Improving Adolescent Asthma Management Using a Smart Phone Application

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Abstract

Asthma is a common condition in adolescence and finding a way to optimize asthma care management is a priority in primary care. The purpose of this project was to introduce an electronic asthma action plan using a smartphone application to help adolescents improve asthma control, medication adherence, self-efficacy, and overall quality of life. This quality improvement project compared asthma control testing scores between traditional paper-based asthma action plans and the smartphone application. The setting was a pediatric private practice and the sample goal was twenty or more participants who presented to the clinic for well adolescent or back to school sports physical visits. The evidence-based practice intervention was to implement the change from paper-based asthma action plans to a new smartphone application for all patients with asthma seen in clinic. The Asthma Control Test was the tool used to measure improved asthma control outcomes by using the application. A 13.2% average increase in asthma control test scores post- intervention was achieved in this project. The world is moving to a technology focused and mobile health application centered plan, and the use of an asthma action plan could positively impact adolescent and other population asthma control, reduce healthcare costs, reduce missed school and work and improve quality of life.

Keywords: asthma, asthma action plan, smart phone application, adolescent

Improving Adolescent Asthma Management Using a Smart Phone Application

Asthma affects approximately 8.3% of children in the United States and is one of the most common chronic medical conditions of childhood (Fedele et al., 2018). Asthma is a common respiratory condition that is characterized by symptoms including wheezing, shortness of breath, cough, and chest tightness (Harris et al., 2019). An asthma action plan consists of three tiers of treatment corresponding to a medication treatment plan and intervention at each level (Global Initiative for Asthma [GINA], 2018). Children and adolescents with chronic, persistent asthma experience decreased quality of life and health complications due to lack of self-care management that is largely preventable with proper asthma medication administration (Fedele et al., 2018).

Economic, Policy, and Health System Significance

Many adolescents struggle to manage complex medication and treatment plans and adherence is poor in this population leading to increased exacerbations and missed school days (Naimi et al., 2009). Adherence and other psychological influences need to be addressed in any adolescent treatment plan to optimize outcomes (Drotar & Bonner, 2009). Effective disease self-management lowers the burden of asthma on the patient and a mobile application could be a tool to help improve quality of life (Tinschert, Jakob, Barata, Kramer, & Kowatsch, 2017).

Asthma is a common chronic condition worldwide and places a serious burden on patients, families, communities, and health systems (Belisario, Huckvale, Greenfield, Car, & Gunn, 2013). An initiative identified in Healthy People 2020 is to promote respiratory health through better prevention, detection, treatment, and education efforts and one possible method is to integrate mobile health technology into a comprehensive asthma care plan ("Healthy People 2020: Respiratory Diseases," 2018).

Local Issue

Asthma is one of the most common reasons for a clinic visit in pediatric primary care in the U.S. (Cook, Modena, & Simon, 2016). It was noted in the local clinic that many patients did not have an updated asthma action plan in their chart and many patients were not educated on what to do when they have an increase in asthma symptoms, when to use their inhalers, or when to call the primary care provider. The need for care improvement arose from discussions with the other providers in the clinic, and all agreed that an improved and more modern approach to asthma care management was needed to help enhance asthma outcomes for the office teen population.

Diversity Considerations

The clinical project was conducted in a suburban location in Kansas City, Missouri in a private practice that only accepts private insurance. No Medicaid patient population is served in the practice and limits socioeconomic diversity of the project. Though there are no state-provided health care patients, many families do come from a wide variety of locations and financial situations such as low-income, remote rural, inner-city, middle-class, single-parent, and same-sex parents. The patient population was ethnically diverse with various races, including Caucasian, African-American, Somalian, Indian, Asian, and other. The urban location is close to a major interstate highway which brings in patients from the metropolitan area and surrounding small towns and suburbs. This wide geographic and diverse socio-economic patient population aligns well with the project topic and intervention.

Problem Statement

Asthma is one of the most common health conditions among children and quality of care need is to optimize delivery and management of asthma action plan education. A smartphone

application for asthma medication and symptom tracking could be an intervention to positively impact asthma outcomes and improve quality of life. The treatment regimen for chronic, persistent asthma is complex and time consuming but a mobile health technology application could be an effective tool to help adolescents manage their medications, control their asthma and improve self-care management (Fedele et al., 2018). Adolescents use their phones frequently with 91% accessing the internet using a smart phone and phone applications could be a simpler way to engage teens in asthma management technologies (Perry et al., 2017). National organizations recommend the use of a written asthma action plan for all patients with asthma but paper plans may no longer be relevant for the adolescent population that is technology-oriented and smartphone-focused (Burbank et al., 2015).

The evidence shows that nearly half of children ages 2-17 never received an asthma action plan and even more children of minorities and on public health insurance lack this important asthma care component (Simon & Akinbami, 2016). The major international clinical practice guidelines recommend the inclusion of asthma action plans and self-management programs in comprehensive asthma treatment plans and mobile health applications could be a useful component to the current program (Belisario et al., 2013). The evidence demonstrates that mobile applications for asthma self-management show promise in improving outcomes, asthma control, medication adherence and quality of life (Cook, Modena, & Simon, 2016). Adolescents are also part of a unique psychological demographic that make interventions more complex and tailored treatment plans need to address their unique needs like the use of a smart phone for primary intervention (Drotar & Bonner, 2009).

Teens with poorly controlled asthma had improved Asthma Control Test scores after using an asthma management application in outpatient setting studies (Perry et al., 2017).

Another problem noted is that adolescents have unique barriers and facilitating factors that influence their medication adherence and asthma care that need to be addressed (Blaakman, Cohen, Fagnano, & Halterman, 2014). Asthma is one of the most common health issues among children and the need for optimized delivery and management of asthma action plan education (Hui et al., 2016). A smartphone application for asthma medication and symptom tracking could be an intervention to positively impact asthma outcomes and improve pulmonary function (Wu, 2016).

Intended Improvement with Purpose

The intended improvement of this project was to streamline asthma action plan access by introducing a smart phone application into the adolescent asthma patient's plan of care. Utilizing smart phone mobile technology for asthma self-care management and medication adherence may improve patient asthma care consistency, reduce symptom days, and positively impact quality of life (Perry, 2018). The purpose of the project was to determine if the change from a traditional paper-based asthma action plan to a smartphone mobile asthma action plan application positively impacts asthma control test scores over a six-months.

Facilitators & Barriers

The clinic staff and providers supported the project and they were an important facilitator to project success. Other facilitating factors were low expense (see Appendix A), stakeholder support, minimal time commitment from others, and easy sustainability after project completion. A barrier could have been resistance to change but with proper education and support this was minimized. To overcome other barriers, the team leader provided clear goals and strategic plan to the care team, communicated with team members as the project was implemented, used effective teamwork with the care team, and engaged the organizational

culture to adopt the change from paper-based asthma action plans to the new smart phone application. Sustainability of this project was also a strong facilitator since this is the project team leader's place of work and information on the asthma action plan application was accessible for all providers to use this project in their practice population. The project was successful during the implementation phase, and clinic infrastructure in place to maintain the use of this evidence-based practice change for all asthma patients seen in clinic to utilize the smart phone application in routine care.

Inquiry

In the asthmatic adolescent population age 10-21 years, does introducing a smart phone asthma tracking application improve asthma control test scores and medication compliance over six months in a primary care pediatric private practice.

Search Strategies

Databases accessed through the University of Missouri- Kansas City school of Health Sciences libraries included Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, and Medline. Key words used in the search were asthma education, adolescent smart phone use, asthma education smart phone application, asthma control testing, asthma action plan, and asthma medication compliance (see appendix B for definition of terms).

Inclusion criteria included studies using technology as education tool for adolescents, asthma education programs and asthma control testing. Exclusion criteria for the inquiry were literature published before 2009. Of the reviewed articles, 119 of 325 met the project criteria, with 119 records screened, 35 full-text articles assessed for eligibility, and thirty were included in evidence table for detailed analysis. Using the level of evidence system, there were four level I results of interventional and observational studies, three level III quasi-experimental studies, one

level IV case-control study, two level IV/V mixed-methods studies, thirteen level V systematic reviews, one level VII, three editorial responses, and one evidence-based practice guideline (see appendix C).

Evidence by Themes

Three general themes were identified in the review of the literature included in the inquiry. The use of smartphone asthma action plan applications was the primary topic of inquiry with sub-topics in telemedicine advances, school-based asthma management programs, and application design, psychological influences, and supportive factors specific to the adolescent population. The primary topic is asthma care management using smartphone application technology as measured by Asthma Control Test (ACT) scores in a primary care setting. The primary tool used in measuring outcomes in asthma care management clinical studies is the ACT and it is widely accepted and used in clinical care to assess control of asthma symptoms, impact on quality of life, and measured outcomes (Nathan et al., 2004).

Evidence Based Practice Guideline

The most commonly used and up to date evidence based clinical practice guideline is the guide to asthma management and prevention created by the Global Initiative for Asthma (GINA, 2018). This global organization reviews and revised these guidelines annually and the comprehensive report provides a detailed plan of care for children age five and older to adults with asthma. With an estimated 300 million patients worldwide affected by asthma, it is a serious global health issue and creates a burden on patients, communities, and nations (GINA, 2018). The organization recommends a partnership between patient, provider, and family to optimize symptom control and reduce the risk of health complications by the use of a written or electronic

asthma action plan that is personalized to the level of health literacy and used at regular intervals of monitoring (GINA, 2018).

Asthma Action Plan Applications and Telemedicine

The major focus of this inquiry was to identify evidence for the use of a smartphone application for the asthma action plan and management of adolescent asthma. Interventional studies reported a positive effect of smartphone apps on asthma control, medication adherence, and self-efficacy (Alquran et al., 2018). There are four major components of asthma management. They include measures of assessment and self-monitoring, education for asthma partnership, control of environmental factors, and pharmacologic therapy and all can be positively integrated using a mobile health application (Wu, 2016).

Interventions using a mobile health component are designed to assist adolescents with persistent asthma to develop asthma self-management skills and seek to leverage technology to improve asthma outcomes (Fedele et al., 2018). Findings suggest that technology-based programs and interventions are acceptable, feasible, and positive though there is concern that long-term sustainability is limited as novelty disappears and engagement decreases (Fedele et al., 2018). Enabling adolescents to promote self-management and self-care reliance can promote long-term use as well as improve longitudinal benefits of asthma control and quality of life (Tinschert, Jakob, Barata, Kramer, & Kowatsch, 2017). Continuing to utilize the mobile asthma action plan over time using positive feedback messaging is a feasible approach to communicate treatment instructions and asthma education (Burbank et al., 2015).

The use of an application as a decision support tool also had support in the literature. In a large ten-year study in an urban care clinic, the asthma decision tool was associated with attaining and maintaining good asthma control in most participants and many had poor control

prior to the introduction of the tool (Kercsmar et al., 2018). The seasonality of asthma can be troublesome for many patients and providers to maintain control but the use of an application with customizability can assist in overcoming this issue and improve self-management of asthma flares with medication cues and reminders (Belisario et al., 2013).

An area of concern is the research-practice gap that exists in telemedicine and mobile applications and developers need to address these issues to optimize application use and impact on illness (Tinschert, Jakob, Barata, Kramer, & Kowatsch, 2017). Adolescent patient satisfaction is high when using an application for self-management and there is evidence to show up to 20% or more of asthma control test score improvement with their use (Burbank et al., 2015). Asthma Control Test scores are a common method of outcome measurement in asthma that is well-studied and validated and peak flow meter testing will assess lung function (Liu et al., 2007).

The comparison of paper-based AAP versus smartphone AAP application care is well studied. Rates of use are similar ranging from 5 days a week with electronic to 7 days a week with paper though asthma control scores were higher with the electronic AAP (Perry et al., 2017). The patient satisfaction score of the electronic AAP was 100% in the 6-month trial and 30% of the patients saw improved asthma control scores (Perry, 2018). Electronic applications were shown to help with medication management, trigger avoidance and provided a better interactive treatment plan than paper (Phillips, Farooqui, Barrett, & Stukus, 2015). Controversy has been reported on the transition from paper to electronic AAP's with the importance on education, continuing education, continuous monitoring, and regular follow-up when making the transition (Portnoy & Murphy, 2017). There is support and great promise when it comes to the implementation of an AAP application and the positive impact on asthma control (Wu, 2016).

School Asthma Management Programs

As children and adolescents spend the majority of their waking time in school, the impact of a school-based asthma care management program has shown to be very beneficial (Salazar, Tarwala, & Reznik, 2018). School-based asthma care initiatives with supervised medication administration revealed improved outcomes, increased adherence, more symptom-free days, fewer absences, less health care utilization, and less uses of steroid bursts (Salazar et al., 2018). Integrating home and school asthma care is ideal but there are barriers to using a school program. These barriers include peer perception, missing class time, distance to walk to the nurse's office, and medication availability at school (Blaakman et al., 2014). A phone application or mobile health intervention can be used by the student with more privacy and less peer intervention or attention (Blaakman et al., 2014).

Interventions using a theoretical framework of self-efficacy and self- care are more successful and even more successful with the integration of parent and home engagement (Harris et al., 2019). School-based initiatives with family and provider support have shown to reduce hospital admissions, emergency department visits, and asthma symptom days with a measured outcome increasing quality of life (Harris et al., 2019). The most important person to support the student at school is the school health care provider or nurse. There is strong support on the need of a school nurse to help educate, support, monitor, and manage the asthmatic child and that support greatly improved outcomes for these children (Harstad, 2013).

Application Design, Preferences and Psychosocial Impacts

Adolescents are a unique and complex population and their preferences and recommendations need to be addressed to increase rates of participation and adoption of a new program (Roberts, Sage, Geryk, Sleath, & Carpenter, 2018). Teens expressed the need for

customization and tailoring to meet their own needs in asthma management application and they would be more likely to adopt a new application if those needs were met (Roberts et al., 2018). Since teens are tech-centric in their lives, examining and understanding smartphone use, application use, and preferences are important to a program's success (Ramsey, Carmody, Holbein, Guilbert, & Hommel, 2018). Integrating these preferences as well as addressing communication patterns in technology can help to promote rate of use, adoptability, and adherence (Ramsey et al., 2018). The uptake of smart phone technology is so widespread, mobile technology is seen as socially acceptable in peer groups as well as a feasible alternative to paper asthma action plans (Burbank et al., 2015). Smart phones are accessible to children as young as eight years of age in over 75% of households and nearly 90% have access in adolescence to mobile technology (Phillips et al., 2015).

Mobile applications need to be customizable, easy to use, and capable of reminding patients when to take medicines (Hui et al., 2016). The ability to create an application that can be customized for the low-health literacy, illiterate, or non-English speaking patient could improve access to the adolescent populations that tend to be underserved (Mosnaim et al., 2015). The design of the application needs to be high-quality, and visually appealing to increase adoptability rates in adolescents (Tinschert, Jakob, Barata, Kramer, & Kowatsch, 2017). There are more than 13,000 health care applications available to the Apple iPhone and 6,000 available to Android users and this boom in mobile health technology shows the widely accepted and used nature of mobile health (Wu, 2016). It is important for providers and patients to choose an application that was developed with evidence-based health care guidelines and by an organization that supports the latest research and evidence to support the content (Wu, 2016).

The impact of family, parental relationships, and peer influence are key items to consider when implementing an adolescent focused intervention. One of the most substantial barriers to success noted was negative parental feelings regarding the use of medications and parental concerns with provider advice (Rhee, Belyea, & Brasch, 2009). The role of the parent in the partnership with the teen in asthma care is critical and fostering this relationship can optimize asthma care (Fedele et al., 2018). Adolescence is a time of great change and turmoil for some. The transition to adulthood can be even more complex when dealing with a chronic illness so helping to teach and support self-care independence is a central piece of asthma management (Fedele et al., 2018).

Family support, parental relationship, and parental influence all play important roles in treatment adherence (Drotar & Bonner, 2009). Identifying personal beliefs on chronic illness as well as the barriers and facilitators of care management need to be addressed to prevent non-adherence (Drotar & Bonner, 2009). Teamwork focused initiatives with parents, peers and other people in the teen's life suggest a model of care that promotes adherence and increased outcomes (Duncan et al., 2012). Another unique concern to consider with adolescents was the reasoning behind why some teens do not adhere to a medication protocol. Adolescents reported that reasons for failure of adherence included poor taste, side-effects, too busy to remember, forgetfulness, no one to remind them, or too many medications to keep organized (Naimi et al., 2009).

Noted in the literature was the high rate of asthma patients who have not received an asthma action plan (AAP). In the systematic review, nearly half of asthma patients surveyed did not receive an AAP, and factors such as socio-economic backgrounds, ethnicities, and insurance statuses that all negatively impact AAP receipt (Simon & Akinbami, 2016). It is a priority of the

healthcare community caring for children and adolescents with asthma that all patients receive, customize and understand their asthma action plan and how to treat their asthma (Portnoy & Murphy, 2017).

The sub-topic of school-based asthma education programs evidence included 4 EBPG, 2 quantitative level 1 SR with meta-analysis. 3 level 5 systematic reviews. The sub-topic of adolescent application design, preferences and the psychology of self-management evidence included 4 EBPG, 2 quantitative level 1 SR with meta-analysis. 2 level 5 systematic reviews. The sub-topic of applications of telemedicine and at-home uses for self-monitoring devices evidence included 3 EBPG, 2 quantitative level 1 SR with meta-analysis. 4 level 5 systematic reviews. The topic of the components of optimized asthma control and management evidence included 11 EBPG, 9 quantitative level 1 SR with meta-analysis. 2 level 5 systematic reviews (see appendix I).

Theory

The Orem model for self-care deficit theory has three central components: self-care, self-care agency, and basic conditioning factors. All are highly relevant to the clinical understanding of self-care in adolescents with chronic illness. Development of nursing interventions or evidence-based nursing practice changes based on the theory to improve self-care deficits in the adolescent population with chronic pulmonary illness holds the potential to improve quality of life (Baker & Denyes, 2008). The basic conditioning factors are age, gender, family income, socioeconomic status, egocentric thought, family life satisfaction, and severity of illness and these factors must be considered when implementing new self-care education (Baker & Denyes, 2008). Using Orem's theory, the project was enhanced by incorporating foundational content to optimize project outcomes and the adolescent's self-care potential (see appendix D).

The theory with application addresses the relationship of self-care options for managing long-term conditions like asthma as well as self-management training for skills to manage the patient's asthma and was modeled from Hemati (2017). Baker also addresses the relationship between self-care, conditioning factors and where a deficit in the process can lead to issues with self-care agency.

Methods

IRB approval was obtained at UMKC and the project was considered a quality improvement project. The physician collaborators have all approved the project and one physician acted as on-site preceptor during the project to guide and supervise project completion. There was minimal cost associated with the project and was provided by the office budget for internal clinical improvements. The project was an add-on component to a scheduled visit and was conducted by the project team leader. The practice is compliant with HIPAA and all interactions with the patient on this project was kept confidential. A waiver was signed so that parents can be included in communication for patients over 18 if so desired. Signed consent was collected at the initiation of the project with parent or guardian. Documentation was housed in a medical records locked office and there were no project team leader conflicts.

Setting and Participants

The setting for this clinical project was a small pediatric private practice. The practice is independently owned and is not affiliated with any hospital or medical group. There are five physician shareholders and they are collaborating on the clinical project. The participants for the project was any child over the age of 10 who had access to a smartphone. The project focused on adolescent asthma control in the age range of 10-21years, and the practice is small with a low

volume of adolescents. The sample included any child being seen in clinic who has been prescribed an inhaler and who has a paper asthma action plan in the chart.

Inclusion criteria consisted of having access to a smartphone, a paper asthma action plan in the chart, a current prescription for asthma medication, and an active diagnosis of reactive airway disease or asthma of any severity. Exclusion criteria consists of no asthma symptoms or no asthma medication use in the last year, lack of access to a personal or family smartphone, or has major co-morbidities such as cystic fibrosis or other severe chronic pulmonary disease. The target sample consisted of including any patient who met inclusion criteria and consented to participate in the project. The sampling method was a convenience sample because the patients were already be in the office for an office visit and identified by staff at intake who met the criteria to be added into the project (see appendix J).

EBP Intervention

An intake process for screening and selecting appropriate participants was standardized. The front office staff had information to flag a patient chart at check-in who had an asthma action plan in the chart and is over the age of 10. Verbal and written agreement to participate in the project was completed, and the intervention took place at the end of a scheduled office visit. The project team leader then educated the patient and family on the intervention and assisted in the application installation and set-up. An Asthma control test was conducted and the asthma action plan application was loaded with a medication plan that was updated from their provider. A follow-up asthma visit was made 3 to 4 months after the initial enrollment visit. Repeat ACT testing and post-intervention occurred at the second visit and may have occurred via telephone or in-person (see appendix G). The intervention focused on moving from paper-based asthma action plans (AAP) to electronic or mobile AAP and comparing asthma control testing scores pre- and

post- intervention to determine if there was an improvement in the asthma outcomes for adolescents in the practice.

Change Process and EBP Model

The change process model for the project was the Change Curve Model. The model is a five-step process that includes stagnation, preparation, implementation, determination, and fruition (Melnyk & Overholt, 2005). This model was chosen for the simplicity and flow from identifying the stagnation of a paper-based plan to the modern smart phone application. The preparation and implementation occurred to assess positive outcomes and improvement in clinical practice. Plans were made to make the project sustainable for long-term clinic use by the use of clinic staff education and continued patient-family education at subsequent asthma visits (see Appendix G).

The chosen evidence-based practice model was the model for practice change six step process (Rosswurm & Larrabee, 2007). The initial step is to assess the change, locate best evidence, and critically analyze the evidence as we have done in the first half of this course. The selected design practice change was to introduce a smart phone application for asthma management to the asthma care plan in private pediatric practice. The final steps were to implement and evaluate the change in practice and then integrate and maintain the practice change (Rosswurm & Larrabee, 2007). Sustainability is likely after project completion due to the positive results and favorable impact on asthma control.

Study design

The study design for this quality improvement project was with a single group design, with pre- and post-evaluation. Pre- and post-intervention asthma control testing was completed

for data analysis. The intervention was the introduction of a smartphone asthma action plan application to assess any positive outcomes and is considered a quality improvement project.

Validity

In the project, the project team leader was seeking to establish a relationship between the use of an electronic asthma action plan smart phone application and improved asthma outcomes. Some internal validity variables to promote integrity of the data were to ensure that the sample size was large enough to address clinical or statistical significance. The short time of the project reduced maturation risk and because the clinic sees low percentages of patient cancellations or no-shows, attrition was reduced and patients were likely to attend post-intervention visits. Practice effects of the testing tool was also a low risk because the tool was only a snapshot of asthma symptoms at the time of testing, not something that can be memorized or increased score with practice.

External validity speaks to the generalizability of the outcomes to other populations and settings. The clinic sees a wide variety of demographic and ethnic backgrounds as well as the study using ages 10-21 and, a diverse sample was be obtained for the project. Timing of the project was in fall, a common time of year to see asthma exacerbations, and this we hoped to be able to extend year-round usability when symptoms are flaring or abating. A threat to external validity can be that some families do not have a smartphone to use for the project. It is noted that over 80% of people have access to a phone and that if the adolescent does not have a phone of their own, the parent's phone was used (Burbank et al., 2015). The clinic does not accept Medicaid patients although state-subsidized coverage is accepted and there are also self-pay uninsured families to help increases insurance type variety for more generalizability.

Outcomes to be Measured

The primary outcome objective for this project was to determine if the addition of an electronic asthma action plan smart phone application is more effective in improving asthma control and management than the traditional paper asthma action plan. This outcome was primarily measured by positive changes in patient asthma control test scores (see Appendix E). Quality of life and functional status outcomes were measured by the ACT tool (see Appendix H). Some secondary outcomes to be considered are long term adoption of the application and project timeline factors (see Appendix F).

Measurement Instruments

The tool that was used to measure outcomes for this project was the Asthma Control Test (ACT) and is widely accepted and used as a way to measure asthma symptoms and control. It was created by Quality Metric Inc. and is in the public domain for clinical use. The ACT has been tested for validity and reliability and is a valuable tool to implement in any asthma care setting (Liu et al., 2007). Completing the ACT was simple for patients, acceptable for use over the age of 12, and takes less than five minutes to complete. The ACT was administered before and after the introduction of the new asthma action plan app. The scoring of the tool in from 5 to 25 and a score of 25 mean no symptoms of asthma with optimal control to a score of 5 indicating severe asthma with poor control.

Quality of Data

For this project, the demographics and data collected was age, sex, years with asthma diagnosis, current medication list, other health conditions, and type of phone being used. Each participant was given the ACT at the start of the project and again at the end of the intervention period to compare the ACT score. Benchmark studies were referred to during study. The improvement of ACT scores after the use of a tailored mobile application as well as improved

medication adherence were seen in the outcomes in the benchmark study (Mosnaim et al, 2015). The use of a mobile application for the improvement in asthma control was found to be positive and impactful (Cook et al., 2016). The student investigator was exploring the difference in score for each patient, positive or negative, and analyzethe impact of the intervention from this measured outcome.

Analysis Plan

The project team leader collected all pre-intervention asthma control test scores and created a baseline set of data for comparison. The post-intervention asthma control test scores were collected and each participant's score was evaluated using scale data and ordinal data for positive, negative, or no change. The statistical analysis included descriptive statistics, paired t-test and Pearson correlation for the scale data, and Wilcoxon Signed rank test and Spearman rho for the ordinal data to determine if the intervention created an improvement. The SPSS system was used in analysis. The sample group anticipated was approximately 40 patients and a post-hoc power analysis was planned but we did not meet that sample size (See appendices K and L). This analysis used SPSS and the Spearman Test for statistical significance of the paired data. The sample size did not meet this goal and enrollment closed at 22 patients. Average percentage change calculations were done to assess the difference in pre- and post- ACT scoring.

Results

Setting and Participants

The initial enrollment began in the late summer of 2019 after UMKC IRB and site approval (appendix M and N). The project was conducted at a small private pediatric practice. Over 2 months, 22 asthma patients were enrolled in the project and initial ACT testing was completed at the intake appointment (appendix J). The patients used the smart phone application

over 4 to 6 months and then a second appointment or contact was made for follow-up. In the final contact, follow-up questions and ACT testing occurred. All patients were contacted by January 2020 for final evaluations. The age range represented was 12-21 years of age and contained multiple types of ethnicity as well as a wide range of asthma severity. All patients had their own phone for personal use. The sample included 50% females and 50% males. The average age was 16.5 years old. There were 54% Caucasian patients, 32% African American patients, and 14% Asian patients in the program.

Intervention Course

The major components of the intervention were initial and final ACT testing along with the associated smart phone application education, asthma action plan review, asthma education and demographic collection. In August 2019, enrollment began in clinic and within 2 months, 22 patients were using the smart phone application for their asthma management. By January 2020, all 22 patients had been seen in clinic or contacted by phone for closing discussion and follow-up ACT testing.

Outcome Data

Twenty-two patients participated in the project (appendix O). No data were missing, and 22 participants completed the project. The average pre-ACT score was 18.68 and the average post-ACT score was 21.14. Nineteen participants had an improvement in the ACT score, and three participants had no change in their ACT score. No participants had a negative score impact by using the application. Overall, there was a 13.2% positive change in pre- to post- ACT mean score, showing a clinically significant improvement in asthma control. With paired samples t-test, a significant change was found in pre- to post- ACT scores ($p<.001$), analyzed using Statistical Package for Social Science version 26. A strong association ($r=.71$) was found with

pre- and post- ACT scores, indicating a positive correlation of the smart phone application and improvement of patient's asthma control scores and asthma symptoms. Of the participants, 100% used albuterol, 50% used Flovent or another inhaled corticosteroid, 55% used montelukast, and 36% used prednisone. The positive change in ACT test scores supports the beneficial impact of this project and that this project is likely to be transferable to like sites with like populations. The small sample size limits statistical significance.

Discussion

Successes

The clinical project was successful in finding 22 asthma patients who met study criteria to participate and use the smart phone application. A 13.2% improvement in ACT test average scores comparing pre- and post- intervention data over six months. The project was simple to implement for staff and providers and continues to be a component of asthma care in the primary care clinic. No patients had a negative impact on their ACT score and 19 had a positive score impact.

Study Strengths

The study had many strengths. The simplicity of implementation was a key component of strength since as time was an essential factor in the primary care visit, and a quick education on application use and ACT testing did not delay clinic work flow. The study was nearly of no cost to the clinic and was free for the patient to use to gain better access to their asthma action plan and use their smart phone to improve their asthma management. Staff and other providers were in support of the project and all worked together to enroll the 22 patients successfully and direct any questions to the project team leader. All 22 participants were able to complete all components of the program and there were no cases of missing or incomplete data. The smart

phone application continues to be a component in comprehensive asthma care for patients in clinic and the clinic has transitioned to all electronic asthma action plans from the paper-based plans used in the past. Providers in clinic report positive receptiveness from patients and families in this change of care and that the use of an electronic asthma action plan is beneficial for our patient population.

Results Compared to Evidence in the Literature

The positive impact of a smart phone application being introduced into primary care asthma management programs has been shown to be beneficial in the literature selected for this review. The project was aligned with the study findings from Mosnaim et al. (2015) and Cook et al. (2016), finding similar positive outcomes with the use of smart phone technology when helping to improve asthma management and control. This study is in alignment with the findings in the literature in which this project was modeled.

Limitations

One of the limitations of this project was the small size of the practice and leading to a low number of patients participating in the study. With only 22 patients it is not as statistically significant a sample but the data still showed a positive benefit of the program. A smaller sample size was expected due to the small nature of the practice. Because of the positive outcomes found in the data, the project continues to be used in clinic and those numbers of patients participating will continue to grow in the future.

Internal Validity Effects

In the project, the project team leader was able to establish a relationship between the use of an electronic asthma action plan smart phone application and improved asthma outcomes. Some internal validity variables to promote the integrity of the data are to ensure that the sample

size was large enough to address clinical or statistical significance. The sample of 22 patients was small but it provided enough data in the small practice to show the project was successful in positively impacting asthma control test scores. The short time of the project of under 6 months reduced maturation risk and because the clinic sees low percentages of patient cancellations or no-shows, attrition is reduced and patients were likely to attend post-intervention visit. Practice effects of the testing tool was low risk because the tool was only a snapshot of asthma symptoms at the time of testing, not something that can be memorized or increased score with practice. The ACT scores were collected 4-6 months apart and there was a positive trend with the use of the application.

External Validity Effects

External validity speaks to the generalizability of the outcomes to other populations and settings. The clinic sees a wide variety of demographic and ethnic backgrounds as well as the study using ages 10-21 as the age range, a diverse sample was obtained for the project. The sample contained 22 patients with an age range of 12 to 21 years of age as well as from multiple ethnic backgrounds as hoped. An expected threat to external validity was that some families will not have a smartphone to use for the project but this was not found to be the case during implementation since phone ownership was at 100% of participants.

Sustainability Effects and Plans to Maintain Effects

Sustainability is strong for this clinical project with intervention. All providers and staff in the clinic are supportive of the program and were able to see the positive impacts using the application made in asthma control. Plans are in place to maintain the program and to continue using the app for all asthma patients seen in clinic. One concern for long-term sustainability is the novelty of using an app can diappear over time. Some patients only use the app when they

are in full symptom flare and not when asthma is well controlled. Reminding patients at routine asthma checks to use the app even when asymptomatic can help maintain the observed gains seen in the first year of use.

Efforts to Minimize Study Limitations

The leading limitation of this project was the small sample size during the implementation time frame of 6 months. One effort that will be utilized is the continued enrollment of new patients to use the smart phone app which will grow the clinic population using the app to access their asthma action plan. The majority of participants found the application to be easy to use and helpful and we hope this positive impact will continue with future participants.

Interpretation

Expected and Actual Outcomes

For this project, the project team leader expected the increased access to asthma action plan and medication schedule to positively impact the asthma control scores and this was indeed the case. One of the most positive benefits was the medication reminder feature of the app to help trigger patients to take their medications as directed. This outcome was targeted and it did help patients increase medication compliance thus improving asthma control. The ACT testing was simple and fast as well as very easy to record demographic data from the patient record. No problems or failures of the program were detected but at times it was difficult to get a follow-up scheduled but with persistence, all patients completed the program successfully. The majority of patients continue to use the app and most parents also found the program helpful. There was no difference in the expected and observed outcomes. The student investigator had hoped to have

positive outcomes and with a 13.2% increase in ACT scoring, the program was able to create positive clinical impact.

Intervention Effectiveness

The positive outcomes for this project drew inferences consistent with the study data that reflected the intervention's effectiveness. The most substantial component of the intervention was the introduction of an electronic asthma action plan versus a paper plan in the chart. This simple yet very effective change of practice helped increase access to medications and asthma education that positively impacted ACT scores for this study group. What was also very impactful was that this small project can be used in other similar private practices to improve asthma control as well as for a wide range of populations and ages. It would be effective in larger groups and the transferability of this clinical project is high due to the low cost and ease of implementation by staff and providers.

Intervention Revision

The positive outcomes and data that supports the use of a smart phone app in asthma management for adolescents supported that the project was meaningful and impactful. More patients participating in the study would have increased the validity of the findings for generalization, but the project tea, leader made every possible effort to enroll as many patients as possible in the short enrollment period for the pilot, improvement project. In the future, a longer enrollment time could have increased participation as well as to start enrollment at the peak of sports physical season in June when one could capture more patients in clinic with exercise induced asthma. Due to delays of approval, this project did not start until the end of August thus limiting those summer physical patients. Overall, the intervention needs no other revision and the

process was smooth and had positive outcomes for participants. Suggestions for improvement were not received from staff or other providers on methods to improve the program.

Expected and Actual Impact to Health System, Costs, and Policy

This evidence-based intervention was able to show a 13.2% increase in asthma control testing scores over 6-months. With improved asthma control one can then infer that patients will be less likely to have asthma exacerbations and the associated medical visits and emergency department visits that can come with an asthma exacerbation. The project consisted of a small group of patients but it can be said that patients who have improved access to their asthma action plan and use their medications as directed by their provider, asthma symptoms will be reduced and patients will have a higher level of quality of life.

Many adolescents struggle to manage complex medication and treatment plans and adherence is poor, leading to increased exacerbations and missed school days (Naimi et al., 2009). Effective disease self-management lowers the burden of asthma on the patient and a mobile application could be a tool to improve quality of life (Tinschert, Jakob, Barata, Kramer, & Kowatsch, 2017). Asthma is a common chronic condition worldwide and places a serious burden on patients, families, communities, and health systems (Belisario, Huckvale, Greenfield, Car, & Gunn, 2013). When an adolescent can achieve better asthma control and fewer symptoms of asthma, overall, the burden of asthma can be reduced. The cost of this program was negligible and since most adolescents have access to a smart phone, this project can be used for any teen with asthma to improve outcomes in a wide variety of clinical settings.

Practical Usefulness of Intervention

Mobile health asthma applications have been shown to improve self- management of asthma in children and adolescents and offer a modern, functional tool to engage the user in

techniques to improve asthma control and medication adherence (Phillips et al., 2015). Major components of mobile application use are to help during periods of asthma exacerbation, seasonal increases in symptoms, and as a reminder on proper medication administration (Odom & Christenbery, 2016). It is also of utmost importance to improve rates of receipt of a personalized asthma action plan and a mobile health initiative could help improve access to asthma care plans and tailored medication management (Odom & Christenbery, 2016).

The evidence shows that there is a positive effect on asthma control, medication adherence, and self-efficacy with the use of smart phone applications and these effects are particularly positive in the tech-centered adolescent population (Alquran et al., 2018). These mobile health initiatives have been shown to be useful in improving provider-patient communication and self-care management improvement (Lancaster et al., 2018). To optimize asthma control, the evidence suggests integration of primary care and school-based asthma initiatives and future studies are needed on how to create a comprehensive treatment plan for children and adolescents at home and at school (Salazar, Tarwala, & Reznik, 2018).

While asthma is one of the most common conditions in children and adolescents, the major evidence shows that asthma management and optimized treatment for this large population is a focus for healthcare providers and future research. The implementation of a minimally burdensome, proactive smart phone application can positively impact asthma control test scores and pulmonary function while maintaining high patient satisfaction scores (Cook et al., 2016). An easily implemented smart phone application to better manage asthma can create a meaningful impact on a wide variety of care sites from small primary care offices to large urban clinics. The goal of this project was to foster a positive trend in the asthma control test scores to determine if this intervention created a positive correlation in the outcome data. After analyzing the data, a

13.2% positive increase in ACT scoring occurred and it can be viewed that this improvement is clinically significant and is highly transferable to like populations and sites. This project was successful in showing the positive improvement in pre- to post- ACT scores thus showing an improvement in asthma control and reduction in symptoms and improved quality of life.

Further Study or Implementation of Intervention

A wealth of data is present on the use of smart phone applications in the adolescent population but this project is unique because of the implementation into standard care practice as a quality initiative in a small private clinic. The findings showed a positive impact, and the project is easy to recreate in a wide variety of clinic and community settings. Due to the low cost and ease of implementation, this quality improvement initiative can be shared with other pediatric practices for general use and the smart phone application is free for public use and only takes a few minutes to educate a patient on use. Removing the paper-based asthma action plans from patient charts and replacing it with an electronic smart phone application improves patient access to their care plan as well as reduces paperwork for the provider. The world of healthcare is trending to all-electronic delivery system and it is ideal to have an integral component of adolescent asthma care planning be electronic on the patient's phone or tablet.

Dissemination

The results of this project were shared with the clinic staff and providers as well as the faculty at UMKC cohort and. The goal of the project team leader was to submit the results to a professional journal. A journal considered is the Journal for Nurse Practitioners and submission for review is pending. Another goal for dissemination is for the project team leader to attend a regional or national conference and complete a poster presentation on the results of the project. The project team leader was scheduled to present at the Annual Pediatrics and Neonatology

Summit in Boston, MA. in April 2020 but the COVID pandemic made this impossible so an online presentation to peers was completed instead. Funding to attend this conference was being supported by The Women's Council at UMKC and the Graduate Assistance Fund at UMKC.

Other ideas for local dissemination were to create a summary of the project outcome and share with other pediatric nurse practitioners in the area with the quality improvement outcomes and share ideas on how they can implement this project at their own places of work. One location in particular would be asthma care providers in the area. At the clinic where the project was completed, a handout will be available with results to share with patients as the staff continues to implement and grow the project to reach all of the clinic's adolescent asthma patients.

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Appendix A

Cost Table for Project

Set for 20 patient participants as goal for sample

Item	Item Description	Quantity	Unit Cost	Anticipated Cost
Print materials	1.) Asthma Control Test 2.) Smartphone App user info sheet 3.) Consent Form	40 (pre- and post-intervention) 20 20	$0.05 per sheet black and white printing $0.12 per sheet color printing (will use color for app guide)	$2.00 $2.40 $1.00
Staff Time	Front desk: gives info sheet to patient at check in Nurses: look at chart for asthma action plan in front of chart- give patient/family consent form	40	0	No Cost integrated into office visit fee
Miscellaneous	Folders for forms	20		$3.50 for 25
Student Time	Enrollment: 15-30min appointment add-on to a routine physical or well child check during the Fall back to school timeframe Analysis: 15-30 min Follow-up appointment at end of intervention and closing discussion	Consent and Q and A session, ACT testing App education and set up ACT Testing Review of App use history and medication use, symptom review.	Goal: <1 hour of student time per patient added into project direct face-to-face with patient/family Non-patient time: 2-3 hours per patient added into project for chart review, medication review, asthma action plan review in chart.	No cost
Total				**$8.90**

Appendix B

Definition of Terms

Asthma: respiratory condition that causes cough, chest tightness, shortness of breath, overactive airways, dyspnea, and wheezing.

Asthma classes: mild-intermittent, mild-persistent, moderate-persistent, severe- persistent, exercise-induced, allergic, cough-variant, occupational, and nocturnal.

Asthma Control Test: 5 question test that assesses the level of asthma control at the time of testing with a scale of 1 to 5 rating scale with 1 being the most severe to 5 being no symptoms.

Asthma Tracker Smartphone Application: created and tested by the American Academy of Pediatrics to be an electronic tool to manage a customized asthma action plan on a phone.

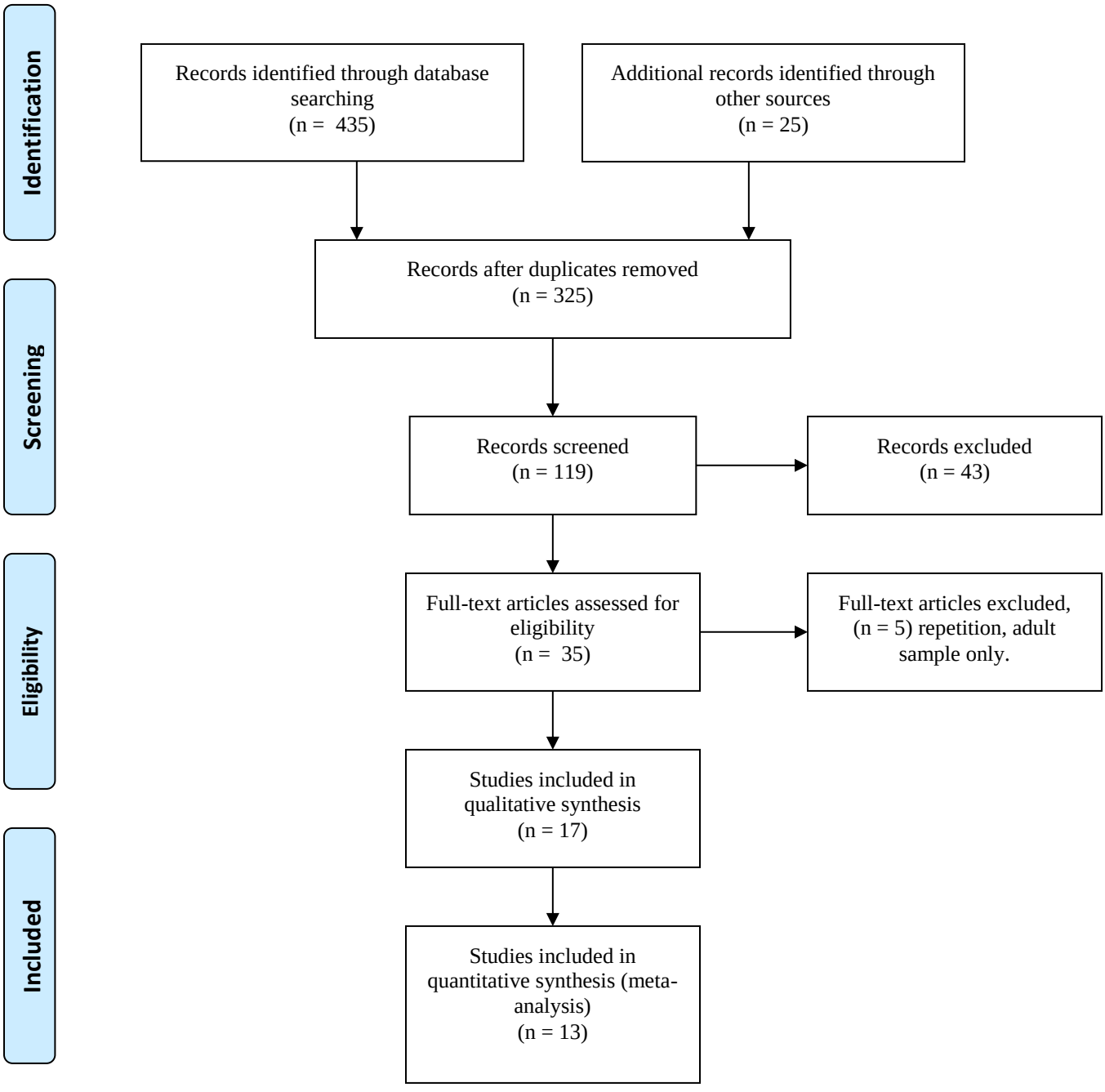
Medication Adherence: describes the degree to which a patient correctly follows medication advice and administration schedule as prescribed.

Self-Efficacy: the belief in oneself to and their capabilities to organize information and execute a course of action to navigate a changing situation

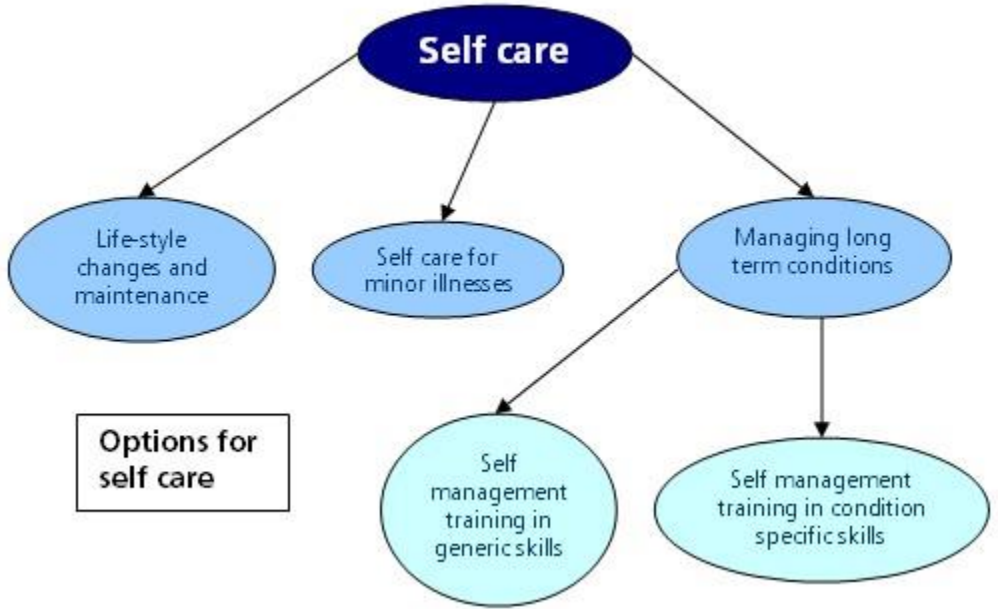
Appendix C

Prisma Flow Chart

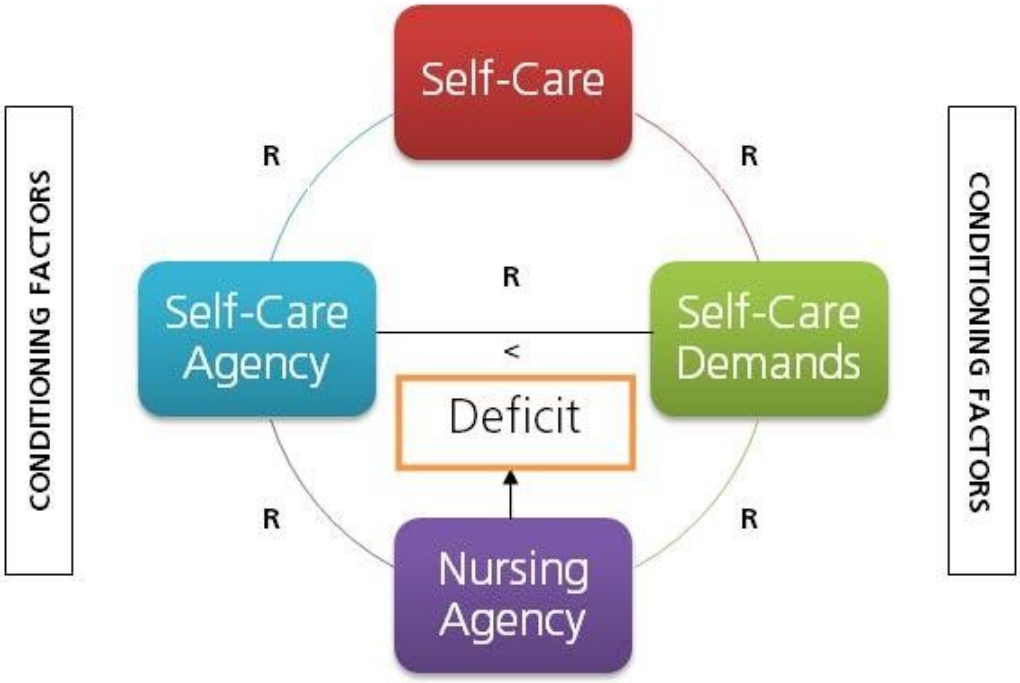
PRISMA 2009 Flow Diagram: adapted for use 2019- Adolescent Asthma Management and Medication Adherence- smart phone application use in primary care: 30 pieces of evidence in review of evidence table



Theory to Application Diagram Orem's Self- Care Deficit Nursing Theory



Conceptual framework of Orem's theory



Graphics adapted from:
Zeinab Hemati, Behzad Shakerian, Farimah Shirani, Fatemeh Sadat Mosaviasl and Davood Kiani, Effect of the Orem Self-care Model on Quality of Life in Adolescents with Asthma, *Journal of Comprehensive Pediatrics*, **In Press**, In Press, (2017).

Appendix E

Outcomes Tables and Project Logic Model

	State	Measurement Instrument Name	Tool validity and reliability	Permission Need	Statistical Analysis
Primary Outcome	Change in ACT scores	Asthma Control Test	High	No- in public domain	Measure change in score (+/-)
Secondary Outcome	Medication compliance	ACT	High	No	Assess score on ACT
Demographics	Age, sex, medication list, years with asthma, co-morbidities	Not applicable	Not applicable	Not Applicable	Descriptive for each group. Comparison statistics if two independent groups.
Participant Completion of the Measurement Tool (Procedure): 5 minutes to answer 5 questions on a scale of 1-5 on the Asthma Control Test. Add up score- uncontrolled severe is 25, no symptoms 0. Tool is administered pre- and post-intervention. ACT Score improvement can also be associated with improved medication compliance.					

Inputs	Intervention(s) *Activities*	Outputs *Participation*	Outcomes -- Impact *Short*	*Medium*	*Long*
Evidence, sub-topics **Smart-phone application uses for asthma** **School Based asthma initiatives** **Design, psycho-social and adolescent application preferences** **Major Facilitators or Contributors** No costs- app is free. Staff and nurses Providers Parents Children with a phone who are interested in using a medical app. **Major Barriers or Challenges** Asthma care can be complex- need to educate! May take 15-30 min to complete intake. Some patients may be missed on days when NP not in office to implement into project.	**The EBP intervention which is supported by the evidence in the Input column** Asthma control EBP GINA guidelines and prescribed provider asthma action plan in chart **Major steps of the intervention** Educate staff on project and inclusion criteria Flag patient charts who are in clinic for appointments. NP to discuss project, assess interest and eligibility, get consent. Review paper plan in chart and current medications. Install app on child and/or parent phone, help show how to use, load custom asthma action plan into app. Conduct asthma control test. Discuss how to use app if asthma exacerbation, yellow zone, red zone and when to call PCP. Set 6- month asthma follow up appointment Discuss experience with app, take ACT. Promote continued use of the app long term and enter clinical note in chart for PCP.	**The participants Patients in clinic age 10-21 with paper asthma action plan and active inhaler prescription** **Site** **Child Care Limited Pediatric private practice KCMO** **Time Frame** **Fall 2019- <6 months** **Consent Needed** **Parental consent under 18 years of age** **Person(s) collecting data** **Sally Ehrich NP** **Others directly involved.** **Clinic nurse who rooms the patient will see asthma action plan and flag the chart for NP review. Other providers are aware of the project and will have NP see the patient to discuss inclusion**	**(Completed as a student).** **Outcome(s) to be measured with reliable measurement tool(s)** **Asthma Control Test Scoring tool** **Statistical analysis to be used.** **Spring of 2020- analyze Fall 2019 data pre and post intervention and compare scores for positive outcomes**	**Outcomes to be measured (past DNP student time).** **At well-check or asthma medication refill appointment, assess if using smart phone app or paper-based asthma action plan.** **Can promote application use after student has completed project- free app and easy for any provider to implement into practice**	**Outcomes that are potentials (past DNP student)** **Increased use of smart phone app for all asthma patients in clinic.** **Reduced need for paper-based plan and more accuracy when updating plan at 6- and 12- month asthma checkups.** **Smart phone app can help improve medication adherence and when to adjust medications due to asthma exacerbation- app can help improve long term asthma control and improve teen quality of life.**

Student: Sally Ehrich CPNP: PICOT Question: In the asthmatic adolescent population age 10-21 years (P), does introducing a smart phone asthma tracking application (I) compared to a traditional paper asthma action plan (C) improve asthma control test scores and medication compliance (O) during a six-month period of time (T) in a primary care pediatric private practice in Kansas City, Missouri (S).
Rev. 7/09, 1/2015 http://www.uwex.edu/ces/lmcourse/interface/coop_M1_Overview.htm Logic-Model Worksheet content revisions by Lyla Lindholm, Applied to DNP EBP Project. Not to be placed on web for public used. For UMKC DNP coursework only.

Appendix F

Project Timeline

Summer 2019:

Project presentation, IRB UMKC internal approval of QI project, preparation

Fall 2019:

Implementation of project at setting, enrollment and education starts, initial visits

Winter 2019:

Completion of project with follow-up visits and data collection

Spring 2020:

Analysis of data, outcome analysis, dissemination, publication, and conclusions

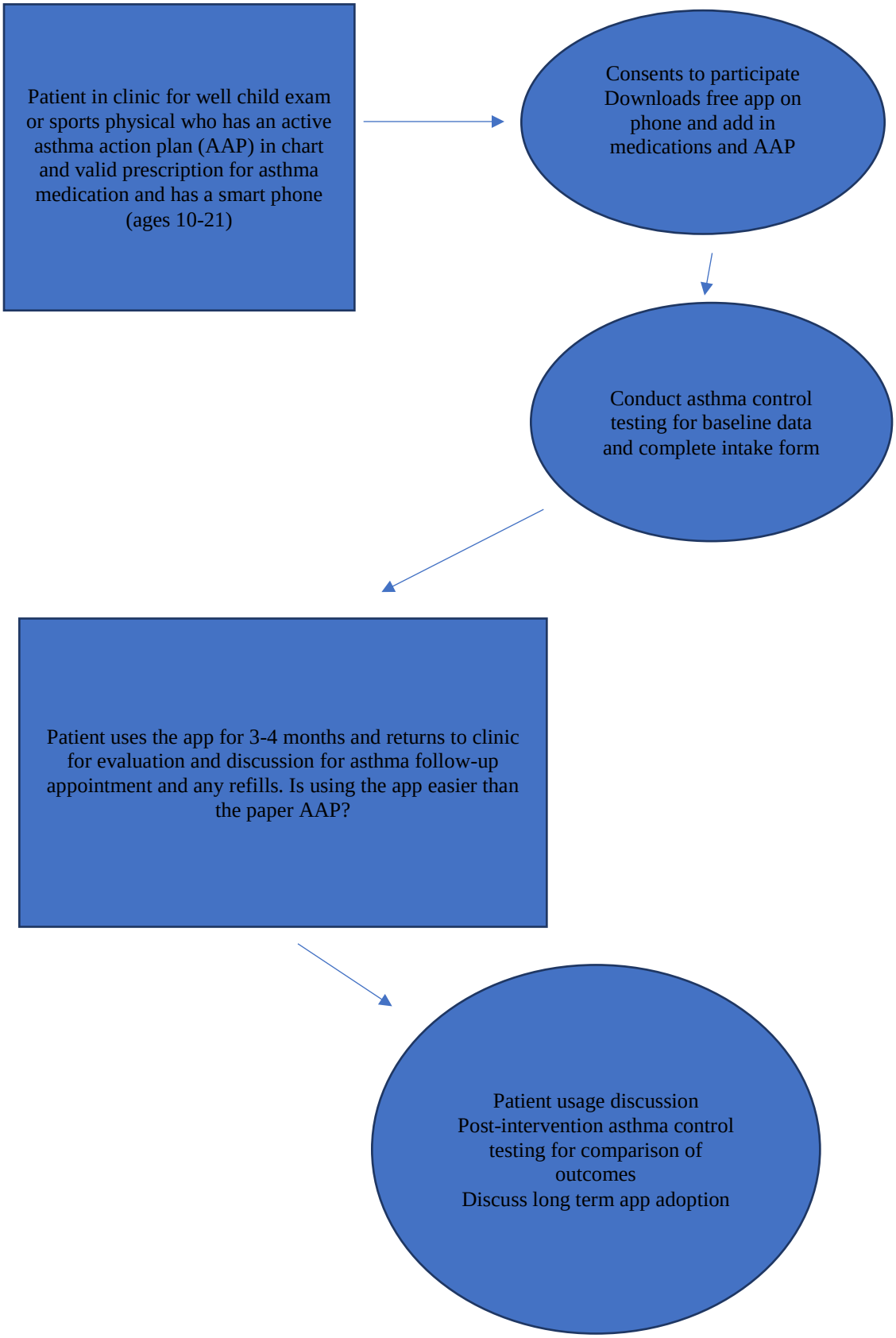
April 23-26 dissemination of final project results at national conference/online UMKC

Future Long-term goal:

Long term adoption of the application use and assess app use in future follow-up appointments for asthma.

Appendix G

EBP Intervention Flow Diagram and Procedure



Appendix H

Measurement Tool and Permission

ACT Test is in the public domain- no permission needed.

Asthma Control Test™ (ACT)

						SCORE
1. In the past **4 weeks**, how much of the time did your **asthma** keep you from getting as much done at work, school or at home?	All of the time 1	Most of the time 2	Some of the time 3	A little of the time 4	None of the time 5	
2. During the past **4 weeks**, how often have you had shortness of breath?	More than once a day 1	Once a day 2	3 to 6 times a week 3	Once or twice a week 4	Not at all 5	
3. During the past **4 weeks**, how often did your **asthma** symptoms (wheezing, coughing, shortness of breath, chest tightness or pain) wake you up at night or earlier than usual in the morning?	4 or more nights a week 1	2 or 3 nights a week 2	Once a week 3	Once or twice 4	Not at all 5	
4. During the past **4 weeks**, how often have you used your rescue inhaler or nebulizer medication (such as albuterol)?	3 or more times per day 1	1 or 2 times per day 2	2 or 3 times per week 3	Once a week or less 4	Not at all 5	
5. How would you rate your **asthma** control during the **past 4 weeks**?	Not controlled at all 1	Poorly controlled 2	Somewhat controlled 3	Well controlled 4	Completely controlled 5	
						TOTAL

Supported, in part, by Mead Johnson Nutrition

American Academy of Pediatrics

Appendix I Table of Evidence

First author, Year, Title, Journal	Purpose	Research Design[1], Evidence Level[2] & Variables	Sample & Sampling, Setting	Measures & Reliability (if reported)	Results & Analysis Used	Limitations & Usefulness
Alquran, A., Lambert, K. A., Farouque, A., Holland, A., Davies, J., Lampugnani, E. R., & Erbas, B. (2018, October 29). Smartphone Applications for Encouraging Asthma Self-Management in Adolescents: A Systematic Review. *International Journal of Environmental Public Health*, *11*, 15-18. https://doi.org/10.3390/ijerph15112403	Assess feasibility and efficacy of mobile technology in improving asthma outcomes in adolescents	Literature systematic review: level 5. 291 articles, 16 eligible, 8 met review criteria: 2 interventional, 2 qualitative, 4 observational	None-systematic review.	Quality assessments conducted on included studies for reliability. Heterogeneity related study design and methods prevented meta-analysis	Intervention studies reported a positive effect of smartphone apps on asthma control, medication adherence and self-efficacy.	Smartphone apps may be an effective asthma control tool among teens who are major users of smart phones. Realistic use. Limited conclusions by a lack of controlled trials and adequate sample sizes.
Lancaster, K., Abuxour, A., Khaira, M., Mathers, A., Chan, A., Bui, V., ... Thabane, L. (2018, December 18). The Use and Effects of Electronic Health Tools for Patient Self-Monitoring and Reporting of Outcomes Following Medication Use: Systematic Review. *Journal of Medical Internet Research*, *12*, 18-25. https://doi.org/10.2196/jmir.9284.	To determine the impact of patient use of eHealth tools on self-reporting adverse effects and symptoms that promote	Literature systematic review: level 5. 14 studies including 13 randomized controlled studies and one	None-systematic review.	Data extractions and risk of bias assessment were performed. Heterogeneity related study design and	The 13 RCT's found statistically significant increases in positive medication changes and found	Patients found he use of the smart tool useful to improve communication with provider and did improve health outcome

	changes in medication use.	open label intervention		methods prevented meta-analysis	improvement of patient symptoms especially in adolescent asthma too users.	s for teen asthma patients. Did not find positive correlation on medication use or patient satisfaction.
Kercsmar, C. M., Sorkness, C. A., Calatroni, A., Gergen, P. J., Bloomberg, G. R., & Gruchalla, R. S. (2018, December 5). A computerized decision support tool to implement asthma guidelines for children and adolescents. *Journal of Allergy and Clinical Immunology*, *18*(ii), 49-76. https://doi.org/10.1016/j.jaci.2018.10.060	Evaluate the performance of a computerized decision support tool, the asthma control evaluation and treatment program (ACET) to standardize usual care for asthma management regimens in multicenter randomized controlled trials (RCT'S)	Randomized Controlled Trial. Level 1.	Children and adolescents with persistent asthma in urban center were recruited into 3 multicenter RCT's. sample not given, dates between 2004-2014.	Computerized decision tool scored patient asthma control and assigned treatment step in step with published guidelines.	Half of participants had symptoms that were not controlled or poorly controlled. Control increased significantly with tool use. 51-70% had good control by randomization and remained controlled through the post treatment visit.	The ACET tool facilitated standardized asthma assessment and treatment in multicenter RCT's and was positively associated with attaining and maintaining good control of asthma in most participants.

Salazar, G., Tarwala, G., & Reznik, M. (2018, May). School-based supervised therapy programs to improve asthma outcomes: current perspectives. *Journal of Asthma and Allergy, 11*, 205-215. https://doi.org/10.2147/JAA.S147524	Conduct review of the literature on school based supervised asthma therapy interventions and the effect on outcomes in children with persistent asthma	Literature systematic review: level 5. 443 titles 9 studies met inclusion criteria	None-systematic review	None reported	School based interventions with supervised asthma medication administration revealed improvement in outcomes, adherence to medication, more symptom free days, less health care utilization, fewer exacerbations, less use of steroids, less day and night time symptoms and less absenteeism	Evidence support of school program was strong and school is ideal setting to implement a school based asthma program. Study only on urban children with persistent asthma
Belisario, M. J., Huckvale, K., Greenfield, G., Car, J., & Gunn, L. (2013). Smartphone and tablet self-management apps for asthma. *Cochrane Database of Systematic Reviews, 11*.	Assess the effectiveness, cost effectiveness and feasibility of using smart phone and tablet apps to facilitate the self-managem	Literature systematic review: level 5. Included 2 RCT's with a total of 408 participants	Included 2 RCT's with a total of 408 participants. Included a parallel RCT comparing smart phone app vs.	To maximize external validity, only included interventions using commercially available devices.	Recent development in mobile health technology such as a smart phone app could help develop	Seasonal nature of many asthma cases made it more difficult to assess as well as long term medication

	ent of asthma patients		traditional paper-based asthma diaries		a platform for the delivery of self-management interventions that are highly customizable low-cost and easily accessible.	adherence.
Tinschert, P., Jakob, R., Barata, F., Kramer, J., & Kowatsch, T. (2017, August). The Potential of Mobile Apps for Improving Asthma Self-Management: A Review of Publicly Available and Well-Adopted Asthma Apps. *JMIR Mhealth Uhealth*, *113*. https://doi.org/10.2196/mhealth.7177	To assess the potential of publicly available and well adopted mHealth apps for improving asthma management	Qualitative level 5 review 523 apps identified, 38 matched criteria	None reported	Four requirements for app potential were app functions, potential to change behavior, potential to promote app by gamification taxonomy, and mobile app rating scale quality	Most common features of the 38 apps were tracking and information add functions, assessment and notifications for usage. Several were chosen as best in area for mHealth use and have the most potential to impact change and a decision support tool	Many apps suffer from low quality and there is a research-practice application gap in this area f mHealth technology and developers need to address these issues for optimal app usage

Blaakman, S., Cohen, A., Fagnano, M., & Halterman, J. (2014). Asthma medication adherence among urban teens: a qualitative analysis of barriers, facilitators and experiences with school-based care. *Journal of Asthma*, *51*(5), 522-529. Retrieved from www.scopus.org	To understand urban teen experiences with asthma management, preventative medication adherence and participation in a school based intervention.	Level 3 quasi-experimental with qualitative meta-analysis	Teens age 12-15 with persistent asthma on meds participate in pilot study with daily med observation and motivational interviewing and surveys	Qualitative content analysis enabled data coding to identify common themes-asthma management and program specific	Teens with asthma benefit from adherence to preventative meds but encounter numerous barriers to proper use. School program proven beneficial.	Barriers in school setting such as missed class time, perceptions about leaving classroom from peers, distance from nurse office. School nurse care especially beneficial in asthma and teen care
Burbank, A., Lewis, S., Hewes, M., Schellhase, D., Rettiganti, M., & Barrow, J. H. (2015, January). Mobile-based asthma action plans for adolescents. *Journal of Asthma*, *52*, 583-586. https://doi.org/10.3109/02770903.2014.995307	To examine feasibility and utilization of a mobile asthma action plan among adolescents	Level 3 quasi-experimental with quantitative meta-analysis	Teens age 12-17 with persistent asthma had personalized asthma action plan loaded into a smart phone app-recorded meds and daily peak flow meter-app responded to data. Asthma control testing	Teens accessed the app 4.3 days per week. Data of ACT score analysis completed using SAS software and data had level of significance of 5%	93% were satisfied with the app and better control was noted. ACT scores improved and medication self-efficacy improved both by nearly 20%	Results suggest a personalized mobile app with asthma action plan is a feasible way to communicate with teens with asthma and can improve control. Must have home or school access for daily peak

			pre- and post-intervention			flow meter use
Drotar, D., & Bonner, M. (2009, September). Influences on Adherence to Pediatric Asthma Treatment: A review of correlates and predictors. *Journal of Developmental and Behavioral Pediatrics*, *30*(6), 574-582. https://doi.org/10.1097/DBP.obo13e3181c3cbb	To identify influences on adherence to pediatric asthma treatment correlates and predictors to success of an asthma treatment program or regimen	Qualitative level 5 review	Review of concepts in the literature that psychologically influence factors that benefit adherence or negatively impact the use of inhaled corticosteroids and the reasons why medication was not taken as directed	None noted	Conceptual model was identified with significant predictors of adherence composed of parental influence, family demographic, family and parent relationship and function, parental beliefs about asthma	Clinical management of asthma needs to be enhanced with clinical assessments of barriers to treatment adherence and anticipatory interventions to prevent nonadherence
Duncan, C. L., Hogan, M., Tien, K., Graves, M., Chorney, J. M., Zettler, M. D., ... Portnoy, J. (2012, December 15). Efficacy of a Parent- youth teamwork intervention to promote adherence in pediatric asthma. *Journal of Pediatric Psychology*, *38*(6), 617-628. https://doi.org/10.1093/jpepsy/jss123	To determine whether a parent youth teamwork intervention improved medication adherence and related outcomes among children with asthma	Level 1 RCT study	48 youth age 9-15 in three groups: teamwork intervention, asthma education, standard care. 2-month intervention with 3-month follow-up	Medication adherence was measured with the MDILOG-II. Mixed linear model analysis evaluated outcome measures	Teamwork group had significantly higher adherence and lower functional severity scores than the other 2 groups and lower parent reported conflict trend	Results suggest support for teamwork model of care to improve medication adherence. Helps to promote learning independent medication administration

					and higher spirometry values.	skills into older adolescence
Fedele, D. A., McConville, A., Thomas, J. G., McQuaid, E. L., Janicke, D. M., Turner, E. M., ... Abu-Hasan, M. (2018, January). Applying Interactive Mobile health to Asthma Care in Teens (AIM2ACT): Development and design of a randomized controlled trial. *Contemporary Clinical Trials*, *64*, 230-237. https://doi.org/https://doi-org.proxy.library.umkc.edu/10.1016/j.cct.2017.09.007	Development of the AIM2ACT or applying interactive mobile health to asthma care in teens-enhance asthma care plan implementation and a smart phone self-guided intervention	Pilot RCT level 1	Teens age 12-15 and caregivers, 50 teens with poorly controlled asthma in sample of pilot study over 4 months	Utilized a parent advisory board to guide the intervention feasibility. Beta testing completed on application used. Statistic analysis using GLMM, had safety monitor of data overseeing safety and data quality.	First study to use parent and teens to focus solely on their partnership in asthma management and to help with the transition from youth to adult in self-management of chronic illness. Demonstrated supportive behavioral skills-based approach helped to improve asthma management	Helps to inform the utility of mHealth applications to foster the development of asthma self-management skills of teens. Narrow age range limited recruitment.
Global Initiative for Asthma. (2018). Pocket Guide for Asthma Management and Prevention for Adults and Children older than 5 years for Health Professionals. *Global Initiative for Asthma*. Retrieved from https://ginasthma.org/wp-content/uploads/2018/03/wms-	Summarized guide for asthma management in ages 5 and up	EBPG widely accepted and studied	None	None	Global thought leader developed EBPG for asthma with recent updates	Does not address reactive airway and asthma care under the age of 5

GINA-main-pocket-guide_2018-v1.0.pdf					is widely used and accepted as a leading resource for clinicians	
Simon, A. E., & Akinbami, L. J. (2016, January 5). Asthma Action Plan Receipt among Children with Asthma 2-17 years of age, United States, 2002-2013. *Journal of Pediatrics, 01*. https://doi.org/10.1016/j.jpeds.2016.01.004	Examine national trends in the receipt of asthma action plans	Level 5 review of the National Health Interview Survey from 2002,2008 and 2013 to assess if an asthma action plan was received	Ages 2-17 with asthma (n=3714) bivariate and multivariate logistic regressions for trending and action plan receipt compared to socioeconomic and asthma severity	Deep statistical analysis of different ages, sex, ethnicities, insurance status, poverty and urban/suburban status	Increases in receipt of asthma action plans by 9% from 2002-2013 with a greater percentage of black children than non-hispanic white and a 10% difference in insured vs. uninsured receipt. Half of children with asthma never received an asthma action plan in 2013.	4 years of missing time in the surveys, some other small pieces of missing data from the survey. Strong socioeconomic and asthma severity correlations to action plan receipt.

Harris, K., Kneale, D., Lasserson, T., Mcdonald, V., Grigg, J., & Thomas, J. (2019, January 28). School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review. *Cochrane Database Systematic Reviews*, *1*(1). https://doi.org/10.1002/14651858	Identify intervention features that are aligned with successful intervention implementation and assess effectiveness of school-based interventions to improve asthma self-management in children	Qualitative level 5 review comparative analysis and outcome meta-analysis, 55 studies reviewed	School aged children with asthma with school intervention and gathered outcome data on health care usage	None reported	School-based asthma self-management interventions reduce hospital admissions and reduce ED visits. Reduction in asthma symptom days and improved quality of life.	Not able to use data to assess missed school days from asthma. Interventions with theoretical framework and engaged parents were associated with more successful intervention
Harstad, E. H. (2013, February). Asthma and Adolescents: Review of Strategies to Improve Control. *Journal of School Nursing*, *29*, 39-51. https://doi.org/10.1177/1059840 4251254546	Integrative review of strategies for school nurses to employ with adolescents to foster self-management skills	Qualitative level 5 review	2005-11 review of research in school setting	None noted	Support the need of school nurses to engage teens with asthma to practice self-management behaviors, monitor asthma control, manage acute asthma episodes and coordinate care with parents	School only setting. Useful to support the important role of the school nurse in asthma care planning

Hui, C. Y., Walton, R., Mckinstry, B., Jackson, T., Parker, R., & Pinnock, H. (2016, October 2). The use of mobile applications to support self-management for people with asthma: a systematic review of controlled studies to identify features associated with clinical effectiveness and adherence. *A Scholarly Journal of Informatics in Health and Biomedicine*, *24*(3), 619-632. https://doi.org/10.1093/jamia/ocw143	To identify which information and communication technology features implemented in mobile apps to support asthma self-management are associated with adoption, adherence to usage and clinical effectiveness	Qualitative level 5 review	2000-2016 review of RCT's, quasi-experimental studies with adults	Assessed papers for quality and outcome measures.	Meta-analysis of data from 3 trials showed improved asthma control. Features were widely varied such as education, diary, action plans and medication reminders.	Adult study. Need to further research to address features associated with adoption and adherence for mobile app use
Liu, A., Zeiger, R., Sorkness, C., Mahr, T., Ostrom, N., Burgess, S., ... Manjunath, R. (2007, April). Development and cross-sectional validation of the Childhood Asthma Control Test. *The Journal of Allergy and Clinical Immunology*, *119*, 817-825. https://doi.org/10.1016/j.jaci.2007.12.662	To review the development and validation of the asthma control test use in childhood	Level 5 systematic review of ACT development and validation	none	none	ACT is widely used and well-studied, valid measure of asthma control for a wide age range	ACT is used in most clinical settings as an excellent tool to gain a snapshot of asthma control and medication use, and quality of life
Mosnaim, G., Li, H., Martin, M., Richardson, D., Belice, P. J., & Avery, E. (2015, March-April). A tailored mobile health intervention to improve adherence and asthma control in minority adolescents. *Journal of Allergy and Clinical Immunology: In Practice*, *3*(2), 288-290.	Aimed to assess the feasibility and explore the efficacy of an intervention using	Level 3 quasi-experimental proof of concept study design-3-week pre-	11-16 year- old African American with persistent asthma with a prescription of	ACT baseline and post treatment measurement, daily SABA and ICS	ACT scores improved significantly, individualized platform proved	A tailored intervention delivered on a mobile phone platform may be

https://doi.org/10.1016/j.jaip.2014.10.011	electronic medication monitor and companion smartphone asthma application to deliver a tailored intervention to improve ICS adherence in low health literacy population	intervention, 8 week intervention with 2 week follow up design timeline	inhaled corticosteroid in the urban primary care clinic at Rush Pediatrics in Chicago-12 patients identified. Low health literacy, low educational literacy, underserved at risk urban teens	medication adherence was monitored and reported, measurement were placed into quartiles and statistically analyzed.	to be very effective and easy way for low literacy teens to use the application, increased medication adherence and could help improve asthma morbidity in this population	a powerful way to promote increased adherence and asthma control among underserved minority adolescents
Naimi, D. R., Freedman, T. G., Ginsburg, K., Bogen, D., Rand, C., & Apier, A. (2009, June). Adolescents and Asthma: Why bother with our meds? *The Journal of Allergy and Clinical Immunology*, *123*(6), 1335-1341. https://doi.org/10.1016/j.jaci.2009.02.022	To describe adherence to preventive asthma medications and explore relevant beliefs and attitudes in older urban teens	Level 4/5 quantitative and qualitative method from a convenience sample	40 patients age 15-18 with a history of asthma hospitalization 2 structured interviews one month apart	Analysis of data for themes and patterns of beliefs	Ideas on medication adherence failure included inconsistency, taste, side effects, too busy, forgetfulness and lack of reminders.	Medication adherence was poor in this population and examining and acknowledging health beliefs in older teens could help them be more compliant and understand medication adherence with a busy complica

						ted adolescent life.
Nathan, R. A., Sorkness, C., Kosinski, M., Schatz, M., Li, J., Marcus, P., ... Pendergraft, T. (2004). Development of the Asthma Control Test: A survey for assessing asthma control. *Journal of Allergy and Clinical Immunology*, *113*, 59-65. https://doi.org/10.1016/j.jaci.2003.09.008	Describe Asthma Control Test development process and its use in patient care and validity	Level 5 quantitative survey administration-22 question survey	Offices of asthma specialists 471 patients in the office being seen for asthma. Specialist's rating of asthma control after in-office spirometry	Stepwise regression methods used to subset the group, internal consistency reliability was computed and discriminant validity tests on ACT scores. Performance of ACT used in logisitic regression methods and receiver operating characteristic analyses.	Five items were selected from regression analyses-as a screening tool the overall agreement of the ACT and specialist rating were 71-78%	Study results reinforce the usefulness of the ACT as a brief, easy to administer, patient-based asthma index of control with high reliability and usefulness.
Odom, L., & Christenbery, T. (2016, May 6). There is an "app" for that: Designing mobile phone technology to improve asthma action plan use in adolescent patients. *Journal of the American Association of Nurse Practitioners*, *28*, 583-590. https://doi.org/10.1002/2327-6924.12375	Project to develop an asthma action plan application for smartphones	Used develop mental studio to create application, software development	Used patient surveys to help guide develop mental design of the app.	none	Application was noted as easy to use and easy to understand for patients with any level of severity-all agreed app would be	Primary goal was to improve assess to asthma action plans and goal was met

					helpful to provide information to improve care and medication administration	
Perry, T. (2018). A randomized trial examining the effectiveness of mobile-based asthma action plans vs. paper asthma action plans (PEAK2). Retrieved from www.clinicaltrials.gov/NCT02091869	Comparison of effectiveness of mobile asthma action plan versus a paper asthma action plan	Interventional randomized trial parallel assignment treatment level 3	34 patients in Arkansas Children's hospital, 17 each in group	Comparison of asthma control test scores, staff biostatistician used number random generator ANCOVA in the protocol. Also used child asthma self-efficacy instrument scores	Paper plan was accessed 7 days per week and mobile app was accessed 4.5 times per week. Slight improvement of AC scores in the mobile app group	Mobile health was accessed less often but showed to be more effective in positively improving asthma control
Perry, T., Marshall, A., Berlinski, A., Rettganti, M., Brown, R., Randall, S., ... Bian, J. (2017, March). Smartphone-based vs paper-based asthma action plans for adolescents. *Annals of Allergy, Asthma & Immunology*, *11*(3), 298-303. https://doi.org/https://doi.org/10.1016/j.anai.2016.11.028	Examine adolescent use of asthma smart phone applications and outcomes vs. paper based asthma action plan	6-month RCT quasi experimental study level 3	34 Teens 12-17 with persistent asthma African American 62% on state insurance 72% in clinical setting-patients used paper AAP or smart phone AAP-	Used PASS and other stat analysis of the data for statistical significance	Smartphone app was accessed 12.7 times per week and recorded data 10 days per month over 6 months Paper group recorded data more	ACT scores improved more on smart phone app compared to paper-30% improved overall scores. No change with paper group. Teen

			measured electronically or mail in diaries-changes in Asthma control test scores were evaluated and self-efficacy scores		often at 23 days,	satisfaction with application use was 100% and all would recommend using the app over paper for asthma application. Need more study on why accessed less but had more improvement-also need to address how to improve app access and adopting into daily life
Phillips, G., Farooqui, N., Barrett, C., & Stukus, D. (2015). Acceptability of an interactive asthma management mobile health application for children and adolescents. *Annals of Allergy Asthma and Immunology*, *114*, 522-536. Retrieved from jaaai.org	Supportive editorial for the use of smart phone mHealth app for asthma management of children and adolescents	Editorial opinion by thought leader and partial level 7 review	Asthma care app with medical content driven by NHLBI asthma guidelines 24 patients in their practice used the app with great outcomes	none	Smartphone apps offer functional modern tool to help with medication management and trigger avoidance strategies and interactive	Future mHealth apps should include evidence based self-management tools and prospective clinical trials to demonstrate efficacy

					treatment plan	
Portnoy, J., & Murphy, H. (2017, March). Is it time for asthma action plan apps? *Annals of Allergy, Asthma and Immunology*, *118*, 239-240. https://doi.org/10.1016/j.anai.2017.01.001	Opinion of KC asthma pediatric specialist on asthma application uses and AAP guidelines	Editorial response to the Perry et al study on smart phone vs paper asthma action plans for teens	None noted	None noted	Believes access to real time online self-management instructions to manage daily asthma symptoms and the use of applications to help bridge the gap between paper and tech application to help manage asthma	Must be a tailored approach to using an app and be sure patient understands how to use it with continuous monitoring and education
Ramsey, R., Carmody, J., Holbein, C., Guilbert, T., & Hommel, K. (2018, September 12). Examination of the uses, needs, and preferences for health technology use in adolescents with asthma. *Journal of Asthma*, *12*, 1-9. https://doi.org/10.1080/02770903.2018.1514048	Examine health technology uses and preferences of adolescents with asthma	Level 5 qualitative descriptive individual interview approach	20 adolescents recruited at asthma clinic during scheduled appointment in asthma office	Interviewed on technology uses and ways health technology could improve asthma management-semi-structured open ended format	Social media and texting were most common uses reported-teens reported that medication and tracking apps, medication reminders, and self-management training on phone all	Teens and parents have challenges managing asthma and health tech should focus on ways to improve adherence and medication self-management and should be able to integrate teen

					would be helpful- most wanted customizability and to be able to communicate with providers via phone app.	preferences- small interview sample
Rhee, H., Belyea, M., & Brasch, J. (2009). Family support and asthma outcomes in adolescents: Barriers to adherence as a Mediator. *Journal of Adolescent Health, 47*, 472-478. https://doi.org/10.1016/j.adolhealth,2010.03.009	Examine the role of barriers to adherence in mediating the effect of family support on asthma outcomes in adolescents	Level 4 case control qualitative study	126 teens age 13-20 Northeast U.S self-reported data	Structural equation modeling was performed to examine direct and indirect relationships	Family support was positively associated with asthma control and quality of life	Largest barrier was parental negative feeling about medications and negative attitudes towards providers
Roberts, C., Sage, A., Geryk, L., Sleath, B., & Carpenter, D. (2018, September). Adolescent preferences and design recommendations for an asthma self-management app: Mixed-Methods Study. *Journal of Medical Informatic Research, 13*. https://doi.org/10.2196/10055	Assess adolescent preferences and design recommendations for an asthma self-management app	Level 4/5 Mixed method study	20 teens age 12-16 with persistent asthma provided feedback on 2 asthma management apps with structured interview	SPSS v24 analysis, MAXQDA 11 thematic coding, recordings and transcribed	Layout, esthetics and visual simplicity were important. Useful, easy to use and customization with medication notification were top features, air quality links and voice comman	Teens want customization and tailoring to meet their own needs in asthma management and will be more likely to adopt into daily frequent use when these preferences are used in

					d were also highlighted.	app design
Wu, A. C. (2016). The Promise of Improving Asthma Control Using Mobile Health: Editorial. *Journal of Allergy and Clinical Immunology In Practice*. https://doi.org/10.1016.j.jaip.2016.04.003	Supportive editorial for the positive uses for mobile health technology and asthma	Editorial response to Cook et al. paper on asthma control	none	None	Supports proof of concept study demonstrates great promise for asthma app use to improve asthma control	Needs larger population and more diverse sample
Cook, K. A., Modena, B. D., & Simon, R. A. (2016, July-August). Improvement in Asthma Control Using a Minimally Burdensome and Proactive Smartphone Application. *The Journal of Allergy and Clinical Immunology: In Practice*, *4*(4), 730-737. https://doi.org/10.1016/j.jaip.2016.03.005	To assess efficacy of improving asthma control using proactive smartphone app without required regular inputs	Level 3 quasi-experiential proof of concept study	60 adults with poorly controlled asthma over 4 months. Asthma control testing done prior and at the conclusion to assess control and application impact	Also conducted peak flow and spirometry evaluations for quantitative data evaluation	ACT scores rose from 16 to 20 into controlled range and had a 7.9% increase in FEV1 and decreased use of steroid use from 0.5 to 0.3 courses per 6 month time. 97% of patients were highly satisfied with the program and the application	Adult study mean age 50- not applied to pediatrics but did have ages 17-82 enrolled

Appendix J

Recruitment Materials and Clinic Information Sheet

Project Recruitment Intake Form

Patient: _____ Project ID #_____

Age: _____ Sex: _____ Race: _____ Most recent weight: _____kg

Asthma Diagnosis in what year: _____

Inhalers used with dosage and strength:
_____

Other Medications:
_____

Co-morbidities:
_____

Asthma Action Plan Updated by Primary Care Physician: yes/no
(place copy of up to date AAP in file)

Type of Phone used: _____

Download AAP Asthma application: yes/no

Education on App use: yes/no

Parental Consent completed: yes/no

Parent download app: yes/no

Adolescent Asthma Project Information Sheet
Project Manager: Sally Ehrich MSN, CPNP-PC clinic nurse practitioner
Fall 2019: Seeking teens to participate in asthma improvement project

Requirements:
Age 10-21, have a smart phone, have a valid and updated asthma action plan in their chart, use a quick-acting inhaler (routinely or just as-needed) and want to improve their asthma control using a smartphone application on their phone

Process:
If you are interested, the nurse will talk to you about taking 10 minutes at the end of your routine office visit today and have Sally, the clinic nurse practitioner, come in and tell you more about the project. Your parent or you if you are over 18 will sign a consent to participate form. Sally will give you a quick 5 question quiz to get an idea of how well your asthma is controlled and review your current asthma action plan. Together with Sally and your parent's help, you will download the American Academy of Pediatrics smart phone application from the app store (it also works on android and on tablets) and then you will learn how to load your medications, use the app and set up notifications and other functions. Go live your life as usual and use the app as often as you need- you can look at the app for medical information on asthma, remind yourself to take your medications as your provider has prescribed, and journal your symptoms or jot down questions for your next visit. You will be asked to return to clinic in 3-6 months for your routine asthma follow-up appointment. At the follow-up visit, Sally will give you that quick 5 question quiz again and talk to you about your experience using the app and your thoughts on how may have changed your asthma management program.

Why are we doing this?
Sally is finishing her Doctorate in Nursing at UMKC this May and this is her final project to make a quality improvement project to change and improve an important part of the clinic's way teens manage their asthma. She wants to help make it easier for asthmatic teens to use their medications correctly, improve their asthma control, and let you have less days with asthma symptoms. She is hoping that with the use of the phone app it will make living with asthma easier and for you to have better quality of life.
Thank you for your time and help on this important clinic initiative!

Appendix K

Data Collection Template SPSS Screenshot

Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
age	Numeric	8	2	years	None	None	8	Right	Scale	Input
gender	Numeric	8	0		{1, male}...	None	8	Right	Nominal	Input
race	Numeric	8	0		{1, white}...	None	8	Right	Nominal	Input
weight	Numeric	8	2	kilograms	None	None	8	Right	Scale	Input
albuterol	Numeric	8	2		{1.00, yes}...	None	8	Right	Nominal	Input
flovent	Numeric	8	2		{1.00, yes}...	None	8	Right	Nominal	Input
singulair	Numeric	8	2		{1.00, yes}...	None	8	Right	Nominal	Input
orapred	Numeric	8	2		{1.00, yes}...	None	8	Right	Nominal	Input
otherinhaler	Numeric	8	2		{1.00, yes}...	None	8	Right	Nominal	Input
pretestact	Numeric	8	2		None	None	8	Right	Scale	Input
postasct	Numeric	8	2		None	None	8	Right	Scale	Input
comments	String	8	0	med changes	None	None	8	Left	Nominal	Input

Appendix L

Statistical Analysis Table Template

	Statistical tests	Correlation Tests
Pre and Post ACT score	Paired T-Test p >0.001 Wilcoxon Test Simple comparison of mean change pre- and post- test scoring	Significant change noted in paired t-testing. No significance found in Wilcoxon. 13.2% average change.
Age, Gender, Race, Weight, co-morbidities with ACT scoring comparisons and correlations.		Spearman bivariate 2 tailed None statistical correlation found.

Comparison of average ACT score change was 13.2%

Appendix M

Faculty DNP Approval Letter

July 17, 2019

DNP Project Proposal Approval UMKC DNP Student

This letter serves to provide documentation regarding Sally Ehrich's Doctor of Nursing Practice (DNP) project proposal. Ms. Ehrich obtained approval for her proposal, Smartphone Asthma Action Plan Application Use in Adolescent Asthma Management, from the School of Nursing and Health Studies DNP faculty on July 17, 2019.

If we can provide further information, please feel free to contact us.
Sincerely,

Cheri Barber, DNP, RN, PPCNP-BC, FAANP
Clinical Assistant Professor DNP Program Director UMKC School of Nursing and Health Studies barberch@umkc.edu

Lyla Lindholm, DNP, ACNS-BC UMKC MSN-DNP Program Coordinator Clinical Assistant Professor DNP Faculty

Appendix N

IRB Approval

Institutional Review Board University of Missouri-Kansas City
University of Missouri-Kansas City
5319 Rockhill Road Kansas City, MO 64110
816-235-5927
umkcirb@umkc.edu

Dear Lyla Jo Lindholm,

A member of the UMKC Research Compliance Office screened your QI Questionnaire to project #2016129-QI entitled "Smartphone Asthma Action Plan Application Use in Adolescent Asthma Management" and made the following determination:
QI Determination: The project has been determined to be a quality improvement activity not The project has been determined to be a quality improvement activity not requiring IRB review. requiring IRB review.

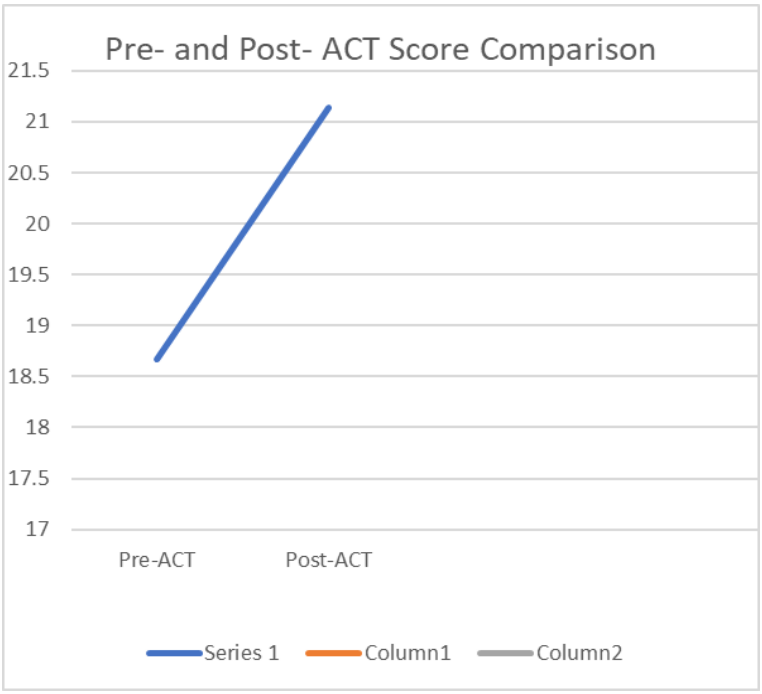
If you have any questions regarding this determination, please feel free to contact our office at 816-235-5927, umkcirb@umkc.edu, or by replying to this notification.
Note Regarding Publications: It is appropriate to disseminate and replicate QI/program evaluation successes, including sharing the information external to an organization. This may include presentations and publications. The mere intent to publish the findings does not require IRB review as long as the publication does not refer to the activity as research.

Thank you,

UMKC Institutional Review Board

Appendix O

Statistical Analysis Results Table and Graphs



n=22
Pre-ACT Post-ACT Average Score Comparison: 13.2% increase in mean ACT scores

Paired T-Test

	Mean	Std. Deviation	Std. Error Mean
PreACT - PostACT	-2.45455	2.32435	.49555

95% CI Difference	
Lower	Upper
-3.48510	-1.42399

	Mean	N	Std. Deviation	Std. Error Mean
PreACT	18.6818	22	3.22765	.68814
PostACT	21.1364	22	1.80727	.38531

Pearson Correlations

	N	Correlation	**Sig. *significant change***
PreACT & PostACT	22	.710	**.000**

Wilcoxon Signed Rank Test: preACT and postACT (positive, negative, no change)
Total N 22
Test Statistic 190.0
Standard Error 24.531
Standardized Test Statistic 3.873
No significance