

Inhaler Technique in Children With Asthma: A Systematic Review

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ABSTRACT

BACKGROUND: Pediatric asthma is an important public health problem worldwide. The primary methods of medication delivery are inhalation devices.

OBJECTIVES: This systematic review examined: 1) what is the prevalence of correct inhaler technique among children with asthma, 2) are educational interventions associated with improved rates of correct inhalation technique, and 3) is improved inhaler technique associated with improved asthma outcomes?

DATA SOURCES: We included experimental and observational studies through searches of PubMed, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, CINAHL Complete, and clinicaltrials.gov.

STUDY ELIGIBILITY CRITERIA, PARTICIPANTS, AND INTERVENTIONS: Studies were eligible for this review if at least 1 outcome measure of the study included and reported results of child/adolescent inhaler technique.

STUDY APPRAISAL AND SYNTHESIS METHODS: The following information was extracted from each included study: study design (experimental vs observational), and outcomes data. The Downs and Black checklist was used to appraise study quality.

RESULTS: Twenty-eight studies were eligible for inclusion. We found that inhaler technique is generally very poor among children, but is better when children use their metered-dose inhalers (MDIs) with spacers. Technique in using turbuhalers and diskus inhalers is better than in MDI, but still poor. Counseling children on correct inhaler technique was associated with improved technique among children in multiple studies.

LIMITATIONS: We examined articles published in English.

CONCLUSIONS AND IMPLICATIONS OF KEY FINDINGS: Inhaler technique in children is generally poor. Physicians and other members of the health care team should instruct children and their caregivers on the proper use of their inhalation devices at every opportunity and correct mistakes when made to ensure effective medication delivery.

REGISTRY: This systematic review was registered under the Centre for Reviews and Dissemination, PROSPERO CRD42015025070 (http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42015025070).

KEYWORDS: adolescent; asthma; bronchodilator agents; child; dry powder inhalers; inhalation spacers; metered-dose inhalers

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WHAT THIS SYSTEMATIC REVIEW ADDS

- Child inhaler technique is poor throughout the world.
- Research consistently shows that teaching children how to use their inhalers and monitoring technique is effective at improving technique.
- Very little research has examined whether better inhaler technique is associated with improved asthma outcomes.

HOW TO USE THIS SYSTEMATIC REVIEW

- Pediatricians should teach children how to use their inhalers correctly and monitor technique at every opportunity.
- Pediatricians should include other members of the health care team, such as pharmacists or nurses, to help instruct and monitor child inhaler technique.

- Future research is needed to examine if improved inhaler technique is associated with asthma outcomes, such as disease control and quality of life.

ASTHMA IS A common condition in the pediatric population, affecting more than 7 million children in the United States.¹ The preferred methods of medication delivery in asthma are through inhalers, which deliver medication straight to the lungs. A previous systematic review that was conducted in 2000 showed that inhalation technique in adults might be poor, and individual studies have shown that inhaler technique in children might be poor.^{2–4} Previous research has also shown that the type of device might have an effect on asthma outcomes, further establishing why technique is important in the selection of an asthma control medication.^{5,6}

The anatomy and physiology of the lungs change during development, making drug delivery to this population already a challenge; the results of inadequate inhalation technique, such as decreased asthma control, are intensified in children because of this reason.⁷ Further, on the basis of developmental stage, the caregiver as well as the child might be responsible for using their asthma medications. The National Heart, Lung, and Blood Institute asthma guidelines recommend that providers check inhaler technique at every opportunity and have been making this recommendation since at least 1997.^{8,9} To our knowledge, there has not been a systematic review of the literature to examine children's inhaler technique. The objective of this systematic review was to answer the following questions: 1) what is the prevalence of correct inhaler technique among children with asthma, 2) are educational interventions associated with improved rates of correct inhalation technique, and 3) is improved inhaler technique associated with improved asthma outcomes?

METHODS

PROTOCOL DEVELOPMENT AND SEARCH STRATEGY

From July through August of 2015, the authors developed and registered the review protocol with the International prospective register of systematic reviews (PROSPERO, CRD42015025070; http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42015025070). The authors used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to guide this systematic review.¹⁰ The following databases were searched to find eligible studies: PubMed, Cochrane Controlled Trials, Cochrane Systematic Reviews, clinicaltrials.gov, and CINAHL Complete. The PubMed search strategy is shown in [Table 1](#). The publication dates were restricted to January 1, 2000 through July 7, 2015. The year 2000 was chosen because that was the same year that a previous systematic review on inhalation technique in adults was published.² We restricted the search to the English language as well as children ages 6 through 12 years of age and adolescents, 13 years of age through 18 years of age. Six years of age was chosen as our minimum age because the coordination required to correctly use a metered-dose inhaler (MDI) is difficult in patients

who are younger than 6 years old.¹¹ Articles were included if at least 1 outcome investigated inhaler technique in our population. The references of articles that met these eligibility criteria were manually searched for relevant articles. Any disparities were resolved through discussion.

INCLUSION CRITERIA

Eligible studies in this review consisted of experimental and observational studies. Studies were eligible for this review if at least 1 outcome measure of the study included and reported results of child/adolescent inhaler technique among children ages 6 through 18 years of age. Studies that included children younger than 6 years were included in this review as long as children who were at least 6 years of age were also included in the study. However, this younger population was not the main focus of this systematic review. Studies in which adults were included were also eligible, provided that the child/adolescent inhaler technique was analyzed separately from the adults and the results reported child/adolescent inhaler technique. To reduce bias from including multiple publications on the same study, the primary investigator examined the list of authors, when the study was conducted, as well as the number of subjects in the study.

DATA EXTRACTION

Two investigators (C.G., J.A.K.) independently screened titles and abstracts and then full-text publications by applying the previously mentioned inclusion criteria. Studies were chosen for review if the abstract mentioned inhaler technique as at least 1 focus of the study. After identifying eligible studies, 2 investigators (C.G., J.A.K.) examined the reference lists for each eligible study to identify studies that were not in the original database search. Disagreements were resolved through consensus and through discussions with another author (N.R.-W.). In studies that did not separate MDI and dry powder inhaler (DPI) technique, we assumed and reported those findings as MDI percentages in this systematic review. The following information was extracted from each included study: 1) study design (experimental vs observational), 2) number of subjects included in the study, 3) age of subjects included in the study, 4) the study's inclusion and exclusion criteria, 5) the type, frequency, and duration of the intervention (if applicable), versus a comparator (active control or usual treatment), 6) how inhaler technique was measured, 7) effect of the intervention on inhaler technique (if applicable). The 2 investigators (C.G. and J.A.K.) met continuously throughout the data extraction process. C.G. abstracted the data with discussion and consensus with J.A.K.

STUDY QUALITY ASSESSMENT

Two investigators (C.G., J.A.K.) independently conducted an assessment of the quality of each study using the Downs and Black checklist, which has been shown to be valid and reliable.¹² The Downs and Black checklist is used to assess study quality through 3 domains: reporting, external validity, and internal validity. Internal validity is assessed for bias, confounding, and power.

Table 1. Search Strategy

Data Source	Search Strategy
PubMed	("nebulizers and vaporizers" [MeSH Terms] OR ("nebulizers" [All Fields] AND "vaporizers" [All Fields]) OR "nebulizers and vaporizers" [All Fields] OR "inhaler" [All Fields] AND technique [All Fields] AND ("asthma" [MeSH Terms] OR "asthma" [All Fields] AND ("child" [MeSH Terms] OR "child" [All Fields] OR "children" [All Fields]) AND ("[i]oat[ri]full text" [sb] AND hasabstract text)) AND "2000/01/01" [PDAT]: "2015/07/15" [PDAT]) AND English [lang] AND "child" MeSH Terms: noexp OR "adolescent" [MeSH Terms]))

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