). The  $Q$  statistic did not indicate significant random error,  $Q(10) = 6.97, p > .05$ . With the fixed-effects model, the point estimate was  $.13, 95\% \text{ CI } [.08, .19]$ , which was significantly different from 0 ( $Z = 4.58, p < .00001$ ) and indicated a positive relationship between family communication and adherence (see [Supplementary Figure S4](#)). Publication bias resulted in one missing effect, with the adjusted point estimate remaining  $.13, 95\% \text{ CI } [.07, .18]$ . The magnitude of the effect size did not depend on child age,  $Q(1) = 3.48, p = .06$ , level of family assessment,  $Q(1) = .01, p > .05$ , type of adherence assessment,  $Q(2) = .28, p > .05$ , or article quality,  $Q(1) = 1.94, p > .05$ .

### Family Problem-Solving

Seven studies investigated family problem-solving and adherence. The  $Q$  statistic did not indicate significant random error,  $Q(6) = 5.94, p > .05$ . The point estimate for the fixed-effects model was  $.12, 95\% \text{ CI } [.04, .19]$ , which was significant ( $Z = 2.90, p = .004$ ). That is, better family problem-solving related to higher adherence (see [Supplementary Figure S5](#)). Publication bias resulted in one missing effect, with an adjusted point estimate of  $.09, 95\% \text{ CI } [.01, .16]$ . Meta-regression indicated that the size of the association was significantly related to child age,  $Q(1) = 3.96, p = .048$ . As child age increased, so did the magnitude of the effect,  $.03, 95\% \text{ CI } [.001, .07]$ . The magnitude of the effect size did not depend on level of family assessment,  $Q(1) = .22, p > .05$ , type of adherence assessment,  $Q(2) = .47, p > .05$ , or article quality,  $Q(1) = .17, p > .05$ .

### Exploratory Analyses

As the effect size observed for family conflict and adherence was among the largest, we conducted exploratory meta-analyses to determine the magnitude of the effects for disease-related conflict (e.g., disease conflict surrounding diabetes management) and generic family conflict. Total 18 studies examined disease-related conflict, while 14 studies examined generic family conflict. For disease-related conflict, the point estimate for the fixed-effects model of disease-specific family conflict was  $-.21, 95\% \text{ CI } [-.25, -.17]$ , which was significant ( $Z = -9.59, p < .00001$ ). Publication bias resulted in four missing studies, with an adjusted point estimate of  $-.19, 95\% \text{ CI } [-.23, -.15]$ . For generic family conflict, the point estimate for the fixed-effects models of generic family conflict was  $-.13, 95\% \text{ CI } [-.18, -.07]$ , which was also significant ( $Z = -4.72, p < .00001$ ). The trim and fill approach showed no missing studies.

## Discussion

This meta-analysis investigated associations between family functioning and medical adherence among pediatric patients with chronic health conditions. To our knowledge, this article represents the first meta-analysis to pool associations across disease groups and family functioning and adherence measurements. Tests were consistent in showing homogeneity of variance across studies, which supported our decision to include all pediatric disease groups and assessment methods. We analyzed 62 unique studies, across 69 publications, and found a significant overall effect of family functioning on adherence. Moreover, components of family functioning were significantly associated with adherence: lower family conflict, greater family cohesion, greater family flexibility, more positive communication, and adaptive family problem-solving each related to better adherence. The effect sizes of family cohesion and conflict were among the highest, falling between the small to moderate range, which may justify prioritization of these domains in psychosocial screening and family-based adherence interventions.

Across the omnibus and family functioning component meta-analyses, effect sizes were almost always consistent across child age, level of family assessment, type of adherence measure, and article quality, supporting the dependability of these findings across the developmental spectrum and methodological approaches. However, as child age increased, so did the correlation between family problem-solving and adherence. This may suggest that during adolescence, when patients are gaining increased responsibility for disease management and problem-solving new adherence-related challenges, interventions that target family problem-solving may be especially relevant. Nevertheless, effect sizes across analyses were generally small. Consistent with social-ecological models (e.g., the Pediatric Self-Management Model; Modi et al., 2012), this suggests that family functioning components are important but not the only factors to consider, when conceptualizing barriers and facilitators to adherence.

This meta-analysis is not without limitations. The studies included in the meta-analysis were heterogeneous with regard to the specific family functioning and adherence constructs assessed, assessment approaches (e.g., informant type, measures), disease type, demographic characteristics (e.g., child age), and study design (e.g., cross-sectional and longitudinal). For example, across the studies included in the meta-analysis, average participant age ranged from infancy to age 15 years. While studies were heterogeneous in several ways, each explored similar self-management tasks such as medication adherence, following dietary recommendations, and monitoring for symptoms.

Cross-disease approaches such as this meta-analysis are less common than disease-specific approaches but are valuable in highlighting the similar processes that bring about adaptive and maladaptive health behaviors across pediatric populations (Martire & Helgeson, 2017). It is also important to consider that we were underpowered to test disease type as covariate (with the exception of type 1 diabetes, individual disease groups were represented in few publications), making within disease meta-analyses of family functioning and pediatric adherence unfeasible at this point in time.

Another possible limitation was our integration of a variety of subjective, objective, and bioassay adherence measurements, each of which possess unique strengths and limitations and do not perfectly correspond (Hood, Peterson, Rohan, & Drotar, 2009; Simons et al., 2009). While subjective measures tend to overestimate adherence rates because of recall bias and social desirability, bioassays such as HbA1C and immunosuppressant blood levels may be influenced by medication and physiological factors independent of adherence (e.g., puberty, timing of the dose; Duncan, Mentrikoski, Wu, & Fredericks, 2014; Stirratt et al., 2015). For these reasons, HbA1C is sometimes characterized as an objective adherence assessment (Duncan et al., 2014; Hommel, Ramsey, Rich, & Ryan, 2017) and other times characterized as a diabetes outcome that is distinct from, but intricately connected to, adherence (Hood et al., 2009). Nonetheless, HbA1C is a commonly used clinical indicator of adherence in routine practice (Wu et al., 2013). Among pediatric solid organ transplant recipients, combining subjective and objective adherence measures had greater sensitivity and specificity for clinical outcomes than a single measure of adherence alone (Simons et al., 2009). We adopted a similar approach in this meta-analysis by integrating each adherence method in an effort to triangulate actual adherence among pediatric patients and their family members. Without weighting or prioritizing certain adherence measures, it is possible that this approach may have impacted findings. However, this appears unlikely, as there were no differences in the magnitude of the effect when we compared these measures.

Additionally, examining specific components of family functioning may not fully capture the family system as a whole. Incorporating family strengths and deficits to better understand distinct family typologies may portray a more accurate image of how families work together to influence child adjustment outcomes (Ghriwati, Winter, & Everhart, 2017; Mandara & Murray, 2002). Ghriwati and colleagues (2017) used pattern-based approaches to identify four profiles of family functioning that related to child adjustment outcomes among a large sample of children with



asthma: cohesive, permissive, controlling/disengaged, and controlling/enmeshed. More research is needed to determine whether these profiles are generalizable across disease groups and whether they relate to adherence outcomes. Finally, our method of estimating  $r = 0$  when statistical data were not provided was conservative and likely led to underestimation of associations. However, this method is preferable to disregarding null findings or incomplete reporting of results (Rosenthal, 1995).

Data from the current study highlight several limitations of the extant research, as well as areas for future research and clinical innovation. First, less than half of the included studies cited a theoretical model. Among those articles that cited a theoretical model, there was notable heterogeneity (i.e., 29 different theoretical models reported across studies). These findings demonstrate the lack of a unifying theoretical framework for understanding how the family context, including family functioning, influences adherence to chronic illness demands over the course of childhood development. Existing pediatric social-ecological models, including the Pediatric Psychosocial Preventive Health Model (Kazak, 2006) and the Pediatric Self-Management Model (Modi et al., 2012), offer overarching frameworks for considering the complexities of managing a chronic illness within the family system while maneuvering broader developmental issues. To extend current models of pediatric disease management, we propose that a more detailed theoretical model of the nonmodifiable and modifiable family factors that relate to adherence is strongly needed (i.e., a model that “magnifies” the family context and highlights priorities for screening and intervention across the developmental continuum). As a starting point, the results from this meta-analysis suggest that family conflict and cohesion may be the most robust family functioning correlates with pediatric adherence.

Second, attention needs to be paid to the conceptualization and measurement of family functioning constructs in relation to adherence. Most of the studies included in the meta-analysis relied on a single family functioning questionnaire, some of which have demonstrated low internal consistency in pediatric populations (Alderfer et al., 2008). Additionally, with the exception of diabetes-related conflict, family functioning surrounding disease management remains largely untested in the literature. It is possible that generic measures of family functioning do not completely assess the family functioning processes that are necessary for adherence (e.g., problem-solving surrounding adherence tasks and clear communication of disease information). Randomized controlled trials that compare overall and disease-specific family functioning interventions are needed to determine whether

targeting family functioning as whole or family functioning surrounding disease management is equally effective. Alternatively, it is possible that general family functioning and disease-related family functioning each account for unique variance in adherence patterns, which is consistent with the findings of relatively equivalent effect sizes for disease-related and generic family conflict with adherence.

Very few studies used observational measures of family functioning. While observational research can be time-consuming and labor-intensive, direct observation offers several benefits. Using observational methods will allow researchers to directly assess more specific types of family interactions (e.g., family communication surrounding the allocation of treatment responsibilities), rather than rely solely on child and family perceptions of generic family functioning (Murphy, Murray, & Compas, 2017; Wsocki, 2015). Electronic methods of family observation, such as using an Electronically Activated Recorder, permit researchers to naturalistically assess multiple aspects of family relationships, as they unfold in everyday life, including during adherence tasks (Imami et al., 2015; Slatcher & Robles, 2012).

Third, studies included in the meta-analysis relied on objective, subjective, and bioassay measures of adherence, with almost half of the studies using more than one measure of adherence. However, of note, none of the included studies leveraged new technologies to assess adherence. Ecological momentary assessment (EMA) strategies involve signaling participants via a smartphone, typically multiple times each day, to report on current or recent behaviors, states, and conditions (Smyth & Stone, 2003; Stone & Shiffman, 2002). Assessing adherence via EMA reduces recall bias and allows for the measurement of real-world, real-time adherence behaviors, and the context in which those adherence behaviors occurred. For example, Mulvaney and colleagues (2013) found that EMA of asthma adherence correlated with asthma control and was feasible and acceptable among African-American teenagers.

Fourth, regarding study rigor, common weaknesses included insufficient statistical power, threats to internal validity from cross-sectional, single-informant data, and questionable generalizability of findings given predominantly white and middle-class samples. It is well established that family functioning and adherence behaviors change over the course of child development. Yet, there remains a dearth of longitudinal research investigating these dynamic processes. Rigorous longitudinal designs with diverse populations will expand our understanding of how dynamic family processes impact adherence across the developmental continuum.

Finally, it is significant that over half of the included studies focused on type 1 diabetes and often used a single disease-specific measure of family conflict. While the emphasis on type 1 diabetes and diabetes-related conflict is relevant given well-documented adherence issues (Anderson et al., 2002; Hilliard, Guilfoyle, Dolan, & Hood, 2011), this knowledge may or may not be generalizable to other disease groups who face unique challenges (e.g., neurocognitive difficulties or greater perceived life threat). Indeed, particular pediatric conditions, such as pediatric cancer and obesity, were entirely unrepresented in the meta-analysis. We recommend further research with these disease groups, as well as attention to socioeconomically diverse families who likely possess distinct family strengths and challenges in relation to adherence.

To summarize, this meta-analysis indicates that overall family functioning and specific family functioning components, including family conflict, cohesion, flexibility, communication, and problem-solving, are correlated with medical adherence across several pediatric chronic health conditions. Therefore, we recommend that consideration of the family as a whole, including routine assessment of family functioning and delivery of family-based self-management support, has implications for adherence promotion. In clinical settings, we encourage health-care professionals to screen for family conflict, cohesion, flexibility, communication, and problem-solving to identify family risk and protective factors for adherence. Given measurement limitations, there is a possible need for a new and updated questionnaire that assesses central family functioning components in relation to adherence. Screening for family functioning will enable opportunities to shift toward prevention and integration of family-based self-management support before adherence problems become significant and health deteriorates (Hommel, Ramsey, Rich, & Ryan, 2017).

### Supplementary Data

Supplementary data can be found at: <http://www.jpepsy.oxfordjournals.org/>.

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