

ABSTRACT

Benefits of Physical Activity Interventions for Asthmatic Children and Adolescents: A Systematic Review

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As an asthma patient since age 3, I have witnessed the effectiveness and importance of physical activity as an aid in asthma management and control. However, despite the extensive research supporting the physiological, social and psychological benefits of an active lifestyle for asthmatic children, very few physical activity interventions that focus on improved changes in long-term exercise behavior have been implemented. Therefore, this thesis is a systematic literature review aimed to synthesize and describe the benefits associated with implementing physical activity interventions for asthmatic children. Additionally, after completion of a detailed systematic review and synthesis of published physical activity interventions, a correlate research literature search was also completed to better understand factors related with physical activity for asthmatic children. Results suggested that asthmatic children benefit a great deal from exercise participation and leading an active lifestyle, especially when a proper physical activity intervention was constructed and implemented. It is important for researchers to learn from previously implemented interventions so as to create more effective approaches to increase physical activity participation of asthmatic children.

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BENEFITS OF PHYSICAL ACTIVITY INTERVENTIONS FOR ASTHMATIC
CHILDREN AND ADOLESCENTS: A SYSTEMATIC REVIEW

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This thesis is dedicated to my wonderful parents for their unconditional love and support throughout my time at Baylor University.

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CHAPTER ONE

Introduction

I have chosen to write my thesis describing the benefits of physical activity for asthmatic children and adolescents and reviewing interventions designed and implemented to increase physical activity of these children because of my passion for health and wellness, my love of people of all cultures and strong desire to serve them, and my first-hand understanding of being a child, and now an adult, with asthma. Aspirations, experiences, and relationships within these categories have led me to be interested in conducting a systematic literature review to analyze the currently published physical activity interventions aimed at implementing behavioral changes among asthmatic children.

To most people, the gift of breath is simply an involuntary function essential to maintain human life. However, growing up as a child diagnosed with asthma at age 3, my entire outlook on the phenomena of breathing changed and I became more aware of the voluntary component of breathing. When further testing revealed allergies to foods and airborne allergens, I became more despondent about my illness. I did not understand why this was happening to me. However, by the start of middle school, I began to learn how to manage my condition with the help of my parents. The knowledge they shared and the support they gave provided me with the tools I needed to use my inhalers. With improved asthma control came the ability to engage in more indoor physical activities. This enabled me to pursue my interest in Taekwondo and dance. As a result of years of commitment and training at my Taekwondo dojang, I earned my third dan black belt at age seventeen.

My experiences and accomplishments as a person with asthma has played a pivotal role in the development of my passion for this topic.

The importance of exercise and an active lifestyle became even more apparent to me as I witnessed my mother's journey as an early stage breast cancer patient. The strength she gained during and after treatment from whole foods, yoga, meditation, and Nia dance continues to inspire me. Now that she is back working full time, I am reminded every day of her dedication to wellness, both physical and mental, as she continues this regimen. Observing the medical treatment of breast cancer coupled with a focus on wellness showed me that patients can improve their wellness. Through my mother's experience, I better understood the benefits of a healthy lifestyle on disease management and prevention and further understood how to apply this mindset to asthma management. While many believe that exercise leads to more asthma exacerbations, evidence suggests otherwise. With properly controlled symptoms, asthmatic children can be just as active as children without asthma. However, there are some barriers to physical activity for asthmatic children, including psychological aspects, environmental influences and the severity of the patient's asthma. These barriers vary based on the person, but I learned that they are very important to understand so as to better individualize my own long-term asthma management regimen.

During the summer of 2014, I witnessed the importance of speaking to families in their native language during my time as a clinical observer/research student under the guidance of Dr. Marianna Sockrider at Texas Childrens Hospital. I attended patient/family asthma education sessions on medication management, self-care, and action plan implementation with Asthma Educator, Kai Sanders. I shared my story as an

asthma patient and helped educate Spanish as well as English-speaking families. I witnessed how formidable language barriers can be and how comforting it is when a family encounters a health care professional who speaks their native language. My internship showed me the important contribution of education for disease prevention, and the positive health effects that appear to multiply exponentially when families are educated in their native language.

Motivated by my experiences as a patient with asthma and as a student interested in public health, I decided to focus my thesis on the benefits of asthma education and improved long-term physical activity behavior through exercise interventions. I chose to focus this review strictly on child and adolescent asthmatics because I believe that disease prevention is most effective when education is provided during the early stages of life when behavioral habits are developing. In a perfect world, families with asthmatic children would be educated immediately post-diagnosis, and would not only be taught effective asthma management techniques, but would also be trained to provide psychosocial support for their child in future exercise participation. Once they reach an appropriate age, children would also be taught how to cope with their asthma and would understand that living an active lifestyle is essential for proper asthma control. If I have learned anything from being a patient with asthma since age 3, it is that a healthy lifestyle is essential when it comes to asthma management and overall disease prevention.

CHAPTER TWO

The Significance of Physical Activity for Pediatric Asthma Health: A Comprehensive Literature Review

Physical activity is not only essential to a healthy lifestyle, but also plays a pivotal role in the development of healthy habits in children. Physical activity, according to van Veldhoven et al., refers to any energy expenditure resulting from bodily movements produced by our skeletal muscles (van Veldhoven et al. 2001). Basic, clinical and epidemiological research evidence support the fact that chronic disease prevention and one's quality of life can be enhanced through implementation of regular physical activity (Sothorn et al. 1999). If children avoided a sedentary lifestyle, which normally includes video games and watching television, and instead accumulated at least 60 minutes of moderate to vigorous intensity physical activity daily, they would benefit greatly from health promotion and disease prevention (Asthma and Physical Activity: What Physical Educators and Coaches Need to Know). The many benefits that come with being physically active were dependent on the type, volume and intensity of the exercise performed. For example, aerobic exercises reduced symptoms of depression, stress and low density blood lipoproteins, while improving endocrine function and one's oxygen transport system. This ultimately increased high density blood lipoprotein levels and therefore improved one's cholesterol ratio (Sothorn et al. 1999). While daily physical activity is important for children overall, it is especially beneficial among those with a preexisting diagnosis of asthma.

Physical activity is vital for asthmatic children and is a key component of disease prevention and other health benefits. Lucas et al. agreed that there are significant benefits of physical activity for asthmatics such as decreased risk of cardiovascular disease and diabetes. Other benefits included increased participation in activities, decreased intensity of wheezing attacks, improved emotional status, increased aerobic fitness and improved running performance (Lucas et al. 2005). Not only did exercise present a noticeable improvement in a patient's physical performance, but also in a patient's psychological state. In addition, physical activity in asthma patients such as running and swimming will improve overall fitness and ultimately decrease the severity of their symptoms (Lang et al. 2004). Physical activity during childhood had also been related with reduced hospital admissions, medication, consultations with the child's general physician, and school absenteeism, in addition to improved ability to cope with asthma (Williams, et al. 2008). Earlier recommendations to asthmatic patients suggested that they should not over exert themselves and take caution when exercising. However, scientists are now suggesting that decreased physical activity is a significant contributor in asthma severity and prevalence, and can ultimately lead to higher risk of obesity in asthmatic patients (Lang et al. 2004). Research also showed that low levels of physical activity within a sedentary lifestyle caused asthmatic children to have poor aerobic fitness (Welsh et al. 2004). Fortunately with proper training, their aerobic fitness abilities could be normalized (Welsh et al. 2004). Scientists insisted that physicians stress the importance and benefits of physical activity and exercise with their asthmatic patients to help them reach the goal of normal physical activity in asthmatic children (Lang et al. 2004). This education by the physicians to their asthmatic patients not only raises awareness of the importance of

physical activity for children with asthma, but also helps the families with asthmatic children kick-start a treatment regimen with aims to normalize their aerobic fitness abilities.

Another empirically supported outcome of physical activity among asthmatic children is an increase in self-confidence (Welsh et al. 2004). It is suggested that a reason for decreased physical activity among asthmatic patients results from fear of triggering their symptoms (Jerning et al. 2013). According to Lang et al., for asthmatic children, not participating in physical activity in school can negatively affect psychological development and self-image (Lang et al. 2004). These children want to feel like they can fit in with their peers, and want to feel that asthma cannot stop them from having a normal life. Feelings of positivity among asthmatic children lead to a belief that they are capable of anything. Additionally, according to Welsh et al., following a 5-month swimming program, asthmatic children showed significant improvement both physically and emotionally. Not only was there a decrease in the frequency and duration of daily asthma, but parents also noticed that their children coped with their disease with greater self-confidence than before (Welsh, et al. 2004). This study also showed improved psychological variables of body image, concentration capacity, ego structure, and social development, resulting in less anxiety and increased confidence when coping with one's asthmatic symptoms (Welsh et al. 2004). Therefore, exclusion from physical activity should not be a go-to treatment plan for asthmatic children.

Trends between asthma and obesity have also been recorded, and suggest that obesity has the potential to make asthma control more difficult (Papoutsakis et al. 2013). According to Litonjua et al., obesity has a negative effect on asthmatic patients in that it

may affect response to treatment and also causes them to have lower asthma quality of life scores than their nonobese nonasthmatic counterparts (Litonjua et al. 2008). When compared to asthma in normal weight children, asthma in overweight/obese children may indicate a unique type of asthma that is more difficult to treat, making it more resistant to steroid treatments, require more medications and ultimately lead to more frequent hospitalizations from the inability to control it (Papoutsakis et al. 2013). Unfortunately, in the past 20 years, childhood obesity rates have been increasing on a global level, with an estimated 22 million children suffering from obesity and being overweight (Jensen et al. 2011). Inevitably, serious health issues arise with both asthma and obesity. Asthmatic children with obesity not only struggle with the symptoms and respiratory complications of asthma, but also have to endure the many other complications that can and will arise from an unhealthy lifestyle. According to Jensen et al., obesity negatively affects pulmonary function in children in that it causes increased frequency of bronchial hyper-responsiveness along with increased number of prescribed medications and inhaled corticosteroid (ICS) use (Jensen et al., 2011). Additionally, overweight/obese asthmatic children also have a reduced peak expiratory flow rate in comparison to non-overweight asthmatic children (Jensen et al. 2011). Therefore, if a patient's obesity worsens so will the severity of the asthma. Also, research has shown that obesity increases the risk for children to develop asthma at an early age (Litonjua et al. 2008). These patients are at an increased risk of bronchial hyper-responsiveness, asthma symptoms and diagnosis (Jensen et al. 2011).

As a result, interventions must be designed and implemented to address pediatric obesity so as to prevent and treat the development of asthma in children. These

interventions can begin in both the home and at school through education of parents, teachers and school nurses. According to Lucas et al., obesity has been associated with reduction in deep breathing, contributing to airway narrowing through smooth muscle latching, decreased forced expiratory flow at 25% to 75% of forced vital capacity, reflux-induced bronchoconstriction, shortness of breath, increased wheezing, and increased release of inflammatory mediators” (Lucas et al. 2005). With weight loss and a healthy lifestyle, patients can have improved lung function and fewer asthma symptoms, ultimately leading to a better quality of life.

Regardless of the documented benefits of physical activity, physical activity participation rates among asthmatic children are low. According to Wenche Nystad, exercise challenge causes bronchoconstriction in asthmatic children, and as a result, children with asthma have been known to participate in less physical activity than nonasthmatic children (Nystad, 2007). Unfortunately, with an increase in the prevalence of childhood asthma comes a rise in children with a sedentary lifestyle, resulting in an decrease in the number of healthy and fit children (Nystad, 2007). According to data from the National Health Interview Survey, from 1969-1975, around one-third of the increase in reported physical activity limitations are from respiratory diseases (Newacheck et al. 1986). A 65% increase in the prevalence of asthma is responsible for almost the entire net change in prevalence of activity-limiting respiratory diseases (Newacheck et al. 1986). According to Lang et al., in the United States, an analysis of the 1988 National Health Interview Survey found that 30% of children with asthma experienced some kind of parent-reported limitation in physical activity (Lang, et al. 2004). However, outside of the United States, a survey of school children in New Zealand found that children with

asthma had positive attitudes toward physical activity, and were actually more active than their nonasthmatic peers (Lang et al., 2004). The authors of the New Zealand study believed that the difference in outlook on physical activity from asthmatic children was a result of a current publicity campaign about the benefits of exercise for patients with asthma (Lang et al., 2004). The differences between overall outlook on physical activity and level of participation among different groups studied suggest that disease awareness is a vital component to improving physical activity participation among children with asthma.

Evidence suggests that are three important factors that play a role in an asthmatic child's participation in physical activity: parental and family beliefs, the illness beliefs of young people, and the knowledge of teachers and organizational arrangements in schools (Williams et al. 2008). Various studies have shown that the low levels of activity observed among children with asthma were influenced by the health beliefs of the parents. In the study conducted by Lang et al., they found that "one fifth of all parents agreed that exercise is dangerous for children with asthma and that one quarter of parents of children with asthma were afraid that their child would get sick if he or she exercises" (Lang et al. 2004). It is this lack of education given to the parents that plays a role in the low levels of physical activity among asthmatic children. Similarly, in a study conducted by Williams et al., the beliefs of the parents about safety, capability and motivation proved to greatly influence both the child's desire to be physically active and the amount of support given by the parents (Williams et al. 2008).

Another potential problem in schools is the incorrect citation of the opinion of the physican by the parents to the school nurses. Parents may attempt to get their children

exempt from school sports based on the “diagnosis” and “advice” given by the physician. In these cases parents insist that their child’s physician advised against physical activity because the child is asthmatic. As a result, school nurses and teachers felt that they could not speak up against medical opinion, and ultimately felt powerless in the situation. Interestingly, “what appeared to influence parents’ support of physical activity, and the child’s willingness to take part in it, was their beliefs about the child’s physical ‘capability’ and the ‘safety’ of exercising in the presence of perceived ‘triggers’ (Williams et al. 2008). For example, an observation of breathlessness of a nonasthmatic child would not mean the same thing as that of an asthmatic child. Parents were living in such a constant fear of triggering an exacerbation that they wanted to take severe preventative measures and completely cut out all physical activity.

There are many significant factors that are related with physical activity behavior among asthmatic children. Disease severity is a major influence on physical activity levels among children with asthma. Unfortunately, physical activity limitation is a consequence of poor disease control, and more than 90% of asthmatic children experience respiratory symptoms as a result of exercise (Walders-Abramson et al. 2009). However, while it is known that overall fitness levels are lower in patients with asthma, this is a result of their levels of daily physical activity rather than the physiological obstruction of their airways (Lucas and Platts-Mills, 2005). In sum, evidence suggests that disease severity influences physical activity, and also that physical activity lessens disease severity. The complex feedback loops and temporality of this disease mechanism complicate scientific inquiry. In addition, parental health beliefs have a direct impact on their child’s overall physical activity levels. A study performed by Dr. David M. Lang,

Arlene Butz, Anne Duggan and Dr. Janet Serwint (2004) suggests that children with asthma whose parents believed that the child was uncomfortable with strenuous activity and those whose parents feared that the child would have an asthma attack from exercising showed more signs of being physically inactive (Lang et al. 2004). Even if the child exhibits the slightest symptom of wheezing that could simply be a normal biological symptom from physical activity completely unrelated to asthma, parents are fearful because they think their child is experiencing asthma symptoms. This may lead to overprotection of the child, negative outlooks on physical activity, and may cause the child to lead a sedentary lifestyle. However, children with asthma who enjoyed being physically active with parents who encourage this behavior and believe they are just as competent to be physically active as their peers were more likely to be active for at least 120 minutes daily (Lang et al. 2004). Parental attitudes and beliefs towards health and physical activity play important roles in disease treatment and management for their asthmatic children.

Given the documented benefits of physical activity for asthmatic youth and several malleable factors related with physical activity within this population, there is great importance in examining and understanding the effectiveness of interventions aimed at improving physical activity of asthmatic children. The purpose of this paper is to synthesize and describe interventions implemented to improve physical activity of asthmatic children and adolescents.

CHAPTER THREE

Physical Activity Interventions for Asthmatic Children and Adolescents: A Systematic Review Manuscript

Objective. Among asthmatic children, physical activity levels tend to decline due to their disease symptoms and a variety of other factors. However, contrary to popular belief, leading an active lifestyle is beneficial for asthmatic children and adolescents. The purpose of this systematic literature review was to summarize the many benefits associated with implementing physical activity interventions for children with asthma.

Methods. A systematic literature review was conducted using SCOPUS, PsycINFO, ERIC, Web of Science and Medline inclusive of all years. *Results.* Seven physical activity interventions met inclusion criteria and were synthesized and described.

Subsequently, a correlate literature review was also conducted. Four recurring goals were common among the seven interventions reviewed: (1) education of asthmatic youth about their disease, (2) increase of overall physical activity levels, (3) enhancement of asthma coping abilities and (4) promotion of long-term wellness through disease management and treatment. The correlate research revealed that youth with asthma have a strong desire to participate in physical activity and be “normal” like all the other children around them, but there are some challenges that make that goal difficult to accomplish.

Conclusions. When a proper physical activity intervention is constructed, asthmatic children and adolescents can benefit a greatly from exercise participation and physical activity interventions. Future interventions should learn from those previously

implemented so as to provide a more effective means for asthmatic youth to improve their overall wellness and better manage their disease.

Introduction

Physical activity is important to children for many reasons: development of healthy habits so as to prevent childhood obesity, improved psycho-social development and better quality of life (van Veldhoven et al., 2001; Strong et al., 2005). Physical activity is essential for asthmatic children. Along with enhancing the overall physical capabilities of children with asthma, exercise has been shown to help children conquer the effects of colds, weather changes, triggers, irritants and the emotional pressures of an asthma attack (Wang & Hung, 2009). Past epidemiological research has also shown evidence that physical activity enhances the quality of life of asthmatic children and improves chronic disease prevention (Sothorn et al., 1999; Fanelli et al., 2007). Lucas et al. agrees that asthmatic children can benefit in many ways from an active lifestyle, including fewer hospital visits and medication use each year, along with a decreased risk of diabetes and cardiovascular disease (Lucas et al., 2005). However, it is even more difficult for asthmatic children to be active than nonasthmatic children. Some of the barriers to physical activity for asthmatic children include the increased incidence of childhood obesity and parental influence due to fear of exercise-induced asthma. Despite these barriers, with proper treatment and maintenance of asthma symptoms, asthmatic children can be just as physically active as nonasthmatic children. The purpose of this paper is to review and describe physical activity interventions for asthmatic children and adolescents to better understand effective and promising intervention approaches.

Methodology

The methods of this systematic review contained specific inclusion and exclusion criteria. All included studies were physical activity interventions, reported physical activity changes, with experimental groups were exclusively asthmatic children younger than 18 years of age, although studies could include comparative general children population control groups. The studies were conducted between 2005-2016. Studies excluded from the review were those utilizing exclusively nonasthmatic populations and populations of asthmatic adults, as well as studies lacking specific physical activity interventions and those conducted earlier than 2005. The electronic databases used include Web of Science, ERIC Institute of Education Sciences, Scopus, MEDLINE, and PsycINFO. All of these databases were accessed through the Baylor University Libraries OneSearch database. Assisting on the literature searches conducted for this systematic review was Arianna Miller, a masters student at Baylor University. The search period spanned from March 2014 to February 2016. Keywords used during the literature searches for physical activity interventions included various combinations of the following: children/youth/adolescents, asthma, physical activity/exercise and intervention. Search results were also restricted to those written in the English language. Additionally, it is important to note that at the beginning of this research process prior to narrowing the search to physical activity/exercise interventions, articles were selected that contained background information on the effects of physical activity on asthma, and why it is important for asthmatic children to exercise.

Results

As shown in Figure 1, the search strategy utilized consisted of the following steps: literary searches conducted in all five aforementioned databases, collection of the search results, then exclusion of articles based on title and abstract. Seven articles were identified that met inclusion criteria from the 386 original article results. These seven articles were included and analyzed in this systematic review. In addition, articles were excluded if the interventions were not strictly physical activity/exercise interventions. For example, articles with medication interventions were excluded from this systematic literature review. After completion of the physical activity literature search, a consensus of all research parties was reached that a correlate research literature search would be beneficial for further analysis the importance of physical activity interventions for asthmatic children. Please see Table 1 for all study characteristics. Results for each of the seven studies reviewed are further described in the following paragraphs below.

Study 1:

In study 1, conducted by NHMJ van Veldhoven and colleagues (2001), a physical activity intervention was implemented using a randomized pretest-post-test control group design. Children were randomized into an experimental group (EG) and control group (CG). The experimental group were given the physical activity intervention, while the control group did not receive any extra treatment. The intervention focused on improving the endurance abilities of asthmatic children with very low fitness levels (n=47, mean age=10.6 years), along with a secondary psychological aim including improving asthma coping strategies and learning to have higher endurance expectations despite suffering

from asthma. This 12-week intervention included 1 hour group exercise sessions twice a week along with a 20-minute home exercise session once a week. The results of this intervention showed improved overall physical health among the experimental group, along with reduced anxiety and better ability to cope with asthma. The experimental group had significant increases in performance levels, and post-intervention could exercise for longer periods of time. Parents post-intervention reported their children spending more time outside engaging in sport activities with others, along with improved enjoyment in these activities (van Veldhoven et al., 2001). Parents post-intervention were positive and had high hopes for their asthmatic children participating in sports in the future. Children also displayed higher confidence in themselves and increased knowledge of their asthma. According to the asthmatic children, after participating in the intervention, they enjoyed being physically active and felt more comfortable knowing how to handle their asthma during exercise. Both parents and children did report, however, that the home program required more perseverance and was more difficult to continue as opposed to the gymnasium program (van Veldhoven et al., 2001).

Study 2:

In study 2, conducted by Latorre-Román and colleagues (2015), a physical activity intervention was implemented using a randomized pretest-post-test control group design. Children were randomized into an experimental and control group. The intervention focused on improvement of quality of life, sport enjoyment and physical self-concept along with increased participation in physical activity (n=105, mean age= 11.53±1.20 years). This physical activity intervention included a 12-week indoor training program with intermittent 60-minute sessions 3 times a week on Monday, Wednesday

and Friday (Latorre-Román et al, 2015). This intervention was deliberately conducted in an indoor facility to avoid exposure to pollution and airborne allergens. This program satisfied the criteria of the American College of Sports Medicine, which recommended any asthma exercise program ensure that its asthmatic participants develop tolerance to cardio-respiratory exercises since these activities require large aerobic muscles (Latorre-Román et al, 2015). This physical activity intervention achieved a high degree of involvement from asthmatic children with a 95.6% attendance rate, displaying a higher overall enjoyment and drive to participate in physical activity despite asthmatic setbacks (Latorre-Román et al, 2015). Higher aerobic ability, like those found in the exercise training in this intervention, were a main goal of physical activity interventions for asthmatic children because it lead to higher quality of life for asthmatic patients (Latorre-Román et al, 2015). In this intervention, the post-intervention experimental group showed increased levels of daily exercise participation. The experimental group also experienced improved physical self-concept due to enjoyment of participating in physical activity. This physical activity intervention suggested that enjoyment of physical activity participation was likely to lead to long-term physical activity behavioral changes among asthmatic children. Asthmatic children were more likely to continue physical activity participation in the future, both on their own and among peers, if they enjoyed it, particularly during the intervention. If their enjoyment lead to continued participation in physical activities after this study, they will also have improved quality of life with their behavioral changes. This study demonstrated the benefit of a physical activity intervention on motivation and positivity which achieve increased enjoyment and long-term behavior changes.

Study 3:

Study 3, conducted by Schneider and colleagues (1980), focused on both decreasing severity of asthma attacks among asthmatic children along with decreasing absenteeism in school ($n=359$, EG: Mean (year 1, year 2) = 9.44 ± 0.92 years, 9.40 ± 0.85 years; CG: Mean (year 1, year 2) = 9.53 ± 1.03 years, 9.52 ± 1.03 years). Researchers designed an intervention where a short exercise program (3-5 minutes) was added at the beginning of the daily physical education classes held at school. A duration of 3-5 minutes was selected because studies have shown that alternating 5-minute exercise periods with rest intervals was the best way for asthmatics to engage in physical activity (Schneider et al, 1980). These exercises are beneficial for both asthmatic and nonasthmatic children in that they strengthen breathing muscles, which may also facilitate aerobic abilities (Schneider et al, 1980). The intervention was designed under the influence of gymnastics and exercise, including exercises that work the upper and lower back muscles, abdominal muscles, breathing exercises and conditioning exercises (Schneider et al, 1980). Diaphragmatic deep breathing exercises were incorporated into this physical activity intervention to reduce anxiety levels, help control wheezing, and increase confidence in the ability to take care of oneself during an asthma attack (Schneider et al, 1980). The experimental group post-intervention experienced increased self-confidence along with slightly lower asthma attack severity. There were significant decreases in average school absenteeism and reduction in severity of asthma attacks during the first year of the study between the experimental and control groups, but unfortunately no significant change in absenteeism rates during the second year of the study. Schneider and colleagues discussed that this difference between the first and

second year may be due to increased parental awareness of the severity of asthma among their children. Parents may have educated themselves on asthma maintenance, and physical education teachers may have altered their classes to meet the needs of the asthmatic children as the study progressed. Schnieder and colleagues believe that an increase in self-confidence is related with better ability to control breathing problems among asthmatic children. Knowing that one has the ability to take control when asthma attacks happen gives asthmatic children the confidence to be just as active as their peers. (Schneider et al, 1980).

Study 4:

In study 4, performed by Basaran and colleagues (2006), a physical activity intervention was implemented using a randomized pretest-post-test control group design. Basaran and colleagues conducted outpatient clinic recruitment of their study population, and children were randomized into an experimental and control group. The physical activity intervention focused on improving the quality of life among asthmatic children along with improving exercise capacity and pulmonary function (n=62, mean age=10.4±2.1 years). This physical activity intervention utilized an 8-week moderately intensive basketball training program to achieve these goals. This program also incorporated a home respiratory exercise program with the hopes of instilling behavioral changes in both the home environment and outside environment. Post-intervention, there were significant increases in the distance in the hallway 6-minute walk test (6MWT) and the physical work capacity at a heart rate of 170 beats per minute (PWC 170), along with improved Pediatric Asthma Quality of Life Questionnaire (PAQLQ) test results within the experimental group and medication scores in both the experimental and control

groups. This intervention resulted in an overall better health status of the experimental group when it came to improvement of symptoms. This intervention had no significant impact on pulmonary function, although there were improved peak expiratory flow (PEF) scores in the experimental group (Basaran et al, 2006). Results of this intervention demonstrated increased quality of life in the experimental and control groups in both the gymnasium and home exercise programs (Basaran et al, 2006). Improved quality of life in the experimental group was higher than that of the control group, but it is important to note that there was improved quality of life in both groups. Regarding how the intervention affected exercise capacity and pulmonary function, the experimental group improved their overall exercise capacity levels as shown by the 6MWT and PWC 170 tests, whereas the control group showed no improvement (Basaran et al, 2006). It is also important to note that there were some limitations to interpreting the 6MWT and PWC 170 results since there are no current data for the health range in either test for healthy children, but only data for healthy adults. Therefore, the improved exercise capacity of the experimental group was analyzed with the healthy adult ranges for both tests, and may be somewhat unreliable. This study demonstrated a clear change in exercise capacity and quality of life among asthmatic children as they participated in the basketball training program, ultimately improving their sport participation and amount of exercise performed (Basaran et al, 2006). However, since this study was only 8 weeks long, Basaran and colleagues were not able to track long-term progress and advised that studies done in the future span over longer periods of time to effectively track exercise capacity and quality of life progress among asthmatic children.

Study 5:

Study 5, conducted by Walders-Abramson and colleagues (2009), presented a physical activity intervention using a case-control intervention study design. Recruitment of children and adolescents from urban primary care clinics took place between December 2005 and July 2007. This intervention focused on maximizing physical activity and minimizing a sedentary lifestyle, while simultaneously educating about the benefits of an active lifestyle ($n=118$, EG mean age= 13.3 ± 1.8 years, CG mean age= 13.2 ± 1.8 years). Walders-Abramson and colleagues hypothesized that, compared to the control group, asthmatic children would have both lower baseline activity levels and a lower overall response to the intervention (Walders-Abramson et al, 2009). Pedometers were used to track physical activity, and were a motivational factor in this study because they provided immediate feedback to the asthmatic children regarding the amount of physical activity in which they were engaging. Developed based on empirically supported behavioral change data conducted in prior studies, the Wonders of Walking, or WOW program, is a family-based, single-session physical activity intervention that promotes an active lifestyle (Walders-Abramson et al, 2009). The WOW program was designed to be easily implemented in other settings, such as home or school programs. During each 45-60 minute session, asthmatic children engaged in physical activity along with social support, education on the benefits of exercise and ways to reduce a sedentary lifestyle, and activity goal-setting (Walders-Abramson et al, 2009). The fact that the WOW intervention used an “open-loop feedback system” is one of the most important features of this intervention because it provided a way for families to keep track of their activity levels and use their pedometers to achieve their set fitness goals. With this system,

families were able to experience and see their physical activity progress, which ultimately played a huge role in improving their overall confidence levels. When assessing baseline physical activity levels, Walders-Abramson et al. actually found that there was not much of a difference between the asthmatic and nonasthmatic children so both groups were combined to analyze the overall impact of the WOW intervention. This intervention also highlighted the psychosocial correlates of physical activity levels among asthmatic children, noting that asthmatic children generally have lower positive attitudes about health as opposed to nonasthmatic children (Walders-Abramson et al, 2009). It is important to note that boys and girls in both experimental and control groups were significantly impacted by the WOW intervention and showed an overall increase in physical activity. Another surprising result of the WOW intervention was that there was no association between increased body mass index, and physical activity levels among both asthmatic and nonasthmatic youth. The WOW intervention was successful and improved physical activity levels for both groups, asthmatic and nonasthmatic, regardless of BMI. Some limitations of this study, however, included the fact that the pedometers used did not specify the intensity of the physical activity performed, and most importantly, this study only included children with well-controlled asthma in the experimental group. For future studies, it would be beneficial to have a study population with children who have mild-moderate asthma severity to see how this physical activity intervention could benefit a less-controlled asthmatic population. Despite these limitations, this study was successful in several ways. It provided a safe, low-cost and easily replicable walking promotion program that ultimately increased exercise behavior on a family level. This program also helped to steer asthmatic youth toward walking and

away from a sedentary lifestyle. While there was no significant association between activity levels and BMI in this study, this kind of intervention was expected to address the problem that is that asthma and obesity overlap with the ultimate goal of preventing asthmatic children from becoming obese. A final success within the WOW intervention was that it emphasized the importance of walking as a form of physical activity, as opposed to a more complex or physically demanding type of physical exercise, reiterating the ease of implementing this intervention into other various settings. While this intervention set the stage for long-term behavior change among asthmatic children and their families, future implementations of this WOW intervention should include a method of follow-up for its study population that includes progress updates and opportunities to reinforce long-term positive lifestyle changes.

Study 6:

Study 6, conducted by Thomas Westergren and colleagues (2016), focused on improving cardiovascular fitness and health-related quality of life, increasing and monitoring exercise intensity and participation in physical activity, improving overall enjoyment of being physically active, and improving children's outlook on independence and normality (n=6, age 10-12 years). To achieve these goals, Thomas Westergren and colleagues conducted a 6-week exercise intervention with 1 hour active play sessions twice a week using a variety of games and activities. Like study 5, this intervention utilized technology to facilitate their monitoring of physical activity levels and intensity levels (Westergren et al, 2016). This intervention monitored the physical activity levels of the children using SenseWear Pro mini Armband activity monitors, and also monitored exercise intensity by instructing the children to wear HR monitors. Additionally, this

study provided a detailed and complete description of the exercises conducted in the intervention. This intervention broke the physical activity session down into 3 sections: warm-up (10-15 min), main section (35-40 min), and cool-down (5-10 min) and then continued to describe each exercise performed while incorporating the rules of each activity. Intervention instructors were also present to participate in each exercise and activity alongside the children to encourage them. However, it is unclear if large child to instructor ratio influenced the overall participation level of the asthmatic children. The presence of instructors among a small study population may have a different effect than if the instructors were working with a larger group of children (Westergren et al, 2016). Similar to previous interventions discussed, this intervention prioritized psychological wellbeing in addition to physical wellness, and implemented focus groups to promote reflection and openness for the children (Westergren et al, 2016). This method of communicating with the children also allowed for the researchers to learn about their active lifestyles outside of the intervention to understand and compare, pre/post intervention, the exercise behavioral changes that took place. Additionally, a key factor that made this intervention successful was that the researchers took into account the activities that children enjoyed when designing the exercises in the intervention. This mixed-methods study design along with the observation of children's perceptions allowed for progress to be made by creating an atmosphere where it was normal to deal with asthma symptoms (Westergren et al, 2016). However, despite these many factors that made this intervention successful, there were also some limitations that should be discussed. One limitation of this study is that the study sample was small with only 6 children participating. These 6 asthmatic children also were considered to have well-

controlled asthma and already had high physical activity baseline levels. Given the small sample size, results were qualitative in nature. And, while there are many benefits to qualitative research, results may not be generalizable to the overall population (Westergren et al, 2016). Therefore, if future applications of this study utilized a much larger, less-controlled asthmatic study population, results more applicable to the general asthmatic population may be obtained.

Study 7:

Study 7, conducted by Hung-Liang Lin and colleagues in Taiwan (2008), focused on educating both asthmatic children and their parents on the importance of exercise, increasing overall exercise self-efficacy and behavior, and enhancing parental support so that asthmatic children will feel they can lead physically active lifestyles with the help of their parents (n=41 students, mean EG=10.07 \pm 1.62 years, mean CG=9.24 \pm 1.61 years). To achieve these goals, Hung-Lin and colleagues designed a 1.5 day asthma summer camp program consisting of health education in physical activity for 20 minutes, 2 sessions of swimming practice for children and a conference with parents for 2 hours. Subjects of this study included asthmatic school children along with one parent of each child (Hung-Liang Lin et al., 2008). Randomization did not take place with participants in this intervention, and children recruited from the asthma education association were assigned to the EG (n=16), while those recruited from the medical center were assigned to the CG (n=25). In addition to the physical activity portion, this intervention also included the following materials to assess both the children and parents: an Exercise Self-Efficacy Questionnaire, a Stages of Exercise Behavior Change Questionnaire and a Parental Support for Exercise Questionnaire (Hung-Liang Lin et al., 2008). Results of

this study included significantly improved stage of change in exercise behavior among children along with more regular exercise behavior 2 months post-intervention within the EG (Hung-Liang Lin et al., 2008). There were many aspects of this study that made this intervention successful. First, this study included both child-specific and parent-specific education materials like pamphlets that were distributed to both parents and children. Second, this intervention educated about the benefits of physical activity to both parents and their asthmatic children with the ultimate goal of improving parental support of asthmatic children leading an active lifestyle. Third, to allow for future questions if necessary, the primary researchers provided their own contact information to all children and parents. Fourth, this intervention used a study population where none of the subjects had previously participated in an asthma summer camp. Fifth, children's severity of asthma in the recent 1-month was significantly different between the EG and CG. Finally, this intervention allowed asthmatic children to experience the pleasure of a swimming physical activity intervention and learn the extent to which they could participate and exert themselves (Hung-Liang Lin et al., 2008). However, while there were many aspects of this study that made it successful, there were some unexpected outcomes. This study did not support the original study hypothesis that the EG participating in the program would exhibit self-efficacy superior to that of the CG. Surprisingly, both EG and CG exhibited decreased 1-month and 2-month post-intervention test scores. There was also no significant difference in the extent to which parents supported their asthmatic children exercising in the intervention (Hung-Liang Lin et al., 2008). This study had some limitations. First, the EG and CG were not randomly assigned, which may have caused a selection effect bias in the data results. Second, the intervention itself only spanned for

1.5 days, and was therefore quite short, and the ability to see self-efficacy improvements would require that this intervention be made longer. Third, pre-camp tests were given to children during their summer vacation, when children had more time to exercise, but post-camp tests were administered during the school year, when children were inevitably more busy. Fourth, ceiling effects may explain the change in support levels of parents to asthmatic children participating in physical activity. Fifth, overall there was limited availability of subjects for this study. Finally, differences in health education content and outcome measures might have lead to different results in the data (Hung-Liang Lin et al., 2008). Some suggestions for future implementations of this study include: increasing length of time of the study, examining the effect of periodically interviewing the subjects to help them assess and overcome obstacles to regular exercise (Hung-Liang Lin et al., 2008), giving pre-camp and post-camp tests during similar times in the year, and finding enough subjects to participate so randomization into the EG and CG is possible.

Discussion

This paper aims to systematically review and describe physical activity interventions for asthmatic children and adolescents to understand effective and promising intervention approaches. The main goals among the seven interventions analyzed were to improve physical activity interventions for children with asthma to educate them about their disease, increase their physical activity levels, enhance their ability to cope with asthma, and promote long-term wellness through disease management and treatment. This was done by conducting a systematic literature review of all physical activity interventions for asthmatic children published between 2005 and the present. All results were then analyzed and based on aforementioned inclusion criteria,

7 interventions were included for review. Among further analysis of all 7 interventions, common goals included improvement of quality of life and sport participation, physical self-concept, and overall endurance to decrease asthma attacks. All studies included a form of physical activity intervention that allowed for positive changes within the experimental group of asthmatic children. Some of these common positive changes included increased self-confidence, improved sport enjoyment, increased overall sport participation, improved physical activity performance, and many studies even saw improved physical activity behavior post-intervention. However, the many positive changes also brought upon some study areas that did not see much improvement. For many of the studies, this was because study populations with already high baseline levels of various categories were used, which ultimately did not allow much room for improvement. Some of the studies also failed to see significant changes in physical activity attitudes, self-efficacy or social support. While there were studies that saw improvement in these areas, the studies that did not were usually due to the fact that their methods of measurement for those areas were not adequate. Overall, all studies analyzed saw many positive changes in their asthmatic children study populations, but there are certain distinguishing characteristics of each study that may or may not have lead to its success.

Out of the seven studies reviewed, only one uses a sample of asthmatic children with very low fitness levels (van Veldhoven et al., 2001). This allowed for data to show that low fitness asthmatic children had the most improvement after participating in the physical activity intervention. Correlate research supports this trend, and according to Tiggelman et al., asthmatic adolescents who participated in exercise programs showed

increased quality of life, asthma control and decreased symptoms of anxiety over time (Tiggelman et al., 2014). Improvement in these three areas of health allowed for further improvement and development of physical capabilities and capacity of asthmatic children.

Another factor that made the van Veldhoven intervention unique was that it involved physical activity sessions in both a gymnasium and home setting. This gave the experimental group exposure to two different settings in which physical activity can be possible, with the hope of influencing future habitual exercise behavior change.

According to Westergren et al., perceived school environment played a role in physical activity levels, but environment may not be as important for asthmatic adolescents than it may be for younger asthmatic children (Westergren et al., 2015). However, in some correlate research it was unclear whether “environment” was referring to the physical environment in which physical activity was taking place or the child’s social environment. Future research should analyze the influence of outside vs. home environments on habitual participation of physical activity among asthmatic children.

Additionally, of the seven studies reviewed, only one had participants who were in control of the intensity of the exercises they were performing, as long as they gradually increased the intensity throughout the program (Latorre-Román et al., 2015). Asthmatic children were given this responsibility and control with the ultimate goal of teaching control of abilities and skills rather than strictly focusing on competition (Latorre-Román et al., 2015). This trend was very beneficial, and was also present in asthmatic physical activity correlate research. According to Tiggelman et al., physical activity was vital to asthmatic children and adolescents in that it could possibly decrease the physiological and psychosocial outcomes of asthma, such as the child’s ability to control their asthma

symptoms and other possible factors like anxiety or depression (Tiggelman et al., 2014). The fact that this intervention allowed for children to monitor the intensity of their own exercise not only taught them how to be independent in their own physical activity regimens, but also allowed for them to not have anxiety about not being able to perform an exercise because it is too intense for them to handle. Giving asthmatic children control of the intensity of their exercise may also allow for them to adhere more to the physical activity intervention because having some control makes the exercises more enjoyable and will therefore increase intrinsic motivation (Tiggelman et al., 2014).

While most research showed that daily exercise levels were lower among asthmatic children compared to nonasthmatic children, this was not beneficial and should not remain a trend for asthmatic children. In fact, other studies found that asthmatic adolescents actually were significantly more active than their non-asthmatic peers (Teng et al., 2014). Correlate research conducted by Protudjer et al. (2012) seemed to also disagree, stating that asthmatic children and adolescents should be just as physically active as their nonasthmatic peers. Chiang et al. (2006) even claims that all children, both asthmatic and nonasthmatic, should follow a physical activity routine to stay active, and this routine should continue from childhood through adulthood to maintain an active and healthy lifestyle (Chiang et al., 2006).

The intervention conducted by Schneider et al., as mentioned earlier, attached short exercise increments at the beginning of already scheduled physical education classes (Schneider et al, 1980). This meant that asthmatic children would participate in the intervention exercises prior to engaging in their regular P.E. class. A benefit of this type of physical activity intervention was that it required little change in the daily

schedule of the children, and once the 3-5 minute intervention was completed, they simply continued their physical education class. Limited correlate research was found about the benefits of adhering to regular daily schedules when working to develop habitual physical activity behaviors. However, future correlate research should consider studying this concept. Nevertheless, the fact that the results of the Schneider et al. intervention are from only a 3-5 minute exercise program showed that it does not take much to instill behavioral and psychological changes that can ultimately improve asthma symptoms and overall quality of life. Hypothetically, if this intervention were to be conducted again with increased exercise time intervals or intervention timespan, these changes may improve absenteeism rates.

While results of the Basaran et al. intervention were consistent with current literature concerning medication reduction, aerobic and symptomatic improvement with physical training in asthmatic children, this study did not assess *long-term* effects of physical activity on quality of life of their study population (Basaran et al, 2006). Unlike the other interventions reviewed, this intervention mainly focused on the *current* benefits of exercise training on quality of life of asthmatic children and did not assess the possible development of habitual physical activity behaviors (Basaran et al, 2006).

Of all seven studies reviewed, one in particular sets itself apart by using a family-based intervention (Walders-Abramson et al. 2009). A family-based intervention allowed for a higher likelihood of long-term exercise behavioral changes because asthmatic children had a support system to encourage their physical activity behavior. There was evidence that suggested high social support, particularly from parents, was directly correlated with the amount of physical activity performed by asthmatic adolescents.

Results from a 2014 study conducted by Teng et al., in agreement with previous research, suggested that the amount of physical activity participation of asthmatic adolescents was highly influenced by their amount of family support (Teng et al., 2014; Tiggelman et al., 2014; Dantas et al., 2014). Therefore, since parental support could be the reason for improving physical activity among pediatric asthma patients, it was essential that parents influence their asthmatic children in a positive manner. Parental support was not only limited to verbal encouragement, but also came in many other forms such as transportation to and from activities, involvement in asthma management both medically and emotionally, and parent financial support of activities (Teng et al., 2014; Clark et al., 1986). However, it is important to note that parental support could also have a negative influence on the amount of physical activity performed by asthmatic children. For example, according to a study conducted by Mansour et al., parents were very concerned about their asthmatic children being physically active, so much so that they unnecessarily restricted physical activity participation based on misunderstanding their doctor's advice or simple lack of knowledge (Mansour et al., 2000). Since family support is essential on the path to effective asthma management, a family-based physical activity intervention was the most beneficial of any other type of asthmatic intervention. Creating an environment for both the parent and asthmatic child to come to an understanding on how to better manage asthma was vital for the asthmatic child's emotional and physical wellness. Some findings showed that the restrictive attitude of some mothers to their children participating in physical activity were due to the mother's level of anxiety about the situation (Dantas et al., 2014). Therefore, an intervention like that conducted by Teng and colleagues (2014) provided a means for parents to bond with their asthmatic child

and understand that even though parents were constantly living in fear of their child having an asthma attack, the children may be just as afraid of their asthmatic symptoms being triggered by physical activity.

Studying exercise intensity levels was an important area of focus for the intervention conducted by Westergren et al., and this was the only study to make it a primary focus to monitor exercise intensity among asthmatic children (Westergren et al., 2016). Monitoring of exercise intensity levels was extremely beneficial, especially since asthmatic children tended to get discouraged if they were constantly feeling set back by their disease. In fact, Chiang et al. explained that most asthmatic children had positive physical self-concepts as long as their asthma symptoms were well-controlled (Chiang et al., 2006). If asthmatic children were constantly worried about the possibility of having an asthma attack every time they participated in physical activity, that stress would ultimately roll over into their level of physical self-concept. Unfortunately, in a study conducted by Chiang et al., at least one exercise-induced asthma attack was experienced by almost half of the asthmatic participants, some even needing emergency care (Chiang et al., 2006). Some children may want to participate in physical activity, and may therefore push themselves too hard because they may underestimate their true exercise capacity (Dimitrakaki et al., 2013) or know the intensity of the exercise. Future interventions should monitor exercise intensity levels as a preventative strategy method to ensure safety of asthmatic children during exercise participation. Additionally, the Thomas Westergren et al. intervention was the only intervention that provided a table complete with a detailed description and layout of the various physical activities performed by the asthmatic children. This was an important section to include in the

study, particularly for researchers, because it could facilitate their future attempts to replicate the study with a larger study population (Westergren et al, 2016).

Additionally, of the seven studies analyzed, one in particular showed certain factors that made it both successful and unique (Hung-Liang Lin et al., 2008). This intervention included an effective health education program that taught children and parents about long-term effects of exercise along with how to help control asthma attacks. This intervention was very successful in that even after a two-month follow-up, adolescents showed continued participation in habitual physical activity compared to controls who never attended the summer camp intervention (Hung-Liang Lin et al., 2008; Tiggelman et al., 2014). This intervention also enabled children to experience pleasure of swimming-focused summer camp and to find the extent to which they could participate. This intervention was also unique in that it provided health education for parents and increased commitment to providing children with opportunities to exercise (Hung-Liang Lin et al., 2008). Devoting a separate part of the intervention strictly to educating the parents of asthmatic children was very important because it provided a higher likelihood that more parental support would be provided to the asthmatic child and would positively influence their overall development of habitual physical activity behavior. Future physical activity interventions should implement a parental education component alongside the exercise component so as to hopefully create a better support system for asthma management and ultimately physical activity participation.

It is important to note that during this systematic review, even though a search was conducted between 2005-current, 2 articles (van Veldhoven et al., 2001; Schneider et al, 1980) that met inclusion criteria otherwise were identified in the search, and were thus

included due to the already low amount of published physical activity interventions for asthmatic children. The van Veldhoven et al. study was published in 2001, and the Schneider et al. study was published in 1980. These unexpected findings revealed a huge gap between the one 1980 intervention found and the six interventions found from 2000-present in this review. Upon analysis, this large gap could possibly have been due to the many medical advances that were taking place during this time period. This 1980-2000s gap was a time where pharmaceutical advances may have been taking place that could have lead towards more clinical interventions. In previous research, many strictly clinical physical activity interventions for asthmatic children were published during this time gap, but these interventions did not focus on the long-term, habitual development of physical activity behaviors among asthmatic children. Rather, these clinical interventions focused more on physiological advantages of physical activity for asthmatic children moreso than behavioral changes and improvements. Therefore, despite the small amount of currently published physical activity interventions for asthmatic children that qualify for this review, having one 1980 intervention to compare to six other interventions conducted from 2000-present showed how far these interventions have improved since the early stages of development. However, it is important that future research do a fully comprehensive search of the literature since the literature found for this review did not include possible interventions published from 1980-2000.

There were very few interventions currently published concerning physical activity among asthmatic children. Therefore, a correlate literature search was also conducted within Web of Science, ERIC Institute of Education Sciences, Scopus, MEDLINE, and PsycINFO. All of these databases were accessed through the Baylor

University Libraries OneSearch database. Based on a review of the literature for current correlates for physical activity among asthmatic children, there were a number of factors that had not been implemented in current interventions that are important to examine. For example, a common trend that research showed was that patients with asthma should not be treated any differently from their surrounding peers during any type of activity because they wanted to be treated the same as their nonasthmatic peers (Protudjer et al., 2012; Dimitrakaki et al., 2013). It is for this reason that many asthmatic children seemed to have equivalent positive attitudes toward being physically active as nonasthmatics, and also showed no behavioral differences toward self-perception or physical self-concept (Dimitrakaki et al., 2013). Instead of getting attention for having asthma, asthmatic children tried to control the effects of their disease in order to be accepted by their peers and live “normal” lives (Westergren et al., 2014; Protudjer et al., 2012). Additionally, another factor to consider was that when it comes to being physically active in particular, asthmatic children would rather participate in sports that are less aerobically demanding than disengage from being physically active altogether (Protudjer et al., 2012). This is important to understand for designing future physical activity interventions because to allow for higher levels of physical activity participation among asthmatic youth, researchers may have to select activities that demanded less aerobic capacity, so as to avoid any sudden asthma attacks, but were still enjoyable for the children to do.

Based on the limitations of the current published interventions, future interventions should include larger pediatric asthma study populations, programs that span over a longer period of time to effectively monitor long-term behavior changes, a follow-up system for families to update their physical activity progress, and a method to

measure exercise intensity of the activities performed. Future interventions need to address the influence of outside vs. home environments on habitual participation of physical activity among asthmatic children, the influence of the encouragement of health-care professionals to motivate physical activity participation, as well as address everything previously listed in the current interventions. Even though our currently published resources are limited, health-care practitioners working with asthmatic children still need to use this evidence to inform others what factors should be integrated to further asthma management, wellness and improvement. Additionally, since there are so few published physical activity interventions for asthmatic youth, there may have been some external factors present that influenced why other studies that were done have not been published. Some of these factors include working with a very large sample size, a much longer study, or researchers simply decided not to publish their study. In addition to the fact that there are very few interventions currently published concerning physical activity among asthmatic children, another major limitation of this systematic literature review is that research was restricted to use of scientific databases only, and therefore it is possible that this research is missing other published asthmatic youth physical activity intervention studies if those studies are not published to scientific databases.

Conclusion

This systematic literature review analyzed seven physical activity interventions for asthmatic children that showed promise at habitual, long-term development of physical activity behavior changes among asthmatic youth participants. Our findings suggest that, when a proper physical activity intervention is constructed, asthmatic children and adolescents can benefit a great deal from exercise participation. However,

many factors need to be considered in future research attempts of developing a physical activity intervention for asthmatic youth. It is important that researchers learn from previously implemented interventions so as to create better means for asthmatics to benefit from physical activity interventions. Future researchers should partner with health-care professionals so as to allow for multiple sources of encouragement and motivation within the intervention to increase the frequency and overall level of physical activity among asthmatic children.

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Figure 1: Method of Physical Activity Intervention Data Collection

