A Systematic Review of Internet-based Self-Management Interventions for Youth with Health Conditions

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Objective Critically appraise research evidence on effectiveness of internet self-management interventions on health outcomes in youth with health conditions.

Methods Published studies of internet interventions in youth with health conditions were evaluated. Electronic searches were conducted in EBM Reviews-Cochrane Central Register of Controlled Trials, Medline, EMBASE, CINAHL and PsychINFO. Two reviewers independently selected articles for review and assessed methodological quality. Of 29 published articles on internet interventions; only nine met the inclusion criteria and were included in analysis.

Results While outcomes varied greatly between studies, symptoms improved in internet interventions compared to control conditions in seven of nine studies. There was conflicting evidence regarding disease-specific knowledge and quality of life, and evidence was limited regarding decreases in health care utilization.

Conclusions There are the beginnings of an evidence base that self-management interventions delivered via the internet improve selected outcomes in certain childhood illnesses.

Key words adolescent; child; chronic illness; internet; self-management.

It is estimated that 15–20% of children and adolescents have significant ongoing health care needs related to a subacute or chronic (lasting more than 3 months) health condition (Newacheck et al., 1998). Chronic illness in childhood can negatively impact all aspects of quality of life (QOL) (Wallander & Varni, 1998; Yeo & Sawyer, 2005). Disease course can be unpredictable and children commonly experience a myriad of symptoms that may restrict physical and social interactions. Disease management is often complex, involving diverse and multiple therapies and requires constant monitoring. Older school-aged children and adolescents are expected to assume greater responsibility for disease management than when they were younger due to their growing independence and autonomy (Sawyer & Aroni, 2005). However, adherence to disease management activities is less than optimal (Fiese & Everhart, 2006; Yeo & Sawyer, 2005). Poor adherence and inappropriate self-management behaviors may reduce the potential benefits of treatment. Furthermore, the vast majority of adolescents do not receive comprehensive disease education linked with self-management therapy due to (a) difficulty accessing these services (e.g., long-wait times), (b) limited availability of trained professionals (e.g., psychologists) especially in rural areas, and (c) costs (e.g., time off work) associated with these therapies (Barlow & Ellard, 2004). Enhanced disease awareness and greater self-management may prevent or diminish illness exacerbation and associated adverse health outcomes.

Self management can be defined as “the individual’s ability to manage the symptoms, treatment, physical and psychological consequences and lifestyle changes inherent in living with a chronic illness” (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002). Self-management interventions typically encompass information-based material and cognitive and/or behavioral strategies designed to increase participants’ knowledge, self-efficacy and use of self-management behaviors (Barlow et al., 2002; Sawyer &
Aroni, 2005). Studies in both adult (Barlow et al., 2002; Krishna, Balas, Spencer, Griffin, & Boren, 1997; Marks & Allegranite, 2005; Murray, Burns, See, Lai, & Nazareth, 2005), and pediatric chronic illness (Barlow & Ellard, 2004; Elgar & McGrath, 2003; Last, Stam, Onland-van Nieuwenhuizen, & Groothuis, 2007) have shown that comprehensive interactive interventions that augment medical treatments with self-management lead to better health outcomes and improved QOL than care that is strictly medically focused. Self-management interventions are meant to augment and not replace the information and support provided by health care professionals.

e-Health technologies offer an innovative approach to improving the health service delivery and acceptability of self-management interventions for youth with health conditions. Murray and colleagues (2005) conducted a Cochrane review of Interactive Health Communication Applications (IHCA), which are computer-based interventions that encompass health information plus at least one of the following: social support, decision-making support, and/or behavior change support. The most common mode of delivering IHCA is the internet; however, they can also take the form of CD-ROMs, telehealth, personal digital assistants, or computer games. Internet interventions are treatments based on effective face-to-face interventions (e.g., cognitive–behavioral therapies) that are operationalized and transformed for delivery via the internet with the goal of symptom improvement. Usually they are highly structured, self-guided or partly self-guided (i.e., use of therapist or health coach), tailored to the user’s needs, and are interactive. Interactivity is enhanced by graphics, animations, audio and video clips, as well as interactive and continuous self-monitoring (diaries), information exchange (chat rooms), follow-up and feedback (e.g., decision-making support through emails) (Ritterband et al., 2003b).

The literature on internet interventions is rapidly growing with studies on the feasibility and utility, as well as some evidence of their efficacy and effectiveness in improving symptom management (Cuijpers, van Straten, & Andersson, 2008; Murray et al., 2005; Wantland, Portillo, Holzemer, Slaughter, & McGhee, 2004). Murray and colleagues (2005) in their Cochrane review of IHCA found they had largely positive effects on end-users in terms of being more knowledgeable and feeling more socially supported and that they may improve behavioral and clinical outcomes as well as self-efficacy compared to non-users. However, they were not able to determine their effect on emotional and economic outcomes (Murray et al., 2005). While the internet has emerged as one of this age group’s main health information sources (Gray, Klein, Noyce, Sesselberg, & Cantrill, 2005), few self-administered multimedia internet programs for youth with health conditions have been developed and validated compared to those that exist for adults (Murray et al., 2005).

This article is a report of a systematic review on internet-based interventions to promote self-management in youth with health conditions. More specifically, in this article we will: (a) describe the internet programs, (b) describe study designs and evaluation methods, (c) summarize their findings in terms of efficacy and effectiveness of the internet interventions, (d) determine their methodological quality, and (e) recommend future direction in the development and testing of internet-based interventions.

**Methods**

**Data Sources**

Electronic searches were conducted by a Library Information Specialist (CN) familiar with the field. The EBM Reviews—Cochrane Central Register of Controlled Trials (First Quarter 2008), Medline (1950–January Week 5, 2008), EMBASE (1980–January Week 5, 2008), CINAHL (1982–December 2007), and PsychINFO (1967–January Week 5, 2008) were searched. Subject headings and MeSH terms included “chronic illness,” “chronic mental illness,” “computer assisted instruction,” “electronic communication,” “computer software,” “internet,” and “web-based.” Other keywords such as “self-care skills,” “health education,” “health knowledge,” “health behavior,” “disease management,” and “self-help techniques” were used to search for the ideal publication type. We also included a broad list of common pediatric chronic illnesses as search engines rarely index papers using generic terms such as chronic condition or disability. All search titles and abstracts were independently rated for relevance by two reviewers (J.S., R.W.). There was 100% agreement on the selected review articles. Reference lists from all identified appropriate papers and review papers were examined and then hand searched for additional relevant studies. No attempt was made to locate unpublished material or contact researchers for unpublished studies (e.g., dissertations or conference proceeding abstracts).

**Study Selection**

To be eligible, articles had to meet the following criteria:

(1) The articles had been published in a peer-reviewed journal during the past 15 years (1993–2008).
The intervention targeted school aged children (6–12 years) and/or adolescents (13–18 years) with subacute or chronic health conditions.

The study evaluated an internet-based or enabled self-management intervention. We excluded studies that involved other forms of IHCAs including handheld computers, video or telehealth programs, CD-ROMs, and video games as it may be difficult to compare outcomes across these different modalities and they vary in their degree of interactivity.

The evaluation examined outcomes based on the potential benefits of internet-based IHCAs including: effects on patients in terms of knowledge, social support, self-efficacy, emotions and health behaviors; health outcomes; QOL; and resource utilization (Murray et al., 2005).

The study was a randomized controlled trial (RCT), quasi-randomized trial, before-and-after design or feasibility RCT study. Given the dearth of research in this area, we broadened the typical inclusion criteria for systematic reviews beyond RCTs to avoid missing important or significant data that would inform the development of this rapidly expanding field of clinical research.

The article was published in English due to additional costs related to translation.

**Review Process**

Two of the authors (J.S., R.W.) examined each computer search to identify potentially eligible articles using the inclusion criteria outlined above. They based their initial judgment on titles and abstracts; subsequently, all articles meeting the criteria were reviewed and eligibility was determined by consensus of all authors.

**Data Extraction**

A systematic approach to data extraction was used to produce a descriptive summary of participants, interventions and study findings (see Tables I and II). The first reviewer (R.W.) independently extracted the year of publication, journal of publication, study participants, study focus (e.g., type of internet intervention) and main results from each study. Detailed data on the intervention (e.g., treatment fidelity) and control groups were extracted as well as whether a theory or conceptual framework was used to guide the development and evaluation of the intervention. Summaries of the main results regarding effects on self-management outcomes were based on the text in the original manuscript, and focused on quantitative summaries when available. A second reviewer (J.S.) checked the data extraction. When data were missing from a study, no attempt was made to contact authors for additional information and we limited our review to the material included in the peer-reviewed articles.

**Methodology Quality**

There are few validated tools available to rate the methodological quality of RCTs, especially non-pharmacological trials. We chose to use the CONSORT (Consolidated Standards of Reporting Trials) checklist which has recently been extended for trials of non-pharmacological treatments (Boutron, Moher, Altman, Schulz, & Ravaud, 2008a,b). The CONSORT statement was developed to improve the quality of reporting of clinical trials (Moher, Schulz, & Altman, 2001) and has more recently been used to rate the methodological quality of randomized controlled trials (Stinson, McGrath, & Yamada, 2003). A copy of the checklist can be found at http://www.consort-statement.org/. The checklist has 23-items and we arbitrarily (23items/3) assigned a score of <8 as poor quality, 9–16 as fair, and a score of >17 indicating good methodological quality. Two reviewers independently assessed the methodological quality of each study using this quality assessment measure (J.S., J.H.). All papers were blinded to the names of the authors, institutions and journals. There was 91% agreement between the two reviewers. Any disagreements in ratings were resolved by consensus.

**Data Synthesis**

We initially attempted to report on effects in terms of standardized mean difference (SMD) and confidence intervals. However, given the heterogeneity of outcomes measures used across the studies, the author’s main qualitative conclusions were reported instead.

**Results**

A total of 806 articles were identified from the electronic searches. One hundred and seven articles were removed after accounting for duplicates, leaving 699 articles for further consideration. Of these, 673 articles were removed as they were general or review articles or other non-internet based IHCAs interventions (5 = CD-ROMs, 7 = gaming, 2 = telehealth for symptom monitoring, and 1 = chat room for social support). From the 29 remaining internet-based studies, a further 11 were excluded as they were not targeting the population of interest, 1 internet intervention provided only social support, and 8 were excluded for design reasons leaving 9 studies (7 RCTs, 1 pilot RCT, and 1 quasi-experimental study) for
<table>
<thead>
<tr>
<th>References, Country</th>
<th>Participants (number, sex, age group, recruitment)</th>
<th>Health condition</th>
<th>Study design</th>
<th>Intervention</th>
<th>Comparison Group</th>
<th>Methodological quality rating&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Timing of outcome assessment</th>
<th>Outcomes measured</th>
<th>Effect&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Dropouts (%)</th>
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<tbody>
<tr>
<td>(1) Chan et al. (2007), China</td>
<td>120 youth F = 45; M = 75 6–17 years Community</td>
<td>Persistent asthma</td>
<td>RCT</td>
<td>In-home Internet-based telemedicine system for symptom monitoring, education and case management (three virtual and three clinic visits) (60)</td>
<td>Traditional office-based in-person education and case management (6 clinic visits) (60)</td>
<td>14</td>
<td>Baseline, 2, 6 12, 26 and 52 weeks</td>
<td>Diagnostic Adherence • Symptom diary + • Assessment peak + Flow technique Disease control 0 • LFT 0 • PEF 0 • QOL 0 • Utilization of services • Rescue therapy use • Asthma knowledge • Symptoms</td>
<td>21.6</td>
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<tr>
<td>(2) Hicks, von Baeyer, and McGrath (2006), Canada</td>
<td>47 youth–parent dyads F = 30; M = 17 9–16 years Community</td>
<td>Recurrent pain/headache</td>
<td>RCT</td>
<td>In-home Internet-based cognitive–behavioral pain treatment program (25)</td>
<td>Standard medical care waitlist (22)</td>
<td>15</td>
<td>Baseline and at 1&lt;sup&gt;st&lt;/sup&gt; and 3&lt;sup&gt;rd&lt;/sup&gt; months posttreatment</td>
<td>Pain • QOL +</td>
<td>28</td>
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<tr>
<td>(3) Jan et al. (2007), USA</td>
<td>164 children F = 101; M = 63 6–12 years Clinical</td>
<td>Persistent asthma</td>
<td>RCT</td>
<td>Blue Angel for Asthma Kids: an Internet-based multimedia asthma education program with interactive asthma tele-monitoring and retrieval analysis system for review of accumulated data on symptoms and PEFR (88)</td>
<td>Traditional asthma education (verbal and written booklet), individualized asthma self-management action plan and asthma symptom diary (76)</td>
<td>16</td>
<td>Baseline and 12 weeks, PEF, symptom diary and pulmonary spirometric tests at 4, 8, and 12 weeks</td>
<td>Disease control • Average weekly + • PEF + • Symptom scores + • Asthma control + Adherence + Asthma knowledge</td>
<td>17</td>
<td></td>
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<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Intervention</td>
<td>Comparison</td>
<td>Measure(s)</td>
<td>Timepoints</td>
<td>Outcomes</td>
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<td>Joseph et al. (2007), USA</td>
<td>314 youth, F = 199; M = 115, 5–19 years School</td>
<td>Mild, persistent asthma symptoms with/without formal diagnosis</td>
<td>School Internet-based, tailored asthma management program and proactive follow-up by healthcare referral coordinator (162)</td>
<td>Regulated browsing of generic asthma education websites controlled by limited security access and time limited (30 minutes) and self-initiated access to healthcare referral coordinator (152)</td>
<td>Baseline, and 12 months postbaseline</td>
<td>Functional status: + Number of symptom days/2 weeks ● Symptom nights/2 weeks ● Days of restricted activity/2 weeks ● Days of restricted activity ● Days school missed/30 days Medical care use: + ED visits/12 months Hospitalizations/12 months QOL</td>
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<td>Krishna et al. (2003), USA</td>
<td>228 children and parents, F = 80; M = 148, 7–17 years Clinical</td>
<td>Asthma</td>
<td>Interactive Multimedia Program for Asthma Control and Tracking (IMPACT): A clinic-based internet-enabled Interactive multimedia CD-ROM self-management education program (121)</td>
<td>Traditional clinic-based patient education (107)</td>
<td>Baseline and 3 and 12 months</td>
<td>Knowledge: + QOL + Disease outcomes: + Health services utilization (ED visits)</td>
<td></td>
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<td>Ritterband et al. (2003*), USA</td>
<td>24 children and parents, F = 5; M = 19, 6–12 years Community</td>
<td>Encopresis</td>
<td>Internet-based enhanced toilet training program that incorporates behavioral therapy and medical management (12)</td>
<td>Usual care (12)</td>
<td>Pretreatment and 3 weeks posttreatment</td>
<td>Bowel habits (# accidents): + Knowledge: 0 Bowel specific problems: 0</td>
<td></td>
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<tr>
<td>Runge, Lechek, Horns, Tews, and Schaefer (2006), Germany</td>
<td>438 youth, F = 5; M = 19, 8–16 years Clinical and community</td>
<td>Asthma</td>
<td>Two intervention groups: (1) Internet-based asthma education program (IEP) in addition to SPMP (146) (2) SPMP—series of 5 standardized educational sessions (127)</td>
<td>Usual care (wait-list control group received intervention at 6 months) (85)</td>
<td>Baseline and 6 and 12 months</td>
<td>Cost-benefit analysis: + 18% in IEP Reduction in asthma-related emergencies: + 63% in SPMP School absenteeism: + Rescue medication use: 0 Lung function: + Health care resource utilization: + QOL</td>
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*Note: RCT = Randomized Controlled Trial, QOL = Quality of Life, ED = Emergency Department, SPMP = Standardized Patient Management Program*
<table>
<thead>
<tr>
<th>References, Country</th>
<th>Participants (number, sex, age group, recruitment)</th>
<th>Health condition</th>
<th>Study design</th>
<th>Intervention (N)</th>
<th>Comparison Group (N)</th>
<th>Methodological quality rating&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Timing of outcome assessment</th>
<th>Outcomes measured</th>
<th>Effect&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Dropouts (%)</th>
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<tr>
<td>(8) Wade, Carey, and Wolfe (2006), USA</td>
<td>40 youth and family &lt;br&gt; F = 17; M = 23 &lt;br&gt; 5–16 years</td>
<td>Moderate or severe traumatic brain injury</td>
<td>RCT</td>
<td>In-home Internet-based cognitive–behavioral family treatment program with weekly/biweekly synchronous videoconferencing and usual therapy (20)</td>
<td>Internet resources comparison (IRC) group receiving usual psychosocial care (24)</td>
<td>15</td>
<td>Baseline and follow-up (timeline not specified)</td>
<td>Child behavior problems &lt;br&gt; Social competence</td>
<td>0</td>
<td>0</td>
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<td>(9) Williamson et al. (2006), USA</td>
<td>40 adolescent–parent dyads &lt;br&gt; F = 40 &lt;br&gt; 11–15 years</td>
<td>Obesity &lt;br&gt; BMI &gt; 85th percentile&lt;sup&gt;b&lt;/sup&gt; &lt;br&gt; BMI &gt; 30&lt;sup&gt;i&lt;/sup&gt;</td>
<td>RCT</td>
<td>In-home Internet-based interactive lifestyle behavior modification program (NR)</td>
<td>Passive non-interactive Internet health education program (links to healthy lifestyle websites) + face-to-face counselling sessions (NR)</td>
<td>11</td>
<td>Baseline and months 6, 12, 18 and 24 during the intervention</td>
<td>Body fat &lt;br&gt; Body weight</td>
<td>+&lt;sup&gt;j&lt;/sup&gt;</td>
<td>17.5</td>
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Note: F, female and M, male. PEF, peak expiratory flow; LFT, lung function test; ED, emergency department; IEP, internet education program; SPMP, standardized patient management program; NR, not reported.

<sup>a</sup> CONSORT Checklist used to rate methodological quality.

<sup>b</sup> +, Effect refers to a statistically significant change in the outcomes measured between groups.

<sup>c</sup> 0, No significant difference in outcomes measured between groups.

<sup>d</sup> Time 2 (T2).

<sup>e</sup> Time 3 (T3).

<sup>f</sup> Difference was statistically significant at T2 and T3.

<sup>g</sup> Difference was statistically significant for IEP compared to control and SPMP groups.

<sup>h</sup> IEP and SPMP compared to control group.

<sup>i</sup> Measure of obesity used for adolescents.

<sup>j</sup> Measure of obesity used for parents.

<sup>k</sup> Difference was only statistically significant at T2 for parents.

<sup>l</sup> Difference was only statistically significant at T2 for adolescents.
<table>
<thead>
<tr>
<th>Article</th>
<th>Content of intervention (plus interactive features)</th>
<th>Contact</th>
<th>Usage</th>
<th>Treatment integrity</th>
<th>Number</th>
<th>Length</th>
<th>Duration</th>
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</table>
| (1) Chan et al. (2007) | ●Web-based interactive asthma education  
●Disease management  
●Asthma in-home monitoring using digital video camera to capture peak flow meter and inhaled medication technique at prescheduled times; videos sent to case manager who provided feedback on technique  
●Web-based daily asthma diary | Regular weekly contact with case manager 2/week for 6 weeks then weekly | Significantly greater diary adherence in internet group (p < .01; however no diary entries were recorded for 60–80% of days. Electronic Peak flow was only one-fourth of that required by protocol) | •NR² for research team (four case managers)  
●Customized participant education and monitoring based on a clinical pathway | 6 | NR² | 52 weeks |
| (2) Hicks et al. (2006) | ●Symptom tracking, identifying triggers, and overview of pain reduction methods  
●Information on headaches, goal setting, deep breathing  
●Physical pain management methods  
●Relaxation strategies (plus personalized relaxation tape)  
●Cognitive strategies (changing negative thinking) including thought journal  
●Healthy lifestyle choices  
●Developing plan to manage pain, recognize progress, and managing the program  
●Two chapters for parents on promoting healthy behavior  
●Paper or online pain diary (participant choice) | Email contact (5 times) + telephone contact (3 times) | NR | •NR² for research team  
●Standardized web-based material  
●Standardize schedule for email/phone contact | 7 | One chapter per week | 7 weeks |
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<tr>
<th>Article</th>
<th>Contact</th>
<th>Usage</th>
<th>Treatment integrity</th>
<th>Lessons/sessions</th>
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<tr>
<td>(3) Jan et al. (2007)</td>
<td>MD feedback regarding changes in medications via email or telephone based on symptoms as needed</td>
<td>Diary adherence was significantly higher in internet group but declined over time in both groups</td>
<td>NR° for research team</td>
<td>NR° NR° 12 weeks</td>
</tr>
<tr>
<td>(4) Joseph et al. (2007)</td>
<td>Proactive contact by referral coordinator as needed</td>
<td>Internet students more likely to complete all four sessions compared to control group</td>
<td>NR° for research team</td>
<td>4 Estimated time to complete each session was 30 minutes 180 days post baseline</td>
</tr>
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<td>(5) Krishna et al. (2003)</td>
<td>NR</td>
<td>40–100% of parents completed three sessions; while 7- to 17-year olds who completed visit 3 had mastered 48–100% of material and completed 58% or more of the program</td>
<td>NR° for research team</td>
<td>44 Entire program can be completed in 80 minutes; varied based on duration of clinic visit 12 months</td>
</tr>
<tr>
<td>(6) Ritterband et al. (2003°)</td>
<td>Contacted 3 times to answer questions regarding use of site</td>
<td>Site accessed average of 14 times during 3 week period. Two modules were never accessed by participants</td>
<td>NR° for research team</td>
<td>3 plus additional modules based on individual needs 60–90 min to complete core modules; 5–10 min for treatment modules; follow-up sessions completed 1 week after core modules 3 weeks</td>
</tr>
<tr>
<td>Study</td>
<td>Intervention Features</td>
<td>Outcomes</td>
<td>Duration</td>
<td>Notes</td>
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<td>Runge et al. (2006)</td>
<td>Proper use of different inhaler devices, classification of reliever and controller medications, avoidance of asthma triggers, limitation of allergen exposure, peak flow measuring, and its interpretation. IEP. Additional asthma module with quiz. Interactive adventure game. SPMP material. Medical module including individual medication plan, scheduled chats with asthma expert, and on-line peak flow protocol. Chat room.</td>
<td>Ability to communicate with health care providers via email (not scheduled). Logged on an average of 2 h/month. Peak flow protocol, chat room, and adventure game were most widely used.</td>
<td>5 hours</td>
<td>NR²</td>
</tr>
<tr>
<td>Williams-on et al. (2006)</td>
<td>Nutrition education. Counselling. Lifestyle and physical activity. Weight and physical activity graphs. Television self-monitoring. Problem solving. Behavioral contracting. Links to African-American health websites. Links to women’s health websites. Quizzes, goal setting, and food monitoring with feedback via email from counsellor.</td>
<td>Internet counselling via weekly emails + four face-to-face counselling sessions. Website use decreased over time with significant decrease in year 2 compared to year 1.</td>
<td>52</td>
<td>NR²</td>
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*NR² not reported.
The number of sessions. The shortest intervention lasted 3 weeks and the longest was 2 years, with a mean of 36.53 weeks and a standard deviation of 35.93 weeks. Six were solely in-home interventions (Studies: 2, 3, 6–9), while one was a combination of clinic and home-based sessions (Study: 1). In the remaining two studies, participants accessed the intervention at school in one study (Study: 4) and during regular clinic visits in the other (Study: 5). Participants in the control groups in three studies were provided with internet restricted access to general illness specific information in addition to standard medical care (Studies: 4, 8, 9); while two were waitlist control groups (Studies: 2, 7), three provided standard education and medical care (Studies: 1, 3, 5), and one was a usual medical care group (Study: 6).

All of the interventions were psycho-educational in nature, involving combinations of information and skills training modules targeting improved health outcomes. Most skills training embraced self-management skills directed to a variety of issues, including symptom management (recognizing symptoms, how to use medications, avoiding triggers; Studies: 1–9), cognitive restructuring to reduce pain and/or stress (Studies: 2, 5, 6, 8), and promote problem solving/decision-making and healthy lifestyle choices (Studies: 2, 5, 6, 8, 9) as outlined in Table II. Specific therapeutic techniques included cognitive (e.g., changing negative thoughts, positive self-talk) and/or behavioral therapy (e.g., modeling, reinforcement, and self-mastery) and educational modules specific to the illness concerned. Three of the interventions were described as behavioral therapies (Studies: 5, 6, 9), two as Cognitive–Behavioral Therapy (CBT) (Studies: 2, 8), while four interventions did not describe the techniques used in detail (Studies: 1, 3, 4, 7). Parents were included in five of the nine studies as active participants (Studies: 2, 5, 6, 8, 9). One study had specific modules for parents (Study: 2) and in two studies children and parents were asked to complete the sessions together (Studies: 6, 8). Six of the nine studies included electronic symptom monitoring (pain diary, asthma attacks, weight monitoring) as part of the intervention (Studies 1–3, 5, 7, 9). Two studies included chat rooms as part of the intervention (Studies: 7, 8).

One of the benefits of internet-based interventions is that they allow for standardization of the treatment. However, the majority of these interventions also involved the role of a health coach or therapist to help tailor the information and cognitive–behavioral strategies to participant’s individual needs. Very few studies reported the measures that were taken to ensure treatment integrity especially regarding therapist contact. Of those that did, only one elaborated on the training that the interviewers
and therapist received to ensure implementation fidelity (Study: 8). Three studies described the use of a standardized protocol that was followed by the participants in the intervention and control groups (Studies: 1, 2, 6), while one study incorporated the use of specific treatment integrity tests such as checklists or periodic observation by a third party (Study: 8).

Outcomes of Studies

The studies included in this review evaluated a variety of outcome measures as shown in Table I. Improving health outcomes in terms of symptom management or disease control were investigated in all of the studies using a wide variety of outcomes (e.g., symptom free days, use of medications, days of school missed, and activity restrictions). Seven of the nine studies demonstrated significant improvements in health outcomes compared to the control groups (Studies: 2–7, 9). Four of the nine studies examined the effects of treatment on disease related knowledge (Studies: 1, 3, 5, 6); knowledge significantly increased compared to the control group in two studies on asthma (Studies: 3, 5) but not in a third asthma study (Study: 1) and the encopresis study (Study: 6). Six of the nine studies investigated the effect of the treatment on the participants’ QOL (Studies 1–4, 5, 7); two found a significant difference from the control group (Studies: 3, 7).

Four of the nine studies, all involving asthma participants, reported on the use of health care resources (Studies: 1, 4, 5, 7); two studies found significant decreases in utilization of health care resources (i.e., emergency room visits, physician consultations) (Studies: 5, 7), one found significant decreases in emergency room visits, but not hospitalizations (Study: 4), and one found no significant decreases in the utilization of services (Study: 1) compared to control groups. None of the studies measured outcomes on self-efficacy, social support, or emotional well-being. Finally, timing of outcome measurement varied greatly; four studies measured outcomes pre- and post-intervention (Studies: 2, 3, 6, 8), four studies measured outcomes up to 1-year (Studies: 1, 4, 5, 7) and one study assessed durability of treatment outcomes at regular 6-month intervals for 2 years (Study: 9). Interestingly, this study revealed that the significant reductions in weight loss at 6-months postintervention were not maintained over the remaining 2-year follow-up period.

Four studies investigated the cost-effectiveness of the intervention (Studies: 2, 3, 5, 7). However, none evaluated cost-effectiveness from the participants’ perspective (i.e., travel time and/or time off work). Instead, cost-effectiveness was appraised from the perspectives of labor costs, resource utilization, health insurance, and societal costs. In one study, the intervention was estimated to be 5.5 times more cost-effective than the traditional office-based program with respect to resource utilization, specifically the therapist’s time (Study: 2). Krishna and colleagues (2003) found a reduction in emergency room visits resulting from the intervention that translated into a savings of approximately $907.10 per child as opposed to the group receiving solely traditional patient education who only realized a savings of $291.40 per child. One study looking at costs of program delivery found an estimated labor cost of $6.66 per treatment student for a referral co-ordinator as the students were provided access to computers in the school setting (Study: 4). The study whose main focus was the economic implications of an internet-based education program (IEP), found that the cost-benefit ratio improved from 0.55 to 0.79 when adding an IEP to a traditional education program (Study: 7). Runge and colleagues (2006) also observed incremental morbidity cost savings, with cost-benefit ratios of 1.07 and 1.42 for patients with moderate or severe asthma, for standard education and IEP, respectively. Although cost savings did not exceed program costs in the entire study population, the significant decline in morbidity costs indicates that IEPs may yield further cost savings in the long term (Study: 7).

All of the studies reported on the feasibility of the interventions. Most often, feasibility was discussed in terms of treatment efficiency, access and compliance. Two studies reported that the intervention might be more suitable for certain patient populations (Studies: 8, 9). For example, an internet-based cognitive–behavioral program was more effective for older children and those of lower socio-economic status (SES) compared to younger children and those with higher SES in children with traumatic brain injury (Study: 8). In another study, Williamson et al. (2006) argued that internet interventions may overcome obstacles to traditional face-to-face interventions and be considered more feasible for African-Americans. Of the six studies requiring participants to use a home computer, three included internet access as one of their inclusion criteria (Studies: 1–3), and three provided participants with computers and free internet access (Studies: 6, 8, 9). The remaining studies required them to be able to access it either at home, school or in a clinic setting (Studies: 4, 5, 7). Compliance varied greatly across the studies. One of three studies including an electronic diary component showed very poor compliance in both the intervention and control group with no diary entry on 60% of study days (Study: 1). Furthermore, the two studies having a duration of at least 1 year showed a steady
Five of the nine studies reported on the usability of the intervention (Studies: 2, 3, 5, 6, 8). In one study, more than 80% of the children rated the website and videoconferencing as easy to use; however, 25% perceived that the website was not as easy to use when compared to other sites used for health information (Study: 8). Hicks and colleagues (2006) found that participants identified the treatment website as “one of the well-designed aspects of the program” (p. 732). However, with respect to helpfulness, the therapist’s telephone calls were endorsed more frequently than the website. One study measured the participant’s attitude toward computers (i.e. enjoyment, satisfaction and comfort with computers) at baseline; which was found to positively correlate with greater website use for parents in the behavioral group (Study: 9). Finally, few studies reported on the usage of the internet interventions (e.g., session time and site visits).

Methodologic Quality of Studies

Using the 23-item CONSORT statement checklist for non-pharmacological RCTs (Boutron et al., 2008a), the studies methodological quality ranged from a score of 10–16 out of 23 with mean of 13.77 and standard deviation of 2.22 as outlined in Table I. Given that all of the studies fell within the fair quality range it was difficult to determine whether outcomes differed by methodological quality scores. However, it should be noted that the pilot RCT (Study: 6) and the quasi-experimental study design (Study: 7) had lower quality scores than six of the seven RCTs. Two of the nine studies provided precise details on: (a) interventions intended for each group, and how and when they were administered; (b) how the interventions were standardized; (c) details on different components of the intervention and how they were tailored to individual patients; and (d) how adherence of care providers (health coach, therapist) with protocol was assessed or enhanced (Studies: 3, 8). The majority of papers lacked details regarding randomization procedures (Studies: 2, 3, 5, 6, 7, 9). As with many psychological interventions, it usually is not possible for researchers and participants to be blind to the intervention a participant is receiving. Therefore, there is a potential risk of reporting or scoring bias that might mask a real intervention effect. Bias could be minimized by the use of procedures such as blinding of coders or using web-administered questionnaires as was done in two of the studies (Studies: 5, 8). Five of the nine studies did not report sample size calculations (Studies: 2, 4, 6–8). However, five of the nine studies used an intention-to-treat analysis that would indicate how the overall result was affected by participant attrition (Studies: 1, 2, 4, 7, 8). Finally, while monitoring for adverse effects in psychological trials is not common practice, one of the nine studies mentioned the method used to assess for adverse effects in intervention and control groups (Study: 4).

Discussion

This study sought to critically appraise the research evidence on the effectiveness of self-management interventions delivered by the internet for youth with health conditions. In the past 5 years, nine studies using rigorous study designs (eight RCTs and one quasi-experimental) have examined the effectiveness of the internet as a medium for delivering self-management interventions to youth with health conditions. Most of these were published in the past 2 years and it can be expected that the number of trials will continue to grow exponentially. Overall, there is consistent evidence that they lead to improvements in symptom or disease control in four of the five health conditions. However, there is limited evidence regarding their impact on health care utilization (some evidence with asthma), knowledge and quality of life outcomes. We were unable to determine the effectiveness of internet interventions on self-efficacy, social support or emotional well-being.

Several recent systematic reviews have found that internet interventions have been effective in improving symptoms in adults with mental and other chronic health conditions (Cuijpers et al., 2008; Griffiths & Christensen, 2006; Murray et al., 2005; Spek et al., 2007; Wantland et al., 2004); however, the effects appear to differ across target conditions (Cuijpers et al., 2008). For example, Cuijper and colleagues (2008) found that internet interventions targeting pain and headaches were comparable to face-to-face treatments; however, they found that the effectiveness differed across other target populations such as those with chronic health conditions. In contrast to these findings, we found improvements in symptoms in four of the five health conditions. Finally, the studies included in our review did not allow us to draw definite conclusions about whether self-management interventions delivered through the
internet are as effective as face-to-face therapies as most of the studies used usual care or wait-list control comparison groups.

Wantland and colleagues (2004) conducted a systematic review and meta-analysis of 22 studies that compared web-based to non-web-based self-management interventions in adults. They found substantial evidence that use of internet interventions improved behavioral change outcomes in terms of increased exercise time, increased knowledge of nutritional status, increased knowledge of asthma treatment, increased participation in healthcare, slower health decline, improved body shape perception, and 18-month weight loss maintenance compared to non-web-based interventions across a wide variety of chronic conditions. Those interventions that directed the participant to relevant, individually tailored materials reported longer internet usage (session time and site visits). Additionally, those sites that incorporated the use of a chat room demonstrated increased social support scores. Unfortunately, few studies in our review reported on internet usage or utilized chat rooms. In keeping with our review and others (Murray et al., 2005), they were not able to determine the durability of treatment effects or cost-effectiveness of internet therapies.

The internet interventions in our review varied in the degree of interactivity that was provided through animations or games, video and audio clips, use of chat rooms for social support, and feedback and decision-making support from a therapist. All of these additional features that enhance interactivity may influence outcomes, dropout rates, as well as compliance with and use of the internet site (Wantland et al., 2004). Poor adherence is a significant issue for most health interventions, including internet interventions. Therefore, it would be important to identify characteristics of the interventions as well as end-users (cognitive development in children and youth) that affect adherence to internet interventions. Nijland and colleagues (Nijland, van Gemert-Pijnen, Boer, Steehouder, & Seydel, 2008) recently examined patients’ and caregivers’ perceptions of the user-friendliness of internet applications for supporting self-care. They found that inadequate navigation structures, search options, and lack of feedback features hindered the usability of the applications. Furthermore, participants felt the information was not sufficiently tailored to meet their individual information needs and that the language/readability level of the information provided appeared to be a barrier to using self-care advice. In addition to conducting usability testing studies, researchers should use the tools offered by this medium to track the use of an internet site (visits to pages, dwell time). Utilization patterns would help to determine what dose and which components of the interventions are most effective.

The main aim of these internet interventions was to produce cognitive and behavior change that leads to symptom improvement (Ritterband et al., 2006). A theory-driven approach would further our understanding of how internet interventions work. Theory should be used to guide the development of these interventions as well as study design and outcome measurement (Sidani & Braden, 1997). Models specific to internet interventions are needed as there are obvious differences in treatment delivery from traditional interventions (Ritterband et al., 2006). Murray and colleagues (2005) have recently developed a pathway for change whereby internet self-management interventions are hypothesized to work by combining information with peer, decision-making, and behavioral change supports to allow internalization and interpretation of the information by the user. A combination of enhanced self-efficacy with motivation and knowledge enables users to change their health behaviors, leading to changes in clinical outcomes. The use of a theoretical framework would help standardize the essential ingredients of self-management programs (i.e., information, skills training, social support), interactive features (e.g., feedback), and use of therapist or health coach as well as help to standardize outcomes for internet interventions (Clarke, 2007).

**Future Directions for Research**

The present study also revealed areas for future research on internet self-management interventions. First, more high quality studies with adequate samples sizes, using both clinical and community samples of children with a wide range of health conditions are needed to confirm these findings and to elucidate the best type and way to deliver internet interventions, and to conduct cost-benefit analyses comparing them to standard approaches (e.g., face-to-face, group formats). Second, due to the cost of developing internet interventions, it would be beneficial to develop consensus on the steps to take in the development and testing of internet interventions to ensure their usability and feasibility. These steps are crucial to determine that participants can be identified, recruited and maintained in the project, that the intervention can be delivered consistently, and that the end-users are satisfied with and receptive to these modes of intervention delivery. Third, greater uniformity of assessment intervals across studies is recommended in order to more effectively evaluate the long-term effects of these interventions. Finally, more research is needed to elucidate the mechanism of action of internet
self-management and how it differs from traditional methods of delivering self-management interventions.

Limitations
The present study has several limitations. First, because few internet interventions targeting self-management in youth with health conditions have been conducted over the past 15 years, our findings are based on a very small number of studies and five illnesses. Future independent replications will be required to establish whether internet treatment approaches are reliably efficacious for treating a wide variety of acute and chronic illnesses. Due to the limited data reported in the studies included in this review, we were only able to provide a qualitative synthesis. Furthermore, conducting systematic and meta-analytic reviews on internet interventions is challenging due to the wide variability in the treatment programs, as well as differences in nature of health conditions and their treatments. In addition, several factors may limit the generalizability including limiting studies to English and that the studies found were primarily conducted in North America.

Conclusions
The internet shows great promise as a mode of delivering self-management interventions for youth with health conditions. In the past, psychological interventions aimed at promoting self-management in traditional formats (group or individual formats) have been found to be effective. Evidence from this review lends support to the delivery of these types of interventions using the internet to improve symptoms in youth with health conditions. Further research is necessary to increase the scope of these findings using rigorous study designs so we can harness the full potential of the internet as a medium for delivering self-management interventions.

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