Systematic Review: Computer-Based Programs for Youth Asthma Self-Management

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Abstract

Introduction: Poor asthma management accounts for a large number of hospitalizations and absences among the school-aged population. Computer-based learning is an effective strategy to improve knowledge, behaviors, and clinical outcomes. The aim of this systematic review was to determine if implementing computer-based programs improved asthma outcomes among technology-savvy school-aged youth.

Methods/Findings: A systematic review of Medline, CINAHL, PsycINFO, ERIC, Cochrane, and Psychology and Behavioral Sciences Collection databases was conducted using the following major search terms: computer-assisted instruction, internet-based learning, asthma, self-management education, self-care, child, and adolescent. Of 49 articles retrieved, 20 met inclusion criteria: described computer-based asthma programs with self-management strategies and reported patient outcomes. The computer-based programs for asthma self-management were categorized by program usefulness and technology usability (i.e., web-based, CD-ROM, mobile/handheld applications). Improved patient knowledge mean differences ranged from 0.50 to 9.73 (n=13), self-management of symptoms from 0.93 to 8.00 (n= 8), and emergency department encounters from 0 to 1.31(n=6) as compared to baseline or control. While the features of the programs varied in intervention dose (i.e., single session to twelve months) and outcomes measured, 77% reported improved patient knowledge, and 50% reported increased patient self-efficacy.

Conclusion: The results of this systematic review support computer-based learning for asthma self-management among technology-savvy school-aged youth for improvements in healthcare utilization and, most importantly, asthma outcomes.

INTRODUCTION

Asthma is a chronic lung disorder characterized by airway inflammation. The prevalence of asthma in children in the United States (U.S.) is significant. In 2013, there were 7.1 million (9.5%) children with asthma. (1) Asthma is a significant public health problem and an economic concern in the U.S. Latest estimated costs of asthma to society, which include medical expenses, loss of productivity, and premature death, were $56 billion. (2) Healthcare utilization of children with asthma is also high, as evidenced by: routine office appointments (75.7%), asthma-related hospital stays (5.5%), emergency department (ED) (22.2%), and urgent care encounters (39.8%). (2) Uncontrolled asthma negatively affects children and their families by limiting daily activities and increasing absenteeism from work and school. Children miss more than 10 million days of school due to asthmatic episodes in the course of a year.

The goals of asthma treatment include controlling symptoms, maintaining normal pulmonary function, and preventing exacerbations. Established national healthcare guidelines recommend using a stepwise approach to identify appropriate pharmacologic treatment options [National Asthma Education and Prevention Program Expert Panel Report 3 (NAEPP EPR3), 2007]. (3) A major emphasis is preventing asthma attacks by promoting asthma education at multiple points of care, such as primary care clinics, EDs, schools, and home settings. Key points of asthma education include early recognition of signs and symptoms of asthma exacerbations, use of spirometry or peak expiratory flow to monitor changes in asthma status, avoidance of asthma triggers, proper use and technique of metered-dose inhalers, implementation of a home asthma action plan (AAP), and adherence to prescribed control therapy. (3)

Despite the widespread dissemination of Expert Panel Report 3 (EPR-3) guidelines, the care provided to the

majority of children with asthma in the U.S. did not incorporate recommended evidence-based practices. Children and their parents reported little asthma education from their physicians, ranging from 25.6% on goals in asthma management to 76% on the use of inhalers. (4) A trend of decreased asthma education was found by Hersh, Orrell-Valente, Maselli, Olson, and Cabana (5) and is highlighted by multiple study findings of improper inhaler techniques and inability to correctly recognize signs and symptoms of asthma exacerbations by children and their caregivers. (6-11) Unfortunately poor asthma control increases asthmatic children's need for emergent care. (12-15) Asthma education is essential for the health and wellbeing of children to adequately control asthma symptomatology. Many asthma education programs have proven their educational benefits in decreasing asthma-related ED and inpatient encounters [CDC's National Asthma Control Program (NACP), 2013]. (2) Asthma literacy can be taught during the following: office appointments or home visits, counseling sessions, online websites, or software programs.

Computer, or internet-based education, offers significant patient benefits, such as greater accessibility and flexibility, fast and relatively low-cost access in virtual classes, and reduced time and costs of travel. Several studies have supported teaching chronic disease self-management using computer and internet-based programs, which have a positive impact as found in face-to-face education. (16-18) Computer-aided education helps children learn and gain concepts. (19,20) Computer and internet-based programs teach asthmatic children self-management skills in schools, at home, and in ED settings. This systematic review examined the literature to evaluate whether computer-based learning is an effective strategy to improve asthma knowledge, behaviors, and clinical outcomes among school-aged youth.

METHODS

A systematic review of the literature was conducted to determine if computer-based programs are an effective strategy to improve asthma knowledge, self-management behaviors, and clinical outcomes as demonstrated through decreased emergent health care appointments. Additionally, these authors included computer-based asthma program delivery features that would fit within the primary care delivery systems for school-aged youth. The databases of Medline, CINAHL, PsyINFO, ERIC, and Psychology and Behavioral Sciences Collection were accessed using the

search terms: *computer assisted instruction internet-based learning, asthma education, self-management, self-care* with Boolean connectors AND and OR. Initially, minimal retrievals resulted, so a stepwise approach was conducted. The MEDLINE Complete database was searched for *computer-assisted instruction* AND *asthma*, resulting in 30 retrievals; those results were searched by combining subject terms *adolescent* OR *child*; *self-management* is not found in MEDLINE, therefore, *self-care* was entered, resulting in 12 citations. Similarly, the CINAHL search yielded 43 retrievals and PsyInfo added 8 additional, unique publications. Continuing the process, ERIC—has no term for *asthma* so *diseases* was used along with *computer assisted instruction* (n=7), yielding a total search retrieval of 88 reports. Moreover, *asthma* AND *Online* OR *Internet* OR *Mobile* OR *Application* OR *App* OR *eHealth* OR *mHealth* were identified as newer delivery modes and added to the search. Investigators followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. (21)
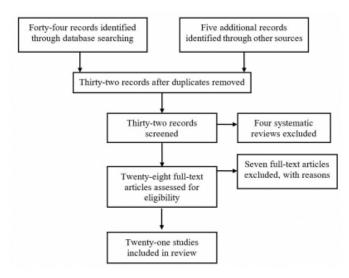
The quality and strength of evidence of the studies were reviewed using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system. (22) The studies adequately described study objectives, population, and comparison of participants, interventions, and results. Approximately half of the studies utilized a randomized control design, which decreases the potential for bias. Of those randomized studies, blinding was applied in six. (23-28)

The intervention was administered to the individual participants in most of the studies. However, four of the studies administered the intervention in a group setting, which may have influenced certain outcomes. (29-31) All of the studies reported issues with attrition; however, one study listed this issue as a possible limitation of the study. (32) Many of the studies measured outcomes via self-report only, which may have affected internal validity, while four studies measured patient outcomes using instruments. (29,33-35) Five studies combined self-report and other instruments to measure outcomes. (25,28,30,36,37)

Titles and abstracts included English language, publication dates between 2000 and 2015, reporting on youth six to 17 years, and patient outcomes of asthma knowledge, self-management and/or emergent care provider encounters. Full papers were reviewed by two researchers (PW and SL) plus one other independent researcher (JS, LS, MN, KS). After excluding duplicate publications, systematic reviews on

related topics, publications on intervention theory, and development of asthma education programs, 21 reports remained (Figure). The team verified data extraction by consensus and data are displayed in the Table.

Figure 1

Data Extraction and Study Selection

Forty-four records identified through database searching

Five additional records identified through other sources

Thirty-two records after duplicates removed

Thirty-two records screened → Four systematic reviews excluded

Twenty-eight full-text articles assessed for eligibility → Seven full-text articles excluded, with reasons

Twenty-one studies included in review

RESULTS

Objectives. The purpose of many of the studies was to evaluate the effectiveness of specific computer-based educational programs. The *Watch, Discover, Think, and Act* (WDTA) program was the focus of three studies. (32,33,35) Two studies evaluated the *Okay with Asthma* program. (37,38) The remaining studies analyzed a variety of additional computer-based educational programs (See Table).

Table 1

Comparison of Selected Computer-Based Asthma Self-Management Programs by Level of Evidence, Setting, Features, and Patient Outcomes

Citation	GRADE	Computer Program	Setting	Features	Knowledge Outcomes	Self Management Outcomes	ER Encounter Outcomes

Settings. The studies took place in two predominant settings: schools (46%) (23,26,27,32,35,37,39,40); and

healthcare facilities (40%). (24,28,33,34,36) One study was set in the ED (36) and one was in a home (25). Most of the studies were conducted in the U.S. One study was conducted in the United Kingdom (34), one in Germany (30) one in the Netherlands (31), and two studies were conducted in Taiwan. (41,42)

Population. Participants ranged from three to 19 years of age. In more than half of the studies, participants were middle school age (23-25,28,32,34-36,37,39) Elementary school-age participants were the focus of four studies. (24,28,32,36) Six studies included high school-age students. (23,26,27,28,33,36) All studies included children with asthma, but without pulmonary comorbidities. The ethnicities of the samples were: White, Black, Hispanic, and Asian, with two studies specifically focusing on Black students. (26,27) The studies included both genders with the exception of one study, which was all male. (34)

Study design. The studies applied quasi-experimental design, and randomized controlled interventions. The quasi-experimental designs consisted of a single group pretest-posttest comparison involving 302 participants. (23,32,34,36,38,39) The controlled intervention studies randomly allocated 1,411 participants to intervention groups, where the subjects participated in computer-based asthma education programs. The control groups received traditional asthma educational and typical educational materials. (24,25,26,27,28,33,35)

Outcome measures. Specifically, outcome measures varied with purposes of the studies. The outcomes analyzed for this review focused on asthma knowledge, asthma self-management, and number of asthma related ED encounters. Most of the studies (n=16, 80%) reported outcomes for asthma knowledge. (23-25,28,31,32,34-37) Less than half of the studies (n=8, 40%) evaluated outcomes of asthma self-management. (23,31-33,35,39-41) Five studies (23.8%) measured outcomes of ED encounters after interventions compared to standards of care. (24,26,28,33,39) Only one study evaluated all three outcomes—asthma knowledge, asthma self-management, and ED encounters. (33)

Intervention dose. Studies incorporated computer-based education programs, however, the intensity, frequency, and duration of the programs varied. The length of the intervention sessions ranged from 15 minutes to two hours. The frequency of the sessions ranged from one session to weekly sessions for the duration of the program. Program durations varied from a single session to 12 months in

length.

Technology features. Seven programs contained multimedia components. (24,25,28,32,33,35,36) These multimedia programs utilized traditional written or verbal instruction, interactive internet games and/or education, and/or video instruction. Four programs were internet-based. (26,27,37,39) One study utilized a CD-ROM computer program. (34)

EFFECTS OF YOUTH COMPUTER-BASED INTERVENTIONS

Asthma knowledge. Studies that measured the impact of computer-based intervention on asthma knowledge demonstrated improvements over baseline or control. (28,32-34,36,37) The mean differences of the measurements ranged from 0.50 to 9.73. Other studies demonstrated improvements in both control and intervention groups, without a significant difference between the groups. (24,25,35)

Asthma self-management. Asthma self-management scores improved in about half of the studies. (23,28,32,35,39) Other studies demonstrated improvements in both the control and intervention groups compared to baseline, without a significant difference between the two groups. (24,25,33) Improved self-management resulted in reduction of daily asthma symptoms, less reliance on quick relief medications, less school absenteeism, or improved peak flow values. The range of mean differences was from 0.93 to 8.00.

Asthma related emergency department encounters. The computer-based interventions failed to demonstrate a significant difference in the number of ED encounters compared to baseline or controls. (23,26,27,39,32,33) One study reported decreases in both intervention and control groups. (28) The mean differences in measurements ranged from 0 to 1.31.

METHODOLOGICAL ISSUES

External validity. A diverse sample representation was included for both gender and ethnicity. The focus of two studies was restricted to asthma in Black students (26,27), and one study consisted of only male participants. (34) Seven of the studies utilized participants from a single site, while other studies utilized multiple sites. Generalizability of findings improved as the majority of the studies consisted of a diverse sample with interventions applied in multiple sites and settings.

DISCUSSION

This systematic review of computer-based asthma self-management programs highlights the benefits of using computer-based asthma self-management tools for youth who are diagnosed with asthma. Peer-reviewed evidence from 2000 to 2013 years included a variety of settings, populations, intervention doses, and technology features. Due to this variation, meta-analysis and specific comparisons between computer-based asthma self-management programs was not possible. Generalizations are possible based on knowledge, behaviors, and clinical outcomes of the studies.

Despite the many variations, the reviewed studies found computer-based asthma educational programs are an effective tool, regardless of technology forms, when used in schools, in healthcare or emergency clinics, or in the children's homes. The programs are designed for youth between the ages of three to 19, and in White, Black, Hispanic and Asian ethnic groups. Computer-based asthma programs are adaptable and effective in increasing asthma knowledge and management of asthma symptoms. Improvement in asthma knowledge was evident in 77% of the studies reviewed. Half of the studies demonstrated improvement in asthma self-management skills. Although some studies failed to show a significant improvement in the number of asthma-related ED encounters, it is reasonable to believe that increases in knowledge and self-management may decrease future ED encounters, hospitalizations, and school absenteeism in youth diagnosed with asthma.

Though the review offered insight into the usefulness of computer-based asthma programs, some weaknesses and limitations were noted. Limitations included small sample size, inadequate access to the intervention, outcomes measured by self-report, and study design. Randomized controlled trials (RCTs) are the most reliable studies from which to draw conclusions, making them the gold standard in research studies. Half of the studies in this systematic review were RCTs and the remaining 10 studies were quasi-experimental designs. The conclusions for this review were strengthened when considering the RCTs in the reviewed studies.

One report addressed knowledge, behaviors, and clinical outcomes, which were assessed in this systematic review. Five reports measured decreased ED encounters as a clinical outcome. Based on the findings of these five studies, the reliability of the conclusion would be improved if a larger

number of studies addressed clinical outcomes. The technology features varied between studies, demonstrating that computer-based asthma programs improve patient education and management with multiple sources of technology, as these programs offered ease of use, functionality and adaptability between populations and settings. Computer and internet-based asthma programs can be accessible from any location at any time. Patient outcomes with hand-held device applications remain unclear, as there was limited research found on mobile technology asthma programs.

CONCLUSION

This systematic review indicates that computer and internet-based asthma programs are an effective tool for improving knowledge, behaviors, and clinical outcomes in school-aged children. Given the prevalence rates of asthma in children and the benefits of computer and internet-based interventions (i.e., greater accessibility, low cost, the potential to reach target groups), efforts should be undertaken by Advanced Practice Nurses (APNs) and other healthcare providers to implement computer and internet asthma self-management education. Considering the use of hand-held devices (i.e., smartphones and tablets) among school-aged children, future work should be expanded to address these devices and applications for asthma self-management. APNs can lead the way in creating opportunities for matching youth to innovative technology-savvy teaching and learning strategies that fosters their patient's self-esteem and self-management.

ACKNOWLEDGEMENTS

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