Meta-Analysis of Psychological Interventions to Promote Adherence to Treatment in Pediatric Chronic Health Conditions

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Objective To estimate the effectiveness of adherence-promoting psychological interventions for pediatric populations with chronic health conditions. **Methods** A meta-analysis was conducted on 70 adherence-promoting psychological intervention studies among chronically ill youth using a weighted least squares approach and random effect model. **Results** Medium effects sizes were found for the behavioral (mean $d = .54$, 95% confidence interval [CI] = 0.34–0.73, $n = 10$) and multi-component interventions (mean $d = .51$, 95% CI = 0.45–0.57, $n = 46$), while educational interventions displayed a small effect size with adherence (mean $d = .16$, 95% CI = 0.10–0.22, $n = 23$). Study designs incorporating pre–post comparisons yielded effect sizes approaching the medium range (mean $d = .42$, 95% CI = 0.36–0.48, $n = 30$). **Conclusions** Behavioral and multi-component interventions appear to be relatively potent in promoting adherence among chronically ill youth. Recommendations for future research and methodological issues are presented.

Key words adherence; chronic health conditions; meta-analysis; pediatric; psychological intervention.

Large numbers of children and adolescents in the United States have chronic health conditions that threaten their physical health and quality of life (Newacheck, McManus, Fox, Hung, & Halfon, 2000). Modern advances in pediatric care have created a range of available medical treatments that can reduce illness-related symptoms and longer term complications, decrease healthcare utilization, and enhance quality of life. Children with chronic health conditions and their families are responsible for managing multidimensional treatment regimens that can include medications, dietary requirements, and physical therapy. However, children and adolescents with chronic illness have great difficulty completing prescribed treatment regimens, which can be complex and burdensome (Rapoff, 1999). High rates of nonadherence to treatment (averaging 50% or more) have been reported for various pediatric chronic conditions, such as asthma, juvenile rheumatoid arthritis (JRA), and diabetes (Drotar, 2000; Lemanek, Kamps, & Chung, 2001; Rapoff). Such rates of nonadherence indicate that many pediatric chronic health conditions are undertreated relative to recommended standards of medical care. Nonadherence to treatment may account for increased morbidity symptoms, complications, and health care utilization and limitations in quality of life (Drotar). Nonadherence also complicates research concerning the development and evaluation of medical treatments. For example, children's nonadherence to pharmacological treatment research protocols may result in erroneous conclusions that medications are not effective when in fact they are not taken in the proper doses (Johnson, 2000).

Recognition of the critical importance of promoting adherence to medical treatment among children and adolescents and their families has led to the development and evaluation of psychological interventions to enhance adherence to medical treatment (Drotar, 2000; Lemanek et al., 2001; Rapoff, 1999).[1] Various reviews of empirically supported interventions have indicated that interventions

[1]The concept of self-management is one which overlaps with adherence and adherence-related behaviors. Self-management usually refers to the methods by which a child and his/her parent engages, manages, and/or controls a wide range of treatment regimen behaviors, while adherence refers to the extent to which the prescribed treatment has been completed.

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have shown mixed success in improving adherence to treatment (Drotar, 2006; Lemanek). Some behavioral intervention models (Rapoff et al., 2002) appear promising, while the Behavioral Family Systems model (Wysocki et al., 2006) and individualized written (self) management plans (Toelle & Ram, 2002) have produced mixed results in improving treatment adherence.

The results of adherence-promoting intervention studies targeting pediatric conditions that have been conducted to date, however, are difficult to summarize because they have been published in a wide range of medical and psychological journals and incorporate disparate methods. In addition, of the published research, several narrative reviews were not systematic (Fotheringham & Sawyer, 1995), did not focus exclusively on adherence to treatment (Barlow & Ellard, 2004; Beale, 2006), or failed to provide a quantitative summary or synthesis of adherence-promoting interventions (Lemanek et al., 2001). Two meta-analyses have also been conducted on studies of psychological interventions with pediatric chronic health conditions (Beale, 2006; Kibby, Tyc, & Mulhern, 1998), but these did not focus specifically on adherence-related interventions. Other meta-analyses of interventions have focused largely on adult populations and/or included interventions to promote adherence in populations without chronic illnesses (McDonald, Garg, & Haynes, 2002; Peterson, Takiya, & Finley, 2003; Tsai, Morton, Mangione, & Keeler, 2005). An overall summary or meta-analysis is needed to evaluate the state of the current research, and specifically to ascertain and summarize patterns of findings related to the effects of interventions that promote adherence to treatment across a wide range of chronic conditions while using a common metric. To the authors' knowledge, no such meta-analysis has been conducted.

The primary focus of the current meta-analysis was to summarize information about the efficacy of various psychological interventions that have been used to promote treatment adherence for children with chronic health conditions and their families. The present work is unique in its focus on multiple pediatric chronic health conditions. In addition, we examined the relationship of various characteristics and methodological factors, such as study design (e.g., experimental and control group comparisons vs. pre–post single sample designs) and time point of adherence assessment (postintervention vs. long-term follow-up) on effect sizes related to adherence outcomes.

Methods

Literature Search

Comprehensive literature searches using various medical and psychological bibliographic databases, including PsycINFO and PUBMED/MEDLINE, were conducted in order to identify articles in peer-reviewed publications that reported on psychological interventions (e.g., behavioral, educational, combined, and peer-based) for various chronic pediatric conditions in which adherence was measured either as a primary or secondary outcome. Search terms such as *intervention, treatment, adherence, compliance, asthma, diabetes, cystic fibrosis (CF), cancer, hematology, oncology, sickle cell disease, obesity, overweight, transplants, gastrointestinal disorders [including Crohn's disease, colitis, and irritable bowel disease (IBD)], pain disorders, JRA, infectious diseases [including tuberculosis (TB) and human immunodeficiency virus (HIV)]* were utilized in the search for articles.[2] In addition, the reference sections of various identified articles were examined as were various noted systematic reviews of interventions for pediatric conditions (Bernard & Cohen, 2004; Drotar, 2000; Hampson et al., 2001; Lemanek et al., 2001) and Cochrane Reviews (Yorke, Fleming, & Shuldam, 2005) in order to glean additional articles.

The authors constructed a template form, in order to extract all relevant information from identified articles. The template forms incorporated many criteria from the Consolidated Standards of Reporting Trials (CONSORT; Moher, Schulz, & Altman, 2001), the Cochrane Database of Systematic Reviews (Mulrow & Oxman, 1997), and the Standards for Reporting of Diagnostic accuracy (STARD; Bossuyt et al., 2003) criteria, in order to cull all relevant information and assess the methodological rigor associated with the included studies. The authors as well as other raters (e.g., undergraduate research assistants) completed the template form for each included study.

Inclusion Criteria

The studies included within the current review used quantitative methods to examine rates of adherence to prescribed treatments across a variety of pediatric chronic conditions. Only English-language articles published in peer-reviewed journals were included. Studies that reported adherence to medication, dietary, and exercise/behavior regimens were included, as were those which examined overall adherence (to multiple domains) and self-management and/or self-care behaviors (see Appendix I of the Supplementary Material found electronically

[2]Based on the Centers for Disease Control criteria for defining obesity (National Center for Health Statistics, 2000), obesity was defined specifically as a body mass index (BMI) of at least between or above the 97th percentile for age and gender. Studies which did not measure BMI or employed the 85th–95th (at risk for overweight and overweight, respectively) for BMI percentile were excluded.

at http://www.societyofpediatricpsychology.org/~division 54/index.shtml for specific aspects of adherence, which were measures across the included studies). In addition, studies with various methodological designs were included, such as pre–post evaluations for the treatment and/or control groups, or direct comparisons of experimental and control groups at the end of an intervention. Some studies described percentage change from pre-to-post for the experimental groups, while others reported percentage change comparisons for the experimental versus control groups.

Exclusion Criteria

Articles were excluded on the following grounds: (a) treatment adherence was not assessed; (b) the study focused primarily on measurement and did not include an intervention (or an intervention with a psychological component; (c) the study was based on a sample that was comprised of individuals older than 19 years of age or included a mixed sample of adults and children; (d) the study reported group statistics on combined samples comprised of chronically ill and nonill children; (e) the article did not include sufficient statistical data to compute effect sizes; (f) the findings combined experimental and control group data (or the authors indicated that control groups had received the intervention previously); (g) the study utilized a within-group comparison (i.e., pre–post intervention design) and did not report either a paired *t*-test value, standard error of the differences between means, or correlation between pre- and post- intervention on an adherence measure; (h) the study involved case reports or single-*n* designs that did not contain any measure of variability (e.g., standard deviation) necessary to compute effect sizes; (i) the study included only one group and reported percentages of adherence (or the percentage of participants who were adherent) at pre- and post-interventions (as effect sizes could not reliably be estimated from these data); (j) the study employed experimental and control groups that were significantly different on targeted adherence outcomes at baseline; and (k) the study subsumed several subgroups within an experimental group and noted significant differences between these subgroups on targeted outcome adherence variables. After these exclusion criteria were applied, a total of 70 empirical studies were identified for the current review (see Table I for a description of studies).

Categorization of Treatments

Table II details the classification of interventions utilized in the included studies. Educational interventions were those that focused on providing instruction or teaching related to the illness and/or related treatment and were delivered in person by an interventionist. Behavioral interventions were defined as those that emphasized *applied* behavioral methods (e.g., problem-solving, parent training), in order to increase treatment adherence. Multicomponent interventions incorporated multiple modalities, the most common of which included some variant of behavioral and educational treatment models. Other multi-component interventions included a social-support, social skills training, or family therapy component along with either behavioral or educational treatments. Psychosocial interventions focused exclusively on addressing broad psychosocial targets, including family functioning or providing intensive crisis intervention in order to enhance adherence to treatment regimens. Finally, technology-based interventions used various technologies (i.e., glucose meter) or interactive games, which focused on a particular disease and its treatment in order to promote adherence. Importantly, these interventions differed from educational treatments in that they did not include direct clinical interface or interaction between the interventionist and the child and family. In order to evaluate the reliability of the classification scheme regarding the types of intervention employed in the included studies, the first author and a PhD-level psychology postdoctoral fellow conducted inter-rater reliability for ~25% (18/70) of randomly selected studies. Acceptable to good inter-rater reliability ($\kappa = .80$) was established.

Data Analytic Plan and Other Methodological Considerations

Strategies to Enhance Methodological Accuracy

The authors employed various strategies in order to ensure methodological accuracy. For example, if the same sample was used in several studies, it was only included once in the meta-analysis. Multiple dependent variables based on the same sample were aggregated across studies as long as they were methodologically (e.g., both derived from pre–post or experimental vs. control group designs) or conceptually (e.g., measuring the same adherence construct) similar. This technique was used in order to avoid a significant distortion of the standard error estimates that typically results when treating nonindependent studies as independent (Gleser & Olkin, 1994). Furthermore, when a study reported multiple effect size estimates for the same general construct, they were averaged to calculate an overall effect size.

A total of 90 effect sizes were initially calculated from 70 studies. The majority of studies ($n = 57$) contributed

one effect size. However, 13 studies were included that reported multiple effect sizes. These effect sizes could not be aggregated because of the methodological or conceptual differences between the multiple dependent variables reported in each of these studies. The studies included: four studies that contained two experimental versus control groups or separate and multiple experimental group comparisons (i.e., comparing separate experimental vs. control groups over the course of 4 years); three studies that provided sufficient information to compute effect sizes for both pre–post and experimental versus control group differences, separately; four studies with adherence outcome measures that were conceptually different and could not be averaged; and two studies that provided data to compute effect sizes for pre–post differences for the experimental and control groups, separately, and also included conceptually different outcomes. As such, due to these methodological or conceptual differences, the authors treated the multiple effect sizes gleaned from these studies as independent from each other.

Studies were weighted by their sample size. A weighted least squares approach was utilized in the analyses, as this approach emphasizes findings from studies with larger samples and more precise estimates (Hedges & Olkin, 1985). Many of the pre–post designs did not report the psychometric data, and specifically the *Pearson r* correlation, for the adherence outcome measure that was necessary to compute the inverse variance weight (as described by Lipsey & Wilson, 2001). As such, the authors selected the median *r* (the *Pearson r* or pre–post correlation for a specific outcome measure) from the studies that did include such information and utilized it for computing all of the inverse variance weights for the studies with pre–post designs. Consequently, 90 weighted-effect sizes were used in the primary analyses of adherence outcomes.

Statistical Approach

Studies that utilized within- or between-group designs typically reported *t*, *F*, and chi-squared statistics. Based on Rosenthal (1991, 1994) and Hedges and Olkin (1985), all of the statistics were converted to Cohen's *d* in order to yield a single common measure of effect size. Social science researchers generally interpret Cohen's *d* effect size values as .2 for small, .5 for medium, and .8 for large effects (Cohen, 1988), with higher *d*-values indicating a stronger relationship with adherence. The use of effect size statistics for both within- or between-group differences is consistent with current standard statistical practices (Lipsey & Wilson, 2001). Confidence intervals associated with effect sizes were calculated as well. Confidence intervals not including zero were statistically significant effects, while those including zeroes were not.

Q statistics were examined to test for homogeneity among the effect sizes associated with any given predictor. Significant *Q* statistics indicated that the variability among effect sizes was greater than subject-level sampling error alone and likely due to systematic differences among the studies (Lipsey & Wilson, 2001). The random effects model was used to calculate all mean effect sizes because this method provides a more conservative estimate of the mean effect size by including study-level sampling error as well as subject-level sampling error. Use of the random effects model is recommended when analyzing a relatively small number of studies that contain small sample sizes (Lipsey & Wilson).

Results

Description of Studies

Study Design Characteristics

Thirty-two studies (45.7%) involved asthma, 16 with diabetes (22.9%), 10 with CF (14.3%), 2 each with JRA and obesity (2.9%, respectively), and one each for hemodialysis, hemophilia, HIV, IBD, phenylketonuria (PKU), seizure disorders, sickle cell disease, and TB (1.4% each). Of the 70 included studies, 29 (41.4%) were identified as RCT. Furthermore, over half of the studies (42/70 or 60%) reported an effect size based on an experimental versus control group design, while 19 (27.1%) included an effect size based on pre–post differences, and another 9 (12.9%) reported effects for both experimental versus control group and pre–post comparisons (or group by time interaction effects).

Demographic Characteristics

Mean age of the youth ranged from 2 to 15 years ($M = 10.24$, $SD = 3.16$). Fifty-three studies reported gender prevalence, which was distributed relatively equally across studies (53.3% males vs. 47.4% females). With respect to ethnicity, $n = 26$ (37%) of the studies included relevant information. Caucasians represented 82% of the included individuals in all the studies combined, with African-American, Latino, and other minority groups constituting the remainder. Fifteen studies (21.4%) included information on socioeconomic status (SES) of the included samples; however, these data could not be aggregated because they were based on very different indices of SES status (e.g., percentage on Medicare, Hollingshead index).

Table I. Description of Studies Included in the Meta-Analysis

Author	Disease	Type of intervention	Effect size comparison	Total sample used	Percent female/ percent male	Ethnicity total	Who implemented intervention	Involved in intervention	Number of sessions	Rater of adherence	Whose behaviors were adherent
Baum & Creer, 1986	Asthma	Multi-component	RCT; Exp. vs. control	16	25/75		PhD Psychologist	Child, Parent	2 h session; weekly meeting with experimenter	Child	Child
Bonner et al., 2002	Asthma	Educational	RCT; Exp. vs. control	100	50/50	71–75% H; 22–23% AA	Family coordinator	Child, Parent	3 month (3 sessions using 3 intervention components)	Caregiver	Family
Brazil, McLean, Abbey, & Musselman, 1997	Asthma	Psychosocial	Exp. vs. control	35; 49; 44	30/70		Physiotherapist, nurse educator, social worker, physician	Child, Parent	3 month inpatient (3 times a week with child; 1 monthly parent meeting)	Father, Mother, Child	Child
Burkhart, Dunbar-Jacob, Fireman, & Rohay, 2002	Asthma	Multi-component	RCT; Exp. vs. control	42	26/74	98% W	Nurse	Child, Parent	5 weeks (3 1-h sessions)	Electronic monitoring, Child	Child
Butz et al., 2006	Asthma	Educational	RCT; Exp. vs. control	181; 192	34/66	89% AA; 11% other	Community health nurses	Parent	6 months (6 1-hour sessions)	Pharmacy records, Parent	Child; Parent
Carson, Council, & Schauer, 1991	Asthma	Educational	Pre–Post	33		100% W	Physicians, nurses, respiratory therapist, pharmacist	Child, Parent	6 weeks	Parent	Child, Parent
Clark et al., 2004	Asthma	Educational	RCT; Exp. vs. control	674		98% AA		Child, Parent	6 treatment components	Parent	Parent
Dahl, Gustafsson, & Melin, 1990	Asthma	Behavioral	RCT; Exp. vs. control	19	42/58			Child, Parent	4 weeks (4 1-h sessions)	Child, Parent	Child
Guendelman, Meade, Benson, Chen, & Samuels, 2002	Asthma	Technology-based	RCT; Exp. vs. control	128; 122	43/57	74–79% AA; 8–12% W	Physician, case worker, nurse	Child	6–12 weeks (daily)	Parent	Child

Gustafsson, Kjellman, & Cederblad, 1986	Asthma	Psychosocial	Exp. vs. control	11			Therapists	Child, Parent	8 months (2–21 sessions)	Allergist	Child
Hill, Williams, Britton, & Tattersfield, 1991	Asthma	Educational	Exp. vs. control	296; 102	48/52		School nurse, teachers	Child, School	1 appt. with physician; 1 session with school nurse (30 min)	Teacher	Child, School, Parents
Homer et al., 2000	Asthma	Technology-based	RCT; Exp. vs. control	106	~31/69	55–64% AA; 2–9% H		Child	3 visits; 8 monthly phone check-ins	Parent	Child
Hughes, McLeod, Garner, & Goldbloom, 1991	Asthma	Educational	RCT; Exp. vs. control	89	37/63		Respirologist; study nurse researcher	Child, Parent	At least 4 visits to clinic every 3 months; 2 home visits over 1 year	Child, Parent	Child
Kotses et al., 1991	Asthma	Behavioral	Exp. vs. control	29	31/69				8.5 months (4 sessions at baseline, 16 other sessions)	Child	Child
Kubly & McClellan, 1984	Asthma	Educational	Pre–Post and Exp. vs. control	28	25/75		Researcher, nursing graduate student	Child, Parent	3–4 weeks (weekly sessions, 1-1–5 h each)	Parent	Child
Lewis, Rachelefsky, Lewis, de la Sota, & Kaplan, 1984	Asthma	Multi-component	RCT; Exp. vs. control	71	23/77	36% W; 33% AA; 24% H	Teachers, health educators, nurses	Child, Parent	Weekly (5 1-h sessions)	Parent	Child
Maslennikova, Morosova, Salman, Kulikov, & Oganov, 1998	Asthma	Educational	Pre–Post	60	36/64		Investigators, pediatricians	Child, Parent	4 weeks (weekly, 1–1.25 h sessions)	Child	Child
Miklich et al., 1977	Asthma	Behavioral	Exp. vs. control	26					10 weeks		Child

(continued)

Table I. Continued

Author	Disease	Type of intervention	Effect size comparison	Total sample used	Percent female/ percent male	Ethnicity total	Who implemented intervention	Involved in intervention	Number of sessions	Rater of adherence	Whose behaviors were adherent
Perez, Feldman, & Caballero, 1999	Asthma	Multi-component	RCT; Pre–Post and Exp. vs. control	29	55/45			Child, Parent	2 parent sessions; 6 1-h sessions for child	Child	Child
Rakos, Grodek, & Mack, 1985	Asthma	Multi-component	Pre–Post	43	37/63			Child, Parent	Once in mail	Child	Child
Ronchetti et al., 1997	Asthma	Educational	Exp. vs. control	209	35/65		Physicians	Child, Parent	4–8 sessions (weekly, 1-h sessions)	Parent	Child
Rubin et al., 1986	Asthma	Technology-based	RCT; Exp. vs. control	54	31.5/68.5		RA	Child, Parent	10–12 months (about 6 sessions; 45 min each)	Child, Parent	Child
Shames et al., 2004	Asthma	Technology-based	Exp. vs. control	106; 102; 97	42/58	56–58% H; 20–23% AA	Asthma case manager, allergist, immunologist	Child, Parent	3 meetings; 2 visits to immunologist	Child, Parent	Child
Sly, 1975	Asthma	Educational	Exp. vs. control	32				Child, Parent	1 session (14 min)	Parent	Parent
Smith, Seale, Ley, Shaw, & Bracs, 1986	Asthma	Multi-component	Exp. vs. control	196	40/60		Postgraduate student, physicians	Child	1–2 visits	Clinician	Child
Smith, Seale, Ley, Mellis, & Shaw, 1994	Asthma	Multi-component	Pre–Post	53	57/43		Physician	Child, Parent	6 visits (every 2–4 month intervals)	Child, Parent	Child
Staudenmayer, Harris, & Selner, 1981	Asthma	Multi-component	Pre–Post	37	40/60					Parent	Parent
Taggart, Zuckerman, Lucas, Acty-Lindsay, & Bellanti, 1987	Asthma	Educational	Pre–Post	12		100% AA	Nurse, physician	Child	1 visit (35–35 min)	Child	Child
Tal, Gil-Spielberg, Antonovsky, Tal, & Moaz, 1990	Asthma	Educational	Exp. vs. control	28			Social worker, pediatric pulmonologists	Child, Parent	6 weekly meetings, 2 h each	Child	Child

van Es, Nagelkerke, Colland, Scholten, & Bouter, 2001	Asthma	Multi-component	RCT; Exp. vs. control	97; 86	48/52	75% W; 25% non-W	Pediatrician, asthma nurse	Child	3 individual visits every 4 months (30 min each); 3 group sessions (1.5 h each)	Child	Child
Whitman, West, Brough, & Welch, 1985	Asthma	Multi-component	Pre-Post	19	34/66			Child, Parent	4 weeks (8 1.5-h sessions)	Outsider	Child
Wilson et al., 1996	Asthma	Multi-component	RCT; Exp. vs. control	64; 60	35.5/64.5	11% Minority	Nurses	Child, Parent	Weekly (4 sessions, 2 h each)	Parent	Parent
Bartholomew et al., 1997	CF	Multi-component	Exp. vs. control [quasi-exp. pre–post non–equal comparison]	178	52/48		RA	Child, Parent	12–18 months (one time-reading material)	Child/ Adolescent	Child/ Adolescent
Downs, Roberts, Blackmore, Le Souef, & Jenkins, 2006	CF	Multi-component	RCT; Pre–Post and Exp. vs. control	18; 43	44/56			Child, Parent	10 weeks (~20 min); phone check-in with nurse at weeks 3, 6, and 9	Parent	Child
Goldbeck & Babka, 2001	CF	Multi-component	Pre–Post	16	56/44		Physician, psychologist, physiotherapist, nurses, nutritionist	Child, Parent, Family	Once monthly (4 sessions)	Parent	Child
Powers et al., 2003	CF	Multi-component	RCT; Pre–Post and Exp. vs. control	7; 4			Dietician, psychologist	Parents	Once every other month (8 sessions, 60 min each)	Parent	Child
Powers et al., 2005	CF	Multi-component	RCT; Crossover; Exp. vs. control	10; 9	40/60	100% W	Therapists	Parent	Weekly (8 sessions)	Parent	Child
Stark, Bowen, Tyc, Evans, & Passero, 1990	CF	Multi-component	Pre–Post	5; 3	60/40		Clinical psychologist, dietician, graduate student, RA	Child, Parent	7 weeks (6 1.5-h sessions)	Parent	Child

(continued)

Table I. Continued

Author	Disease	Type of intervention	Effect size comparison	Total sample used	Percent female/ percent male	Ethnicity total	Who implemented intervention	Involved in intervention	Number of sessions	Rater of adherence	Whose behaviors were adherent
Stark et al., 1993	CF	Multi-component	Pre–Post	3	67/33		Clinical psychologist, dietician, postdoctoral fellow, RA	Child, Parent	8 weeks (7 sessions)	Parent	Child
Stark et al., 1996	CF	Multi-component	Pre–Post and Exp. vs. control	7			Clinical psychologist, dietician; postdoctoral fellow, RA	Child, Parent	6–8 weeks (7 sessions)	Parent	Child
Stark, Mackner, Kessler, Opipari, & Quittner, 2002	CF	Multi-component	Pre–Post	44; 15	50/50	100% W	Clinical psychologist, postdoctoral fellow	Child, Parent	8–9 weeks (6–7 sessions, 1–1.5-h each)	Parent	Child
Stark et al., 2003	CF	Multi-component	RCT; Exp. vs. control	7			Dietician, postdoctoral fellow, RA	Child, Parent	9 weeks (seven 1.5-h sessions)	Parent	Child
Anderson, Wolf, Burkhart, Cornell, & Bacon, 1989	Diabetes	Multi-component	RCT; Exp. vs. control	60	53/47		Diabetes nurse/ educator	Child, Parent	18 months (4–6 sessions, 3 h each)	Adolescent	Adolescent
Anderson, Brackett, Ho, & Laffel, 1999	Diabetes	Psychosocial	Pre–Post and Exp. vs. control	85	50/50		RA	Child, Parent	12 months (3–4 visits per year)	Child, Parent	Family
Bloomfield et al., 1990	Diabetes	Educational	Crossover; Exp. vs. control	48	56/44		Pediatrician, dietician, chiropodist, nurse	Child, Parent	5 visits per year	Child, Parent	Child
Boardway, Delamater, Tomakowsky, & Gutai, 1993	Diabetes	Behavioral	RCT; Exp. vs. control	17	58/42	68.42% W; 21% AA	Nurse	Child	6 months (10 + 3 sessions)	Child	Child
Brown et al., 1997	Diabetes	Technology-based	RCT; Exp. vs. control	59				Child	6 months (34 h overall)	Parent	Child

Elamin, Eltayeb, Hasan, Hofvander, & Tuvemo, 1993	Diabetes	Educational	Pre–Post	34	50/50		Dietician	Child, Parent	3 months (4 weekly sessions; sessions biweekly for 2 months)	Child, Parent	Child
Ellis et al., 2005	Diabetes	Multi-component	RCT; Pre–Post and Exp. vs. control	110	51/49	63% AA; 26% W	Therapists	Parent, Child, Family, Community	6 months (48 sessions)	Adolescent	Adolescent
Galatzer, Amir, Gil, Karp, & Laron, 1982	Diabetes	Psychosocial	Exp. vs. control	223	50/50		Nurse, endocrinologist, psychologist, dietician, social worker, psychiatrist	Child, Parent	7 months (daily for a week; 2 times weekly for 2 months; monthly for 5 months	Clinician	Child
Greco, Pendley, McDonell, & Reeves, 2001	Diabetes	Multi-component	Pre–Post	21	48/52	81% W; 14% AA; 5% Biracial	Licensed psychologists	Child	4 2-h sessions	Adolescent, Parent	Adolescent
Horan, Yarborough, Besigel, & Carlson, 1990	Diabetes	Technology-based	Exp. vs. control	20	70/30	80% W; 20% AA		Child	15 weeks	Child	Child
Lorini et al., 1990	Diabetes	Educational	Pre–Post	36	53/47		Dietician, physician	Child	Weekly for a month; biweekly for 2 months		Child
McNabb, Quinn, Murphy, Thorp, & Cook, 1994	Diabetes	Multi-component	Exp. vs. control	22				Child, Parent	6 weeks (weekly 1-h sessions)	Parent	Child
Mendez & Belendez, 1997	Diabetes	Multi-component	Exp. vs. control	37	51/49		Psychologists	Child, Parent	12 sessions (24 h total)	Adolescent	Adolescent
Satin, La Greca, Zigo, & Skyler, 1989	Diabetes	Behavioral	Pre–Post	21; 20	62.5/37.5		Psychologist, social worker, nurse practitioner	Child, Parent	6 weeks (6 1.5-h sessions)	Parent	Child
Wysocki, Green, & Huxtable, 1989	Diabetes	Technology-based	Exp. vs. control (2 treatments)	30			Nurse, physician	Child	16 weeks	Child	Child

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Table I. Continued

Author	Disease	Type of intervention	Effect size comparison	Total sample used	Percent female/ percent male	Ethnicity total	Who implemented intervention	Involved in intervention	Number of sessions	Rater of adherence	Whose behaviors were adherent
Wysocki et al., 2000	Diabetes	Multi-component	RCT; Exp. vs. control (one exp. and 2 controls)	76; 74	58/42	78–80% W; 17–22% AA	Licensed psychologists	Child, Parent	3 months (10 sessions)		Child
Magrab & Papadopoulou, 1977	Hemodialysis	Behavioral	Pre–Post; ABA	4	50/50		Dietician, psychologist, unit staff	Child	4 weeks (12–18 dialysis sessions)	Unit staff	Child
Greenan-Fowler, Powell, & Varni, 1987	Hemophilia	Behavioral	Pre–Post	8			Two physical therapists, college student	Child, Parent	Weekly (12 sessions)	Child	Child
Ellis, Naar-King, Cunningham, & Secord, 2006	HIV	Multi-component	Pre–Post	18	38/62	11% W; 84% AA; 5% Other	Mental health specialists, master's level social workers or psychologists	Child, Parent	6.9 months (46 sessions)	Parent	Child
Stark et al., 2005a	IBD	Multi-component	RCT; Exp. vs. control	32	47/53	81–88% W	Ph.D. psychologist, postdoctoral fellow, 2 RAs	Child, Parent	8 weeks (6 1-h sessions)	Parent	Child
Rapoff et al., 2002	JRA	Multi-component	RCT; Exp. vs. control	34	68/32	94% W	Nurse	Child, Parent	12 months (1 30-min session; phone call biweekly for 2 months; monthly for 10 months)	Electronic device	Child
Stark et al., 2005b	JRA	Multi-component	RCT; Pre–Post and Exp. vs. control	49	68/32	92–96% W	Ph.D. psychologist, postdoctoral fellow, RA	Child, Parent	8 weeks (6 1–1.5 h sessions)	Parent	Child

Ebbeling, Leidig, Sinclair, Hangen, & Ludwig, 2003	Obesity	Multi-component	RCT; Exp. vs. control	14	69/31	81.25% W; 18.75% non-W		Child	6 months (12 sessions); 6-month follow-up (including two sessions)	Child	Child
Sondike, Copperman, & Jacobson, 2003	Obesity	Educational	RCT; Exp. vs. control (two active treatments)	22			Dietician	Child	12 weeks	Child, Parent	Child
Singh, Kable, Guerrero, Sullivan, & Elsas, 2000	PKU	Educational	Pre–Post	13	100/0	92.3% W	Nutritionist, pediatric psychologist	Child	1 week	Blood work analysis	Child
Shope, 1980	Seizure disorders	Educational	Pre–Post and Exp. vs. control	51			Clinical social worker	Parent	2 1.5-h sessions	Serum levels	Parent
Berkovitch et al., 1998	Sickle Cell Disease	Multi-component	RCT; Exp. vs. control	20; 13			Social Worker	Parent	1 session; weekly phone calls for 8 weeks	Electronic device	Family
Hovell et al., 2003	Tuberculosis	Multi-component	Exp. vs. control	286	44/56	Mostly H or bicultural (86%)	Bilingual college student coaches	Child	6 months (12 sessions; 5 30-min sessions; 7 15-min phone sessions)	Recall/urine assay	Adolescent

W, White; AA, African-American; H, Hispanic; RCT, randomized controlled trial; RA, Research Assistant; Exp., experimental group; ABA, applied behavior analysis; CF, cystic fibrosis; HIV, human immunodeficiency virus; IBD, inflammatory bowel disease; JRA, juvenile rheumatoid arthritis; PKU, phenylketonuria.

Table II. Categorization of Treatments from Included Studies

Educational interventions
Educational/instructional
Family educational
Audiovisual instruction
Self-management education
Dietary/dietary education/nutrition education
School (educators) education
General practitioner assessment and feedback
Behavioral interventions
Behavioral
Behavior physical therapy
Problem-solving
Behavioral and problem-solving
Behavioral with stress management training
Biofeedback
Family focused problem-solving
Family behavioral
Parent training
Multi-component interventions
Social and educational training
Behavioral and social skills training
Behavioral and educational
Behavioral and nutrition education
Multisystemic therapy
Self-management education with relaxation training
Telephone based follow-up, psychosocial support, and education
Education and exercise
Behavioral, educational and peer-support
Family educational and behavioral training
Family therapy and behavioral training
Psychosocial interventions
Inpatient family-focused (with education component)
Special crisis intervention component of regular therapy
Family Focused/teamwork around diabetes control
Technology-based interventions
Computer assistance (with behavioral and educational components)
Asthma specific computer/video/interactive educ. communicative game Meter
Educational-video game

Intervention Characteristics

Table II details the categorization of interventions from the included studies. Thirty-four (48.6%) were multicomponent in nature; $n = 18$ (25.7%) were educational or instructional; $n = 7$ (10.0%) were behavioral based; and another $n = 7$ (10.0%) were technology based. Finally, $n = 4$ (5.7%) were psychosocial based.

Intervention Format and Participants

Sixty-three studies provided enough data to discern the format of the intervention: of these, 52.4% included groups, 39.7% were individual based, and the remainder included both group and individual components. With respect to participants in the interventions, data could be ascertained for $n = 67$ studies (Table I); of these, $n = 43$ (64.2%) included both parents and children; $n = 16$ (23.9%) included only children; $n = 5$ (7.5%) included only the parents; and $n = 3$ (4.5%) studies included the child, parents, and either multiple family members or broader community agents (e.g., school).

Characteristics of Interventionists

Fifty-five studies provided sufficient information to discern who implemented the intervention. About half ($n = 27$; 49.1%) included multiple interventionists across different disciplines (mental health professionals, physicians, nurses, research assistants, and school personnel), while mental health professionals (e.g., licensed psychologists, social workers, therapists, and postdoctoral psychology fellows) implemented the intervention in $n = 13$ (23.6%) studies. The remaining 15 studies included physicians, nurses, dieticians, research assistants, college students, and management personnel as the primary interventionists.

Duration and Intensity of Interventions

Sixty-nine studies reported meaningful information regarding the duration and intensity of the implemented interventions. There was a range of 1–63 intervention sessions/units, with an average of about nine ($M = 9.1$, $SD = 11.0$) sessions. There were a total of 67 studies that reported information on the raters of adherence. Ratings of treatment adherence were predominantly completed by parents ($n = 26$; 38.8%), children/adolescents ($n = 17$; 25.4%), or both parents and youth ($n = 11$; 16.4%). The remainder of the studies utilized ratings from psychologists or medical personnel ($n = 4$; 6%), an electronic device (not dependent on either child or parent ($n = 2$; 3%), blood work analyses ($n = 2$; 3%), teachers ($n = 1$; 1.5%), an ''outsider'' ($n = 1$; 1.5%), pharmacy records and parent ($n = 1$; 1.5%), urine assay ($n = 1$; 1.5%), and combined electronic device and child report ($n = 1$; 1.5%).

Interventions were of varying lengths and the mean length of time for posttreatment assessments occurred at 7 months ($M = 6.98$, $SD = 12.57$). Follow-up data were defined as any data collected subsequent to both the termination of the adherence-promoting intervention and the completion of posttreatment assessment (i.e., any data collected after the first postintervention point). Sixteen studies (providing 18 effect sizes) contained interpretable follow-up data, with a range of 3–13 months

Table III. Summary of Mean Effect Sizes

	Number of effect sizes	Mean weighted-effect size	95% Confidence interval	*Q*
All adherence effects	90	0.34	0.30–0.38	381.78****
Intervention type				
Educational/instructional	23	0.16	0.10–0.22	128.94****
Behavioral	10	0.54	0.34–0.73	25.08***
Multi-component	46	0.51	0.45–0.57	125.32****
Psychosocial	4	0.44	0.23–0.65	1.49
Technology-based	7	0.08	−0.09–0.25	19.17***
Disorder				
Asthma	37	0.23	0.18–0.28	200.64****
Diabetes	24	0.38	0.30–0.46	44.97***
CF	13	0.74	0.60–0.88	29.03**
Miscellaneous	16	0.54	0.41–0.67	45.20****
Adherence outcome				
Overall	3	0.18	−0.02–0.38	0.49
Medication	30	0.21	0.14–0.28	167.24****
Dietary	19	0.47	0.36–0.58	61.51****
Exercise/environmental/behavioral changes	6	0.47	0.31–0.63	27.33****
Management behavior	19	0.52	0.44–0.60	38.48***
Percentage participants changing adherence behaviors	13	0.23	0.13–0.33	37.25**
Methodological design				
Pre–post	30	0.42	0.36–0.48	223.08****
Experimental vs. control	54	0.23	0.17–0.29	122.78****
Both	6	0.65	0.44–0.86	5.80
Follow-up	18	0.44	0.32–0.56	35.70**

****p <.0001; ***p <.005; **p <.01.

Ninety weighted effect sizes (culled from a total of 70 studies) were used in the primary analyses of adherence outcomes. Both refers to pre–post and experimental vs. control designs. Follow-up data were defined as any data collected subsequent to both the termination of the adherence-promoting interventions as well as the completion of posttreatment assessments (i.e., any).

($M = 6.94$, $SD = 3.72$) subsequent to the initial posttreatment assessment.

Adherence Outcomes

The weighted-mean effect across all of the adherence outcomes was in the small range [mean d =.34, 95% confidence interval (CI) = 0.30–0.38, $n = 90$]. However, there was a significant amount of heterogeneity across all adherence outcomes variables ($Q = 381.78$, p <.0001; see Table III). Due to this significant heterogeneity, the authors investigated several hypothesized potential moderators of the effect size, including type of intervention, type of treatment outcome, type of disorder, and study design. Weighted-mean effect sizes and Q statistics of heterogeneity are presented for potential moderators of adherence behaviors in Table III.

Type of Intervention

Effect sizes for interventions were variable and ranged from the medium magnitude for the behavioral (mean d =.54, 95% CI = 0.34–0.73, $n = 10$) and multi-component interventions (mean d =.51, 95% CI = 0.45–0.57, $n = 46$), small to medium range for the psychosocial interventions (mean d = .44, 95% CI = 0.23–0.65, $n = 4$), and small for the educational/instructional interventions (mean d = .16, 95% CI = 0.10–0.22, $n = 23$). The effect size for technology-based interventions was not significantly different than zero (mean d = .08, 95% CI = −0.09–0.25, $n = 7$).

Type of Adherence Outcome

With respect to adherence outcomes by domain, self-management and self-care behaviors (mean d = .52, 95% CI = 0.44–0.60, $n = 19$), dietary change (mean d = .47, 95% CI = 0.36–0.58, $n = 19$), and exercise-environmental changes (mean d = .47, 95% CI = 0.31–0.63, $n = 6$) produced effect sizes within the medium magnitude range. Medication adherence and the percentage of participants changing adherence behaviors resulted in small effect sizes (around a mean d = .2). The mean effect

size for overall adherence with treatment regimen (mean $d = .18$, 95% CI = −0.02–0.38, $n = 2$) was not significantly different than zero.

Type of Disorder

With respect to disorder type, CF exhibited a medium to large effect size (mean $d = .74$, 95% CI = 0.60–0.88, $n = 13$), while miscellaneous disorders displayed a medium effect (mean $d = .54$, 95% CI = 0.41–0.67, $n = 16$) with adherence outcomes. Diabetes exhibited an effect in the small to medium range (mean $d = .38$, 95% CI = 0.30–0.46, $n = 24$) and asthma displayed a small effect size (mean $d = .23$, 95% CI = 0.18–0.28, $n = 37$).

Study Design

Study design characteristics generally displayed effects in the medium to large range for studies that consisted of both pre–post and experimental versus control group designs (mean $d = .65$, 95% CI = 0.44–0.86, $n = 6$) and in the small to medium range for pre–post designs (mean $d = .42$, 95% CI = 0.36–0.48, $n = 30$). Experimental versus control group comparisons (mean $d = .23$, 95% CI = 0.17–0.29, $n = 54$) displayed small effects. Follow-up data displayed a mean effect size close to the medium range (mean $d = .44$, 95% CI = 0.32–0.56, $n = 18$).[3] In addition, the authors generated a classification scheme that parsed the follow-up data by length of follow-up time. We created cutpoints at intervals of 0–6 months (mean $d = .63$, 95% CI = 0.46–0.80, $n = 9$), 7–12 months (mean $d = .24$, 95% CI = 0.06–0.42, $n = 8$) and >12 months (mean $d = -.50$, 95% CI = −1.15–0.15, $n = 1$). The results indicated that intervention effects were more robust when they were measured within short follow-up periods relative to the termination of the intervention, and analyses also revealed a trend for the intervention effects on adherence to diminish over time.

Exploratory Analyses of Moderators

The authors conducted exploratory analyses of variance, in order to investigate potential moderators of adherence behaviors ($Q = 507$, $p < .0001$; Table III). The overall *F*-statistic was significant for study design [$F(2,84) = 5.59$, $p < .01$], type of disorder [$F(3,86) = 2.81$, $p < .05$], and type of intervention [$F(4,85) = 3.01$, $p < .05$], but not for type of adherence outcome [$F(5,84) = .64$, *ns*]. Five particularly interesting results are noteworthy. First, with respect to study design, pre–post designs demonstrated significantly higher mean adherence differences than experimental versus control designs ($p < .05$). Second, behavioral interventions exhibited significantly higher mean adherence effects than educational/instructional interventions ($p < .05$).

Third, experimental versus control group designs significantly interacted with intervention type [$F(4,49) = 3.15$, $p < .05$]. Specifically, with these types of designs, both behavioral and multi-component interventions produced higher mean adherence effects than did educational/instructional interventions (both *p*'s $< .05$, respectively). Fourth, pre–post designs significantly interacted with type of disorder [$F(3,26) = 4.85$, $p < .01$]. Studies involving participants with miscellaneous disorders exhibited higher mean adherence effects than the asthma group ($p < .05$) and there were trends ($p < .1$) for participants with CF (as compared to asthma) and miscellaneous disorder (as compared to diabetes) to exhibit higher mean adherence effects. These results suggest that studies utilizing pre–post designs that involve CF or miscellaneous disorder populations might report particularly high and possibly spurious mean effects given the limitations of pre–post designs. Fifth, adherence outcome, and specifically dietary changes, interacted with type of disorder [$F(2,16) = 3.88$, $p < .05$], such that higher dietary adherence rates were found among youth with CF as compared to those with diabetes ($p < .05$).

Fail-Safe *N* Calculation

In order to address potential publication bias, specifically the file-drawer problem, the authors calculated a fail-safe *N*-statistic. The significance of the overall weighted-mean effect size for adherence (mean $d = .34$, 95 CI = 0.30–0.38) is unlikely to be a result of publication bias as 522 studies with null results would be needed to reduce the mean effect size to $d = .05$, a negligible effect (Orwin, 1983).

Discussion

To our knowledge, this article is the first meta-analytic review of psychological interventions promoting adherence to treatments among various pediatric chronic health conditions. Several interesting results emerged from the current study. First, across various pediatric chronic health conditions, multi-component and behavioral interventions produced particularly marked effects on adherence behaviors. These findings are consistent with the results of other reviews of empirically supported

[3]For the follow-up analyses, it should be noted that one study (Stark et al., 1990) was removed from the analyses as it was a clear outlier, exhibiting a $d = 9.97$, based on a follow-up pre-post sample of $n = 3$.

treatments for regimen adherence (Lemanek et al., 2001), which have supported the relative effectiveness and potency of various behavioral and multi-component interventions, at least in the short term. Although psychosocial interventions also exhibited effects in the small to medium range, it is difficult to make conclusive decisions due to the small number of studies ($n = 4$) upon which they were based. Educational interventions appeared to produce negligible shifts in adherence behaviors. In light of the available evidence, the clinical implication or ''take-home message'' of such findings is that psychologists working to promote adherence to treatments among children with chronic health conditions should utilize behavioral and/or multi-component interventions in clinical care to target behavioral change and improve adherence behaviors.

Second, follow-up data displayed a mean adherence effect size between the small and medium range. This is the first study that has collectively examined follow-up data across several pediatric chronic health conditions. Additional analyses revealed that intervention effects were more robust when measured within short follow-up periods relative to the postintervention. Intuitively enough, the intervention effects for adherence demonstrated a trend to diminish over time, which is consistent with other research findings that psychological treatment effects become diluted over time in child and adult populations (Cooper, Murray, Wilson, & Romaniuk, 2003; Epstein, Valoski, Kalarchian, & McCurley, 1995). The fact that the intervention effects diminished over time also has important clinical implications, in that it might not be realistic to expect a one-shot bolus of an adherence-promoting intervention to have long and lasting effects. Rather, interventions targeting adherence might need to be an ongoing part of the clinical management of a pediatric chronic illness. It is important to note, however, that <25% (or $n = 16$) of the included studies presented relevant follow-up data and the included studies were often based on relatively small samples, which did not involve follow-up periods longer than 13 months. Thus, these data should be interpreted cautiously.

Third, the mean adherence effect sizes for study design type (experimental vs. control group and pre–post designs) suggested a possible pattern of higher effect size data among studies with pre–post comparisons and/or designs that included both pre–post and experimental versus control comparisons. However, it is important to note that there was significant heterogeneity between the control groups utilized in the between-group comparisons, as they ranged from active treatment groups to those receiving no intervention. Adherence effects emerging from studies utilizing an active control or comparison group are particularly noteworthy, as their standard of comparison is more rigorous than uncontrolled, within-group pre–post designs that exhibited larger magnitudes of effects across several domains.

Apart from the findings of the meta-analysis, one conspicuous methodological issue noted in the undertaking of this review was the lack of consistency and uniformity in measuring and reporting important information related to outcomes and interventions. Many studies did not report relevant psychometric information related to the adherence measures. Few studies reported ratings of treatment fidelity and there was an omission of data related to the natural history of the chronic conditions (e.g., duration and severity of disease, age at diagnosis) and other pertinent demographic variables (e.g., gender, ethnicity).

This review needs to be interpreted in light of several limitations. Certain illnesses, such as asthma, comprised a disproportionate amount of the studies reviewed. In addition, it is possible that null findings not reported in the literature might limit the generalizability of the findings from this review. However, this is unlikely to be a significant issue, as the fail-safe *n*-calculations indicated that 522 studies with null results would be needed to reduce the mean effect size to $d = .05$, a negligible effect (Orwin, 1983). Finally, and perhaps most importantly, are the limitations of summarizing studies by one particular characteristic (e.g., type of adherence outcome) when such characteristics are likely confounded with others (e.g., type of disorder). For example, the CF studies tended to yield the largest mean effects, but these studies also tended to emphasize very particular adherence outcomes, such as nutrition/dietary issues and parent management behaviors (parent training, for example). Indeed, results from the exploratory analyses indicated that studies utilizing pre–post designs involving dietary outcome and/or CF populations reported particularly high and possibly spurious mean adherence effects. In this case, type of study design (pre–post) interacted with both adherence outcome (dietary) and disorder (CF). In order to avoid making overly broad conclusions about disease-specific adherence outcomes, the results of this study and future work clearly need to be interpreted in light of moderators that are confounded with each other.

Based on the findings from this review, the authors provide the following recommendations to advance research concerning adherence-promoting interventions.

First, future research should focus on conducting dismantling studies of behavioral and multi-component interventions, in order to hone in on the active and effective components as well as the underlying mechanisms of the implemented interventions. The inclusion of psychosocial interventions in a greater number of future studies would help to further evaluate their potential efficacy in promoting adherence. Second, future work needs to more systematically conduct longitudinal follow-up studies for longer periods of time, in order to both accurately track the trajectory of the potential effects (and most notably adherence outcomes) of the implemented interventions and to assess the extent to which the intervention continues to be used by families during the follow-up period. Third, RCTs should be implemented whenever feasible. When this is not an option, experimental verses control group designs should be chosen over a within-group design (of an experimental group) to the extent that they are possible. This design methodology allows for a more accurate evaluation of the efficacy and/or effectiveness of an adherence-promoting intervention than within-group pre–post designs. Indeed, weaker research designs can be associated with larger effect sizes (Garrett, 1985), a finding which is supported in the current study. Similarly, although there are several elegant single-*n* design and/or case studies (Rapoff, 1999), they too can suffer from these artifacts and likely do not substantively contribute to the computation of effect sizes across aggregated data. However, we endorse the use of single-*n* designs and case studies in an inductive fashion, and in using them as models and foundations for conceptually driven larger adherence trials.

Fourth, although not examined in the current article because of a lack of a priori hypotheses, future work should further examine and develop models for the interactions between important variables, such as design type and types of adherence outcome, disorders, and interventions. Indeed, recent work which combined both adult and child populations has suggested that adherence is significantly higher in studies involving medication regimens and HIV and gastrointestinal disorders (DiMatteo, 2004). Fifth, and consistent with other recent reviews (Beale, 2006), future studies should report pertinent information regarding the implemented adherence-promoting intervention, including psychometric information on relevant adherence measures, baseline adherence behaviors, and treatment fidelity and integrity ratings. Stark et al. (2005a) and Wysocki et al. (2006) provide two models of such comprehensive reporting. Similarly, with respect to methods that enhance meta-analysis evaluation, studies that utilize within-group comparisons should report the paired *t*-test value, standard error of the differences between means, and/or correlation between pre- and post-intervention of a particular adherence measure.

Sixth, in order to increase the generalizability of adherence-promoting interventions, illness groups need to be better described. Much of the extant work has included studies which often combine youth with varied presentations of illness, ranging from severe to mild illness severity. However, adherence may vary by objectively poorer health (more compromised health status) or conditions higher in seriousness (DiMatteo, Haskard, & Williams, 2007). Seventh, adherence trials should include more racially diverse populations of chronically ill youth. Prior research has demonstrated very limited racial and SES heterogeneity across empirically supported treatments in pediatric psychology (Clay, Mordhorst, & Lehn, 2002). Increasing the racial and SES heterogeneity of the pediatric populations used in many of the adherence-promoting trials would expand the ecological validity, and hence the generalizability and relevance of research findings to more diverse populations. Finally, in the absence of a gold-standard uniform measure of adherence for pediatric conditions, detailed and specific information about the operational definitions of adherence, either conceptually or empirically, within each study is critical.

Supplementary Data

Supplementary Data are available at *JPEPSY* Online.

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Studies included in the meta-analysis are marked with asterisks.