EVALUATING CAREGIVER-LED ASTHMA MANAGEMENT FOR PRESCHOOL CHILDREN WITH UNCONTROLLED ASTHMA IN MAKKAH: QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Uncontrolled asthma remains a significant public health problem among preschool children in Makkah, Saudi Arabia, because young children depend entirely on caregivers for medication administration, symptom monitoring, and trigger avoidance. This study aims to evaluate the effectiveness of a caregiver-led asthma management program for preschool children with uncontrolled asthma. A quasi-experimental pretest-posttest design with intervention and control groups will be used. A total of 120 caregivers will participate, with 60 caregivers in each group. Data will be collected using a caregiver knowledge and practice questionnaire, the Childhood Asthma Control Test, and the Test for Respiratory and Asthma Control in Kids. The intervention will include structured caregiver education on asthma triggers, medication adherence, inhaler technique, symptom monitoring, and home-based management. The study is expected to strengthen caregiver knowledge, improve asthma symptom control, reduce emergency visits, and support family-centered asthma care in Saudi primary healthcare settings.

Keywords: Asthma, Caregiver Education, Preschool Children, Quasi-Experimental Study, Primary Healthcare

INTRODUCTION

Asthma is one of the most common chronic respiratory diseases affecting children worldwide and continues to represent a major public health burden (Almotairy, 2020). It is characterized by airway inflammation, bronchial hyper-responsiveness, variable airflow obstruction, wheezing, coughing, chest tightness, and shortness of breath. Although many asthma symptoms can be managed through appropriate medications and self-management strategies, uncontrolled asthma remains common among children and is associated with repeated emergency department visits, hospital admissions, sleep disturbance, activity limitation, caregiver anxiety, and reduced quality of life. The impact of asthma is not limited to the child alone; it also affects families through emotional stress, missed workdays, healthcare costs, and increased dependence on healthcare services (Szilagyi, 2004).

Preschool children are a highly vulnerable group in asthma care because they are unable to manage their condition independently (Li, 2024). Children aged three to five years depend almost entirely on caregivers for recognizing symptoms, administering medications, avoiding triggers, using inhalers and spacers correctly, and seeking timely healthcare when symptoms worsen. In this age group, asthma symptoms may also be difficult to distinguish from other respiratory conditions, and diagnosis can be challenging because young children cannot always describe their symptoms accurately. As a result, effective asthma management among preschool children is closely linked to caregiver knowledge, confidence, daily practices, and ability to apply health instructions at home.

In Saudi Arabia, childhood asthma remains a persistent and important health problem. National and regional studies have reported high rates of poorly controlled asthma among children, and many children continue to experience recurrent exacerbations despite access to healthcare services. Several factors contribute to poor asthma control, including limited caregiver awareness, incorrect inhaler technique, inconsistent use of controller medications, lack of written asthma action plans, exposure to environmental triggers, and delay in seeking medical care. These factors indicate that medication alone is insufficient unless caregivers are supported with structured education and practical skills that enable them to manage asthma effectively at home (Gumbo, 2022).

The local context of Makkah makes this issue particularly important. Makkah has unique environmental, social, and healthcare characteristics that may influence asthma control among children. Environmental dust, air pollution, seasonal population density, overcrowding, climate variation, and exposure to household irritants such as smoke, incense, and allergens may increase the risk of asthma exacerbations. In addition, caregiving practices in Saudi families may involve mothers, fathers, grandparents, and other extended family members, which can affect consistency in medication administration and trigger control. These contextual factors highlight the need for culturally appropriate and locally relevant caregiver-led asthma management programs.

Caregiver education is widely recognized as a key element in pediatric asthma management (Butz, 2016). International evidence suggests that structured asthma education can improve caregiver knowledge, inhaler technique, adherence to medications, recognition of early warning signs, and appropriate response to worsening symptoms. Educational interventions may also reduce unnecessary emergency visits by helping caregivers manage mild symptoms at home and seek care before severe exacerbations occur. However, the effectiveness of caregiver education depends on the content, delivery method, follow-up, cultural relevance, caregiver engagement, and simplicity of the educational materials.

Several previous studies have evaluated asthma education programs for parents and caregivers. Some studies reported improvements in caregiver knowledge, medication adherence, asthma control scores, and quality of life after structured interventions (Sommanus et al., 2022). Other studies showed less consistent clinical outcomes, suggesting that knowledge improvement alone may not always produce sustained behavioral change (Boutopoulou et al., 2018). This inconsistency indicates that asthma education should not only provide information but also develop practical skills, increase caregiver self-efficacy, and address real-life barriers such as fear of medication, misunderstanding of controller therapy, poor inhaler technique, and environmental limitations inside the home.

In Saudi Arabia, many studies have examined asthma prevalence, asthma control, and caregiver knowledge among children (Aggarwal et al., 2024). However, much of the available evidence is cross-sectional and focuses on broad pediatric age groups rather than preschool children specifically. Cross-sectional designs are useful for describing the problem, but they cannot adequately evaluate whether an intervention can improve caregiver practices and child outcomes over time. There remains a need for intervention-based research that examines whether structured caregiver-led education can improve asthma symptom control among preschool children with uncontrolled asthma in Saudi primary healthcare settings (Dailah, 2021a).

This study addresses that gap by evaluating a caregiver-led asthma management program for preschool children with uncontrolled asthma in Makkah using a quasi-experimental pretest-posttest design with intervention and control groups (Yang et al., 2024). The program will focus on practical caregiver education, including asthma basics, trigger identification, medication adherence, correct inhaler and spacer technique, symptom monitoring, emergency

response, and home management. By comparing outcomes before and after the intervention and between the intervention and control groups, the study will provide evidence regarding the potential effectiveness of caregiver-led asthma management in this population.

The study is also aligned with the Saudi Initiative for Asthma guidelines, which emphasize asthma control, patient and family education, shared decision-making, and written self-management plans (Yang et al., 2024). It is also consistent with Saudi Vision 2030 priorities related to preventive healthcare, improved quality of care, efficient use of health resources, and patient-centered services. Strengthening caregiver capacity may reduce avoidable emergency visits and hospital admissions, improve continuity of care, and support the role of primary healthcare centers in chronic disease management.

The theoretical foundation of the study is consistent with family-centered care and health behavior concepts (Lv et al., 2024). Family-centered care emphasizes partnership between healthcare providers and families, respect for family values, and active caregiver involvement in decision-making. The Health Belief Model suggests that caregivers are more likely to engage in preventive behaviors when they understand the seriousness of asthma, perceive the benefits of management practices, recognize barriers, and feel confident in their ability to act. Therefore, a structured caregiver-led asthma management program may improve outcomes by increasing knowledge, reducing misconceptions, and strengthening caregiver self-efficacy.

The general objective of this study is to evaluate the effectiveness of a caregiver-led asthma management program on symptom control among preschool children with uncontrolled asthma in Makkah (Baek et al., 2019; Gustafson et al., 2012). Specifically, the study will assess caregiver knowledge and practices before and after the intervention, determine asthma symptom control levels among children, compare changes between intervention and control groups, and identify which program components may be associated with improved asthma control. The study hypothesizes that caregivers who receive structured asthma education will demonstrate improved knowledge and management practices, and that children in the intervention group will show better asthma symptom control than children receiving standard care.

METHOD

This study will use a quasi-experimental pretest-posttest design with intervention and control groups (Baek et al., 2019)(Gustafson et al., 2012) . This design is appropriate because the study evaluates the effect of a structured educational intervention in real-world primary healthcare settings where random assignment may not be practical. A quasi-experimental approach allows comparison of outcomes before and after the intervention and between two groups, while maintaining feasibility within healthcare service delivery (Handley et al., 2011). The intervention group will receive the caregiver-led asthma management program, while the control group will continue to receive standard care.

The study will be conducted in selected primary healthcare centers in Makkah, Saudi Arabia. Hadda Primary Healthcare Center will serve as the intervention setting, while Alnawarryah Primary Healthcare Center will serve as the control setting. These centers are appropriate because they provide primary healthcare services for children with asthma and maintain health records that can assist in identifying eligible participants (Hassan et al., 2022). The use of two different centers also reduces contamination between intervention and control groups because caregivers in the control group will not receive the structured educational sessions during the study period.

The study population will include caregivers of preschool children aged three to five years diagnosed with uncontrolled asthma. The caregiver may be a parent or primary family

caregiver responsible for the child's daily asthma management. A total of 120 caregivers will be included, with 60 caregivers in the intervention group and 60 caregivers in the control group. Total population sampling will be used because the number of eligible preschool children with uncontrolled asthma in the selected centers is limited. Including all eligible participants will increase sample coverage and strengthen the practical relevance of the findings.

Inclusion criteria will include caregivers of preschool children aged three to five years, children diagnosed with asthma by a physician, children with uncontrolled asthma based on clinical assessment or asthma control tools, caregivers who are willing to participate in the study, and caregivers who can understand Arabic instructions and educational materials. Exclusion criteria will include children with severe chronic illnesses unrelated to asthma that may affect respiratory symptoms, caregivers who are unable to attend the educational sessions, and caregivers who decline to provide informed consent. These criteria are intended to ensure that participants are suitable for the intervention and that measured outcomes are related primarily to asthma management.

Data will be collected using structured and age-appropriate tools. The Caregiver Knowledge and Practice Questionnaire will assess caregiver understanding of asthma symptoms, triggers, medication use, inhaler technique, action plans, symptom monitoring, and home management practices. The questionnaire will include demographic information about caregivers and children, such as caregiver age, education, relationship to the child, child age, gender, asthma history, and previous emergency visits. These variables may help describe the sample and identify possible factors influencing asthma control.

Asthma symptom control will be assessed using validated tools suitable for preschool children. The Childhood Asthma Control Test will be used for children who meet the appropriate age and reporting requirements, while the Test for Respiratory and Asthma Control in Kids will be used for younger children who depend on caregiver reports. These tools are widely used in pediatric asthma research and clinical practice. They allow standardized assessment of symptom control before and after the intervention and support comparison between the intervention and control groups.

The caregiver-led asthma management program will be structured around practical and culturally appropriate educational content. The program will include asthma basics, causes and symptoms, common triggers, environmental control, medication adherence, correct use of inhalers and spacers, recognition of warning signs, management of mild symptoms at home, when to seek emergency care, and the importance of follow-up visits. Educational methods will include short teaching sessions, visual materials, demonstrations, caregiver discussion, and practice of inhaler and spacer technique. The materials will be delivered in Arabic to ensure clarity and cultural appropriateness.

Caregivers in the intervention group will receive the educational program in the primary healthcare setting. The program will emphasize interactive learning rather than passive information delivery. Caregivers will be encouraged to ask questions, demonstrate inhaler technique, discuss difficulties in medication use, and identify triggers commonly present in their homes. This approach is expected to improve confidence and practical skills. The control group will receive the usual standard care provided by the healthcare center and will not receive the structured educational program during the study period.

Data collection will occur at two main points: before the intervention and after the intervention. At baseline, both groups will complete the caregiver questionnaire and asthma control assessment. After the intervention period, the same tools will be administered again to measure changes in caregiver knowledge, caregiver practices, and child asthma symptom control. Using the same measures before and after the intervention will support evaluation of change over time and comparison between groups.

Data analysis will include descriptive and inferential statistics (Basnet et al., 2024). Descriptive statistics will summarize caregiver and child demographic characteristics, baseline knowledge, asthma control levels, and management practices. Frequencies, percentages, means, and standard deviations will be used as appropriate. Inferential statistics will be used to compare pretest and posttest scores within groups and between groups (Nour et al., 2023). Paired t-tests may be used to assess within-group changes, while independent t-tests or equivalent non-parametric tests may compare intervention and control groups. Additional analyses may examine associations between selected caregiver characteristics and asthma control outcomes.

Ethical approval will be obtained from the relevant Institutional Review Board before data collection begins (Kamp et al., 2023). Written informed consent will be obtained from all participating caregivers (Yang et al., 2024). Participation will be voluntary, and caregivers will have the right to withdraw at any time without affecting the healthcare services received by their children. Confidentiality will be maintained by using codes instead of names and storing data securely. The study will follow ethical principles related to respect for persons, beneficence, privacy, and responsible handling of health information.

Several procedures will be used to enhance measurement quality. Data collectors will receive orientation regarding the study tools and procedures. The educational content will be standardized to ensure consistency across participants in the intervention group. The questionnaire and asthma control tools will be reviewed for clarity, appropriateness, and relevance. Pilot testing may be used to identify unclear items and improve the flow of data collection. These steps will help strengthen reliability and reduce measurement error.

The study design has practical value because it reflects real healthcare conditions in Saudi primary healthcare centers. If the caregiver-led program is effective, it may be integrated into routine pediatric asthma services without requiring highly complex resources. Primary healthcare nurses, physicians, respiratory therapists, and health educators may deliver similar interventions as part of chronic disease management and health promotion activities. This supports the broader goal of shifting healthcare toward prevention and family empowerment.

RESULTS AND DISCUSSION

Because the study is currently in the proposal and pilot stage, final outcome data are not yet available. Therefore, this section presents the expected results and their anticipated interpretation based on the study objectives, design, and previous evidence. It is expected that caregivers in the intervention group will demonstrate improved asthma knowledge after receiving the caregiver-led asthma management program. Improvements are anticipated in knowledge of asthma triggers, medication purpose, controller medication adherence, reliever medication use, inhaler and spacer technique, symptom monitoring, and appropriate response to worsening symptoms.

It is also expected that caregiver management practices will improve after the intervention (Versteegh et al., 2022). Caregivers may become more consistent in administering prescribed medications, reducing exposure to triggers, monitoring nighttime symptoms, identifying early warning signs, and seeking timely healthcare advice. Practical training on inhaler technique is expected to be particularly important because incorrect inhaler use is a common reason for poor asthma control. When caregivers learn and practice correct technique, the child may receive medication more effectively, leading to better symptom control. Furthermore, incorporating validated tools to assess both quality of life and asthma control allows for a comprehensive evaluation of how these educational efforts mitigate the daily interference of the disease in family routines (Amorha et al., 2020;Sarasmita et al., 2021).

Preschool children in the intervention group are expected to show improved asthma symptom control compared with children in the control group. Improvements may include fewer wheezing episodes, reduced nighttime coughing, lower reliance on rescue medication, fewer activity limitations, and fewer unscheduled healthcare visits. Improvements in C-ACT or TRACK scores are expected to reflect better control following caregiver education. Although final results cannot be reported until data collection and analysis are completed, the expected direction of change is consistent with previous research on structured asthma education and family-centered interventions.

The control group may show smaller changes because caregivers will continue receiving standard care without the structured educational program. Standard care remains important, but it may not provide the same level of systematic caregiver training, demonstration, reinforcement, and discussion offered through the intervention. Differences between groups may therefore indicate the added value of structured caregiver-led education beyond routine services. This comparison is one of the strengths of the quasi-experimental design.

The anticipated findings may support the argument that caregiver knowledge is an important pathway to improved child outcomes. Better caregiver understanding may improve daily decision-making, reduce misconceptions about asthma medications, and increase confidence in managing symptoms at home. Caregivers who understand the difference between controller and reliever medications may be more likely to follow prescribed treatment plans. Caregivers who understand triggers may be more likely to reduce dust, smoke, strong odors, and other irritants in the home environment.

The results may also highlight the importance of cultural adaptation. Educational programs developed in other countries may not fully address the realities of Saudi families, local healthcare pathways, language needs, or environmental conditions in Makkah. A culturally relevant intervention can use familiar examples, Arabic materials, and practical strategies suitable for local households. This may improve caregiver engagement and increase the likelihood that caregivers apply what they learn in daily practice.

The expected findings are consistent with family-centered care, which emphasizes partnership between healthcare providers and families. In pediatric asthma, the caregiver is not only a recipient of information but also an active partner in disease management. When caregivers are empowered, they can support continuity of care between the clinic and the home. This is particularly important for preschool children because most asthma management decisions occur outside the healthcare facility.

The study may also contribute to preventive healthcare goals in Saudi Arabia. If caregiver education reduces emergency visits and hospital admissions, it may decrease pressure on healthcare services and support more efficient use of resources. Preventive interventions are generally less costly than repeated emergency care and hospitalization. Therefore, caregiver-led asthma management may have clinical, social, and economic benefits for families and the healthcare system.

The anticipated findings may support implementation of structured asthma education in primary healthcare centers. Primary healthcare is an appropriate setting because caregivers frequently visit these centers for follow-up, medication refills, immunization, and acute care. Integrating asthma education into routine visits may improve accessibility and sustainability. Nurses and health educators can play a central role in delivering education, reinforcing inhaler technique, and supporting caregivers during follow-up visits.

The results may also have implications for policy and future program development. A successful caregiver-led asthma management program could be expanded to other primary healthcare centers in Makkah and other regions of Saudi Arabia. It may also be adapted for digital platforms, including mobile reminders, online educational videos, and telehealth follow-

up. Digital support may help sustain caregiver knowledge and adherence after the initial intervention.

Despite the expected benefits, the study must be interpreted carefully. Because it is quasi-experimental, participants will not be randomly assigned, and differences between centers may influence outcomes. Environmental exposures, caregiver education level, family support, and baseline asthma severity may also affect results. These limitations will be considered during analysis and interpretation. Nevertheless, the design remains appropriate for evaluating interventions in real healthcare settings where randomization is difficult.

The findings are expected to make an important contribution to pediatric asthma care in Saudi Arabia. The study focuses on a high-risk group, preschool children with uncontrolled asthma, and evaluates a practical intervention that can be delivered in primary healthcare settings. It also contributes to local evidence from Makkah, where environmental and social factors may influence asthma outcomes. By combining caregiver education, practical skill training, and standardized assessment tools, the study may provide a useful model for future asthma management programs.

In addition, the anticipated findings may strengthen the evidence base for developing caregiver training pathways within Saudi primary healthcare services. If the intervention improves caregiver knowledge and child asthma control, it may support the development of standardized educational packages that can be used by nurses, physicians, respiratory therapists, and health educators. Such packages could include visual materials, inhaler technique checklists, symptom monitoring forms, and simplified action plans appropriate for families with different educational backgrounds.

The expected outcomes also have implications for reducing health inequalities. Some caregivers may have limited health literacy or limited previous exposure to structured asthma education. A program that uses clear language, demonstration, repetition, and culturally relevant examples may help ensure that asthma education is accessible to a wider range of families. This is important because caregiver understanding should not depend only on formal education level; it should be supported through practical communication from healthcare providers.

Another important implication is the potential improvement in caregiver self-efficacy. Caregivers who feel confident in identifying symptoms, using inhalers, avoiding triggers, and responding to exacerbations may be more likely to maintain consistent management behaviors. Self-efficacy is particularly relevant in chronic childhood conditions because caregivers must make daily decisions without immediate supervision from healthcare professionals. Improved confidence may reduce fear, hesitation, and inappropriate medication avoidance.

The program may also improve communication between caregivers and healthcare providers. During educational sessions, caregivers can ask questions about medication use, side effects, triggers, and warning signs. This interaction may reduce misconceptions and encourage families to follow individualized care plans. Better communication may also improve follow-up attendance and encourage caregivers to seek help before symptoms become severe.

From a health system perspective, caregiver-led asthma management may support more efficient service delivery. Recurrent emergency visits for preventable asthma exacerbations can place pressure on healthcare facilities. If caregiver education reduces unnecessary emergency use, primary healthcare centers may become more effective in managing chronic respiratory conditions through prevention, early intervention, and continuity of care.

Overall, the anticipated results are expected to demonstrate that caregiver-led asthma management improves caregiver knowledge, strengthens home management practices, and enhances asthma symptom control among preschool children. The discussion will connect

these findings to previous literature and emphasize the importance of caregiver empowerment, culturally adapted education, and family-centered primary healthcare. The study is expected to provide evidence that structured caregiver education can be an effective strategy for improving pediatric asthma outcomes in Makkah and similar healthcare contexts.

Finally, the study is expected to contribute to academic knowledge by providing local evidence from Makkah, a setting with distinctive environmental and sociocultural characteristics. Evidence from other countries may not fully reflect the needs of Saudi families or the practical challenges faced in Saudi primary healthcare centers. By focusing on preschool children with uncontrolled asthma and using a quasi-experimental design, the study may offer meaningful evidence for researchers, clinicians, and policymakers. The results may also guide future studies that evaluate long-term outcomes, digital reinforcement, caregiver self-efficacy, and cost-effectiveness of family-centered asthma interventions.

In addition, the anticipated findings may support the integration of asthma education into routine child health services rather than offering it only after severe exacerbations. Preventive education delivered early may help families manage asthma before complications develop. This approach is consistent with health promotion principles and supports the transformation of primary healthcare services from reactive care toward prevention, continuity, and family empowerment. If implemented more widely, caregiver-led asthma education may contribute to improved pediatric respiratory health across Saudi Arabia.

The study may also identify which elements of the intervention are most useful for caregivers. For example, some caregivers may benefit most from learning about medication adherence, while others may need support with trigger avoidance, symptom monitoring, or emergency response. Understanding these components may help healthcare providers refine future asthma education programs and focus on the areas most strongly associated with improved child outcomes. This is relevant for primary healthcare settings where time and resources may be limited and educational programs must be practical, focused, and efficient.

The expected findings may further demonstrate the value of practical training rather than information-only education. Asthma education that only explains disease concepts may improve knowledge but may not necessarily change behavior. In contrast, demonstration of inhaler and spacer technique, discussion of common home triggers, and practice-based learning may improve caregiver ability to apply knowledge in real situations. This distinction is important because effective asthma management requires both understanding and performance. Therefore, the caregiver-led program is expected to produce stronger outcomes when education is combined with skill development and reinforcement.

The intervention is also expected to improve consistency in home-based asthma management. In many families, more than one adult may participate in the child's daily care, including parents, grandparents, or other relatives. When instructions are unclear or inconsistent, medication use and trigger avoidance may vary between caregivers. A structured educational program may provide a shared understanding of asthma management principles, helping families follow the same approach at home. This may be particularly relevant in the Saudi family context, where extended family support is common and multiple family members may influence health decisions (Dailah, 2021b).

Another expected contribution of the study is the improvement of caregiver decision-making during early symptom changes. Many asthma exacerbations begin with mild symptoms that may be underestimated by caregivers, particularly when symptoms appear gradually or occur at night. Through structured education, caregivers may learn to identify early warning signs such as increased coughing, wheezing, rapid breathing, reduced activity, disturbed sleep, and increased need for reliever medication (Magwenzi et al., 2022). Earlier recognition may allow caregivers to respond appropriately and seek medical advice before the child requires

emergency care. This expected improvement is important because preschool children often cannot clearly express symptom severity, making caregiver observation a central component of asthma management.

The expected outcomes may also encourage the development of simple caregiver follow-up tools, such as symptom diaries, medication checklists, and trigger monitoring forms (Au-Doung et al., 2024). These tools may help caregivers maintain daily awareness of the child's condition and provide healthcare providers with clearer information during follow-up visits. Such practical documentation may improve continuity of care and support more individualized asthma management decisions.

These anticipated contributions are important because caregiver-led education can be implemented with limited resources in primary healthcare settings. If the program proves effective, it may provide a practical model for routine asthma counseling, especially for families of young children who require continuous home supervision and early preventive support (Rhee et al., 2021).

Accordingly, the program may become a scalable educational approach that supports both clinical asthma control and caregiver confidence within everyday primary healthcare practice.

LIMITATION OF THE STUDY

The study relies on caregiver self-reported data, which may introduce recall bias or socially desirable responses. The quasi-experimental design also limits random assignment, and differences between healthcare centers may influence outcomes. In addition, the study focuses on short-term outcomes and does not evaluate long-term sustainability of caregiver behavior change or asthma control. Despite these limitations, the study provides useful evidence regarding the feasibility and expected effectiveness of caregiver-led asthma education in primary healthcare settings.

CONCLUSIONS AND SUGGESTIONS

This study is expected to demonstrate that a caregiver-led asthma management program can improve caregiver knowledge, strengthen asthma management practices, and enhance symptom control among preschool children with uncontrolled asthma in Makkah. The study addresses an important gap in Saudi pediatric asthma research by focusing on preschool children, using a quasi-experimental design, and applying a culturally appropriate family-centered intervention. The findings may support integration of structured asthma education into routine primary healthcare services.

Future studies are recommended to evaluate long-term outcomes, include larger and more diverse samples, and examine the sustainability of caregiver-led asthma interventions across different regions of Saudi Arabia. Further research may also explore digital reminders, telehealth education, and school or community-based asthma management support.

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ETHICAL CONSIDERATIONS

Ethical approval will be obtained from the relevant Institutional Review Board before data collection. Written informed consent will be obtained from all caregivers who agree to participate. Participant privacy, confidentiality, and anonymity will be protected throughout the study, and data will be used only for research purposes.

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REFERENCES

Aggarwal, B., Al-Moamary, M., Al-Lehebi, R., Alzaabi, A., Al-Ahmad, M., Amin, M., Damayanti, T., Tho, N. Van, Quyen, P. T. Le, Sriprasart, T., Poachanukoon, O., Yu-Lin, A. B., Ismail, A. I., Limpin, M. E., Koenig, S., Levy, G., Phansalkar, A., Rafih, F., Silvey, M., … Milligan, G. (2024). APPaRENT 3: Asthma Patients' and Physicians' Perspectives on the Burden and Management of Asthma in Seven Countries. *Advances in Therapy*, *41*(8), 3089–3118. https://doi.org/10.1007/s12325-024-02900-2

Almotairy, A. H. A. A. N. D. M. M. (2020). Asthma control and its association with knowledge of caregivers among children with asthma. *Saudi Medical Journal*, *41*(7), 733–739. https://doi.org/10.15537/smj.2020.7.25167

Amorha, K. C., Ayogu, E. E., Ngwoke, B. A., & Okonta, E. O. (2020). Knowledge, attitudes and quality of life of caregivers towards asthma in their children: a Nigerian perspective. *Journal of Health Sciences*. https://doi.org/10.17532/jhsci.2020.860

Au-Doung, P. L. W., Chan, J. C. H., Kui, O. Y. H., Ho, M. K. Y., Cheung, Y. T., Lam, J. K. W., Chan, H., Brannan, J. D., Chan, K. C. C., Li, A. M., & Leung, S. S. Y. (2024). Objective monitoring tools for improved management of childhood asthma. *Respiratory Research*, *25*(1), 194. https://doi.org/10.1186/s12931-024-02817-y

Baek, J., Huang, K., Conner, L., Tapangan, N., Xu, X., & Carrillo, G. (2019). Effects of the home-based educational intervention on health outcomes among primarily Hispanic children with asthma: a quasi-experimental study. *BMC Public Health*, *19*(1), 912. https://doi.org/10.1186/s12889-019-7272-5

Basnet, S., Wroblewski, K., Hansen, E., Perez, E., Lyu, R., Abid, Z., Roach, A., Latham, C., Salibi, N., Battle, B., & Giles, L. (2024). Collaborative Integration of Community Health Workers in Hospitals and Health Centers to Reduce Pediatric Asthma Disparities: A Quality Improvement Program Evaluation. *Journal of Community Health*, *49*(4), 682–692. https://doi.org/10.1007/s10900-024-01331-y

Boutopoulou, B., Koumpagioti, D., Matziou, V., Priftis, K. N., & Douros, K. (2018). Interventions on Adherence to Treatment in Children With Severe Asthma: A Systematic Review. *Frontiers in Pediatrics*, *6*, 232. https://doi.org/10.3389/fped.2018.00232

Butz, M. H. B. A. N. D. C. L. A. N. D. A. N. A. N. D. J. K. A. N. D. S. S. M. A. N. D. M. E. B. A. N. D. A. (2016). Caregiver perception of asthma management of children in the context of poverty. *Journal of Asthma*, *54*(2), 162–172. https://doi.org/10.1080/02770903.2016.1198375

Dailah, H. G. (2021a). Investigating the Outcomes of an Asthma Educational Program and Useful Influence in Public Policy. *Frontiers in Public Health*, *9*, 736203. https://doi.org/10.3389/fpubh.2021.736203

Dailah, H. G. (2021b). Investigating the Outcomes of an Asthma Educational Program and Useful Influence in Public Policy. *Frontiers in Public Health*, *9*, 736203. https://doi.org/10.3389/fpubh.2021.736203

Gumbo, P. M. A. N. D. S. R. A. N. D. E. S. A. N. D. F. Z. (2022). Challenges in the diagnosis of asthma in children, what are the solutions? A scoping review of 3 countries in sub Saharan Africa. *Respiratory Research*, *23*(1), 254. https://doi.org/10.1186/s12931-022-02170-y

Gustafson, D. H., Wise, M., Bhattacharya, A., Pulvermacher, A., Shanovich, K., Phillips, B. R., Lehman, E., Chinchilli, V. M., Hawkins, R. P., & Kim, J.-S. (2012). The Effects of Combining Web-Based eHealth With Telephone Nurse Case Management for Pediatric Asthma Control: A Randomized Controlled Trial. *Journal of Medical Internet Research*, *14*(4). https://doi.org/10.2196/jmir.1964

Handley, M. A., Schillinger, D., & Shiboski, S. (2011). Quasi-Experimental Designs in Practice-based Research Settings: Design and Implementation Considerations. *The Journal of the American Board of Family Medicine*, *24*(5), 589–596. https://doi.org/10.3122/jabfm.2011.05.110067

Hassan, E., Abusaad, F. E., & Mohammed, B. A. (2022). Effect of the Buteyko breathing technique on asthma severity control among school age children. *Egyptian Journal of Bronchology*, *16*(1). https://doi.org/10.1186/s43168-022-00149-3

Kamp, M. van der, Hengeveld, V., Willard, N. P., Thio, B., Graaf, P. de, Geven, I., & Tabak, M. (2023). Remote Patient Monitoring and Teleconsultation to Improve Health Outcomes and Reduce Health Care Utilization of Pediatric Asthma (ALPACA Study): Protocol for a Randomized Controlled Effectiveness Trial. *University of Twente Research Information*, *12*. https://doi.org/10.2196/45585

Li, F. Y. A. N. D. J. Z. A. N. D. H. X. A. N. D. X. W. A. N. D. Y. C. A. N. D. H. H. A. N. D. S. Z. A. N. D. H. (2024). Caregiver burden among parents of school-age children with asthma: a cross-sectional study. *Frontiers in Public Health*, *12*, 1368519. https://doi.org/10.3389/fpubh.2024.1368519

Lv, Q., Zhang, X., Wang, Y., Xu, X., & Zang, X. (2024). Cross-cultural adaptation and validation of the caregiver self-efficacy in contributing to patient self-care scale in China. *BMC Public Health*, *24*(1), 1977. https://doi.org/10.1186/s12889-024-19534-2

Magwenzi, P., Rusakaniko, S., Sibanda, E., & Gumbo, F. Z. (2022). Challenges in the diagnosis of asthma in children, what are the solutions? A scoping review of 3 countries in sub Saharan Africa. *Respiratory Research*, *23*(1), 254. https://doi.org/10.1186/s12931-022-02170-y

Nour, A., Alsayed, A. R., & Basheti, I. A. (2023). Parents of asthmatic children knowledge of asthma, anxiety level and quality of life: unveiling important associations. *Pharmacy Practice*, *21*(3), 1–10. https://doi.org/10.18549/pharmpract.2023.3.2843

Rhee, H., Love, T., Wicks, M. N., Tumiel-Berhalter, L., Sloand, E., Harrington, D., & Walters, L. (2021). Long-term Effectiveness of a Peer-Led Asthma Self-management Program on Asthma Outcomes in Adolescents Living in Urban Areas. *JAMA Network Open*, *4*(12). https://doi.org/10.1001/jamanetworkopen.2021.37492

Sarasmita, M. A., Larasanty, L. P. F., Kuo, L., Cheng, K., & Chen, H. (2021). A Computer-Based Interactive Narrative and a Serious Game for Children With Asthma: Development and Content Validity Analysis. *Journal of Medical Internet Research*, *23*(9). https://doi.org/10.2196/28796

Sommanus, S., Sitcharungsi, R., & Lawpoolsri, S. (2022). Effects of an Asthma Education Camp Program on Quality of Life and Asthma Control among Thai Children with Asthma: A Quasi-Experimental Study. *Healthcare*, *10*(8), 1561. https://doi.org/10.3390/healthcare10081561

Szilagyi, J. S. H. A. N. D. H. L. Y. A. N. D. K. M. C. A. N. D. P. C. A. N. D. G. M. A. N. D. T. L. N. A. N. D. P. G. (2004). The Impact of Childhood Asthma on Parental Quality of Life. *Journal of Asthma*, *41*(6), 645–653. https://doi.org/10.1081/jas-200026410

Versteegh, L., Chang, A. B., Chirgwin, S., Tenorio, F. P., Wilson, C., & McCallum, G. B. (2022). Multi-lingual "Asthma APP" improves health knowledge of asthma among Australian First Nations carers of children with asthma. *Frontiers in Pediatrics*, *10*, 925189. https://doi.org/10.3389/fped.2022.925189

Yang, F., Zhou, J., Xiao, H., Wu, X., Cui, Y., Huang, H., Zheng, S., & Li, H. (2024). Caregiver burden among parents of school-age children with asthma: a cross-sectional study. *Frontiers in Public Health*, *12*, 1368519. https://doi.org/10.3389/fpubh.2024.1368519