The effectiveness of the use of video games and software-based programs for asthma education and self-management for children and teenagers

A eficácia do uso de videogames e programas baseados em software na educação e autogestão em asma para crianças e adolescentes

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Abstract

Introduction: Asthma is a chronic disease of the lower airways characterized by usually reversible airflow obstruction, inflammation, and hyperreactivity to various types of stimuli. It is one of the most common chronic respiratory diseases among children and adults, with an incidence of 300 million people worldwide. Objective: To evaluate the quality of the existent evidence in the literature in order to support the use of videogames and software-based programs on asthmatic children and teenager’s knowledge capacity and self-management compared with standard education. Methods: Search, selection and analysis (starting March 2016) of all the original articles on virtual reality (VR) concerning asthmatic children and adolescents (ages 3 to 18), published up to October 2017, in Portuguese, English and Spanish, at the electronic databases Pubmed, Web of Science, MedLine and LILACS, obtained by using the descriptors: asthma, video game, virtual reality, pulmonary rehabilitation, physical training. Results: Only six original articles were obtained. Of these, five (80%) presented level of evidence A, and one (20%) presented level of evidence B. All authors point out the treatment of asthma from VR as a safe and innovative therapy considering that the motivation and intensity of treatment from the use of VR improves the self-management capacity and aerobic capacity of asthmatic patients. Conclusion: The present study seeks to contribute to the literature by demonstrating that videogames and other software-based systems can be used to improve knowledge capacity and self-management skills in children and teenagers with asthma diagnosis.

Keywords: Asthma. Children. Pulmonary rehabilitation. Systematic review. Videogame.
Introduction

Asthma is a chronic disease of the lower airways characterized by usually reversible airflow obstruction, inflammation, and hyperreactivity to various types of stimuli, manifested by episodes of wheezing, shortness of breath, chest tightness, and cough, having a higher incidence at night or soon after waking up. Asthma is one of the most common chronic respiratory diseases among children and adults, with an incidence of 300 million people worldwide.1

Methods

In March 2016, the search for original scientific articles in the Pubmed, MedLine, Web of Science and LILACS electronic databases was started, and the keywords used were: video game, virtual reality, virtual rehabilitation, always associating with the word asthma.

The articles generated by the search were initially selected through the information contained in their titles and abstracts. The methodological quality assessment included all existing studies that met the inclusion criteria: population aged 3 to 18 years; uncontrolled, partially controlled and controlled asthma; use of rehabilitation programs that included the use of video games in the Spanish, English and Portuguese languages. The selected articles respected the classification of the evidence levels that were made by the GRADE system and have been published in all languages since the search led to a limited number of studies.

For the evaluation of the methodological quality of the articles found, it was decided to use the GRADE system of qualification of scientific evidence, which is a clear and explicit system, which takes into account the study design, its execution, consistency and linear direction in the evaluation of the evidence quality for each important outcome/consequence.

According to the GRADE system, the quality of the evidence is classified according to the levels: high,
moderate, low and very low. Some organizations when using GRADE combine the low and very low categories.

Quality of GRADE evidenced by the American College of Chest Physicians/ACCP 2012:
- High (A): Consistent, with evidence in randomized controlled trials or meta-analyses, without major limitations or with exceptionally strong evidence from observational studies. Further research is unlikely to change confidence in the estimated effects;
- Moderate (B): Evidence of randomized controlled trials with important limitations (inconsistent results, methodological flaws, inaccuracy, indirect results). Additional research is likely to impact the confidence in the estimate of the effect and may change this estimate;
- Low (C): Evidence of at least one important outcome from observational studies, case series, or randomized controlled trials with severe failures or indirect evidence. Additional research is likely to have a significant impact on the confidence of the effect estimate and is likely to change the estimate;
- Very Low (D): Any effect estimate is uncertain.

The judicious evaluation of the quality of the evidence was performed by two reviewers independently, with no disagreement between them, and the final result is presented in Table 1.

Results and discussion

Asthma is a chronic inflammatory airway disease in which many cells and cell elements play a role. Chronic inflammation is associated with airway hyperresponsiveness, which leads to recurrent episodes of wheezing, dyspnea, chest oppression, and cough, particularly at night or early in the morning. These episodes are a consequence of generalized and variable intrapulmonary airflow obstruction that is spontaneously reversible or treated.¹

Treatment should aim at increasing respiratory muscle strength and increasing respiratory muscle resistance to fatigue.² However, the training of respiratory and skeletal muscles is sensitive to physical training and with proper exercise they can improve their strength and endurance.⁴ Education and self-management have been a successful alternative in asthma control, especially when there is the inclusion of multidisciplinary work where all participating professionals set goals and objectives for the maintenance and control of the disease from education to training.⁴

Video games and computer games are one of the most popular pastimes among children in middle- and high-income countries. Studies have been done to investigate its potential benefits for our health and education. The use of video games or software-based applications in the treatment of asthmatic patients for self-management or disease training has been widely used in recent years.⁵ At the end of the search process conducted in this research, seven articles were found (Table 1). These were repeated between the databases.

As a medium that crosses gender, socioeconomic and cultural boundaries, video games are considered an ideal way to get children interested and to meet their own medical needs. Asthma, as one of the most common chronic diseases among children, has been the focus of many video games and computers in recent years.

Currently, there are technologies for digital games, that in addition to broadening some of our sensory systems, increase knowledge capacity, contribute to maintaining the individual’s awareness and self-management.

The major change in the physical activity paradigm can be made through a digital platform and sensors that accompany body movement, games that challenge physical and mental capabilities, providing the patient with efficient exercise (Figure 1).

The first clinical investigation of an educational videogame for children with asthma was conducted in 1986. Rubin et al.⁶ evaluated the results by relating a video game or computer game to asthma in 54 children ages between 7 and 12 years old with a medical diagnosis of asthma randomly assigned to two groups.

Researchers reported that children playing video games showed a better understanding of the disease and how to manage it. The study showed that a standardized educational intervention in the form of a video game or computer can affect knowledge and behavior related to asthma management.

The findings suggest that exposure of children with moderate and severe asthma to an asthma-specific computer game may affect the subsequent management of their chronic disease.

Comparison of differences between control and experiment groups (Signal Test) revealed a greater improvement in the experimental group in 84% of the outcome variables in this study. Changes in behaviors related to asthma management were significantly related to computer game participation.
Table 1 - Main features of the studies

**Delecan et al., 2019**

**Delecan Controlled Clinical Trial**

**Rubin et al., 1986**

**Delecan Controlled Clinical Trial**

**Phelps et al., 2002**

**Phelps Controlled Clinical Trial**

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**Authors**

Bartholomew et al., 2000

**GRADE**

High (A)

**Subjects**

Ages of 7 to 17 years old with a medical diagnosis of moderate to severe asthma. They were chosen from four inner-city asthma practices.

**Prospective pretest-posttest study with randomly allocated intervention**

**Conclusion**

After the intervention, both intervention classes had higher mean scores than the average control room scores, one week after the intervention.

**Results**

This randomized control study was based on a pretest and two posttest assessments of childhood asthma knowledge and self-care skills. The study did not specify the duration of each visit, nor the timespan between each visit.

**Conclusion**

There were no significant changes in asthma symptoms between the two groups before and after the intervention.

**Results**

An interactive educational computer program, Asthma Control, designed to teach children about asthma and its management, was compared with the usual care control group. The study did not specify the duration of each visit, nor the timespan between each visit.

**Conclusion**

The study indicates that a standardized educational intervention, through asthma-specific computer gaming, can significantly improve asthma knowledge and the encouragement of school attendance.

**Results**

Compared with children in the control group, experimental subjects showed improved knowledge of asthma, but there were no significant changes between groups after the intervention.

**Conclusion**

Children in the intervention group showed improved knowledge about asthma during the observation period compared to the non-computer group. Neither the inclusion of a 30-minute asthma conversation nor longer playing times (6-hour average versus 12-hour average) had a significant impact on knowledge gain.

**Results**

There was a significant difference in the number of acute asthma visits between the intervention and control groups (p < 0.13). Children in the experimental group also had higher results in assessing asthma management-related knowledge (p < 0.001), behavior related to asthma management (p < 0.008), and a tendency to reduce acute asthma visits, but there were no significant changes between groups after the intervention.

**Conclusion**

The authors concluded that the intervention program was effective in improving asthma knowledge, self-efficacy, and allergen control.

**Note:** GRADE system for quality of evidence, evidenced by the American College of Physicians (ACP) 2012.
Homer et al. used a self-developed computer game, but a more modern and updated version that had the goal to be achieved in the shortest possible time, with the same objectives as the previous version. The study was conducted with 137 children aged 3 to 12 years with a medical diagnosis of asthma, randomly divided into two groups. The study shows that substantial reductions occurred in the emergency department and outpatient visits. Parents in both groups also reported improvements in child behavior and the use of maximum flow meters. The experiment group had significantly better results than those who received the standard education program, showing greater knowledge about the disease.

Huss et al. evaluated the effectiveness of a computer game for treating and controlling asthma patients. A research was conducted with 101 children aged 7 to 12 years with a medical diagnosis of asthma, randomly divided into experimental group and control group. This study sought not only to find improvement in knowledge and treatment of asthma, but significant changes in the physiology of the disease such as pulmonary function: forced expiratory volume in the first minute (FEV1), peak expiratory flow (PEFR), and their predicted mean values. This study shows that video or computer games did not significantly improve children’s asthma symptoms compared to those who used a control program. In addition, the results indicate that there were no improvements in quality of life parameters or pulmonary function measured by FEV1 or PEF.

Shames et al. met previous research using a video game to improve self-awareness and management of asthma in 119 children aged 5 to 12 years with a medical diagnosis of asthma. Following the pattern of the articles presented, the sample was divided into two groups. Although the intervention achieved statistically significant improvements in asthma knowledge and quality of life, no statistically significant reductions in asthma morbidity measures were observed. Most trends, however, were in one direction favoring the intervention group, with small effect sizes. We did not find consistently defined subgroups that more or less responded to the intervention. The intervention was significantly more effective in reducing symptoms compared to controls among children who reported a recent history of more wheezing episodes and lower onset bronchodilator reversibility (higher severity), but also those who reported recent history of fewer asthma attacks and less urgent baseline care visits (decreased severity).

Yawn et al. conducted a before-and-after survey of 87 children from three fourth grade elementary grades, aged 6 to 12 years old. Intervention groups had a clear impact on the test results of asthma-related questions. Within each intervention class, there was an increase in scores between pretest and posttest one, with a mean increase in each (Wilcoxon p-value = 0.001 and 0.002, respectively). In the control class, no evidence suggested any change in scores between pretest and posttest (sum of score = 0.53). After the intervention, both intervention classes had higher mean scores than the average control.
room scores, one class being more clearly different from
the other (sum of $p = 0.20$ and $0.0009$, respectively).

Bartholomew et al.,\textsuperscript{11} in their study of 133 children
aged between 6 and 17 years old with a clinical diagnosis
of asthma, evaluated the use of a computer game. The
results of the study indicate that there was an increased
knowledge of how to administer asthma for older
children and those who scored higher on the pretest,
suggesting that computer gaming was too complex for
some children. The impact of the program promoted
improved knowledge and control of asthma.

There are few published articles (six) that analyzed
the effectiveness of video and computer games as
education and self-management tools for children and
adolescents with asthma; however, most of them are
randomized controlled trials, which increases the quality
of the study. All of the studies aimed to use video games
for asthma management, with the purpose of education
and disease control.

Using video games requires little physical space, is
easy to handle and has a huge acceptance. We believe
that soon many other studies will be done through video
games aiming at education, physical training and many
other valences, as well as the use of virtual reality for
the treatment of asthma and other pathologies will be
effective.

**Conclusion**

The present study contributed to the literature by
demonstrating that video games and software-based
programs can be used to improve knowledge capacity
and self-management, in asthmatic children. An analysis
of the existing evidence was made in order to support a
treatment and educational program for asthmatic children
and adolescents through video games. After a thorough
search, only six articles met the inclusion criteria. Thus,
it is clear that further research in this area is needed to
introduce new technologies and new forms of treatment
for asthma, especially in environments such as hospitals.

**Authors’ contributions**

RMI was the creator of the project, participating in all
phases of the article. PJCM and SSMB, professors of the project, participated in all phases of the article.

MMS participated in the analysis of the results, statistics
and final review of the project. CTR participated in the
analysis of results, statistics and translation and final
writing of the article.

**References**

1. Global Initiative for Asthma (GINA). Pocket Guide for Asthma
Management and Prevention. United States of America: NHLBI/
WHO; 2005.

2. Laghi F, Tobin MJ. Disorders of the respiratory muscles. Am J
Respir Crit Care Med. 2003; 168(1):10-48. DOI

3. Rohrer V, Schmidt-Trucksäss A. Impact of exercise, sport
and rehabilitation therapy in asthma and COPD. Ther Umsch.
2014;71(5):295-300. DOI

4. Lopes GLB, Yano KM, Tavares NSA, Rego IAO, Marinho RI,
Melo LP, et al. Influência do tratamento por realidade virtual no
equilíbrio de um paciente com paralisia cerebral. Rev Ter Ocup
Univ São Paulo. 2013;24(2):121-6. Full text link

5. Malta DC, Silva JB. Policies to promote physical activity in
Brazil. Lancet. 2012;380(9838):195-6. DOI

6. Rubin DH, Leventhal JM, Sadock RT, Letovsky E, Schottland
P, Clemente I, et al. Educational intervention by computer in
childhood asthma: a randomized clinical trial testing the use of
a new teaching intervention. Pediatrics. 1986;77(1):1-10. Full
text link

7. Homer C, Susskind O, Alpert HR, Owusu C, Schneider L,
Rappaport LA, et al. An evaluation of an innovative multimedia
educational software program for asthma management: report
of a randomized, controlled trial. Pediatrics. 2000;106(1 Pt 2):
210-5. Full text link

8. Huss K, Winkelstein M, Nanda J, Naumann PL, Sloand ED,
Huss RW. Computer game for inner-city children does not
improve asthma outcomes. J Pediatr Health Care. 2003;17(2):
72-8. DOI

9. Shames RS, Sharek P, Mayer M, Robinson TN, Hoyte EG,
Gonzalez-Hensley F, et al. Effectiveness of a multicomponent
self-management program in at-risk, school-aged children with
asthma. Ann Allergy Asthma Immunol. 2004;92(6):611-8. DOI
10. Yawn BP, Algatt-Bergstrom PJ, Yawn RA, Wollan P, Greco M, Gleason M, et al. An in-school CD-ROM asthma education program. J Sch Health. 2000;70(4):153-9. DOI

11. Bartholomew LK, Gold RS, Parcel GS, Czyzewski DI, Sockrider MM, Fernandez M, et al. Watch, Discover, Think, and Act: evaluation of computer-assisted instruction to improve asthma self-management in inner-city children. Patient Educ Couns. 2000; 39(2-3):269-80. DOI

12. Brandão AF, Brasil GJC, Dias DRC, Trevelin LC. GestureMaps: Perspectivas para a desorientação espacial. Proceedings of the IV Colóquio Internacional de Gerontologia; 2013 Oct 18-19; Ribeirão Preto, SP. Ribeirão Preto: Medicina (Ribeirão Preto); 2013;46(4):27-8.