



OPEN ACCESS

Effect of asthma education on health outcomes in children: a systematic review

Wen-Yi Liu,^{1,2,3} Zhu Liduzi Jiesisibieke,² Tao-Hsin Tung ⁴

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/archdischild-2021-323496>).

¹Department of Health Policy Management, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland, USA

²Institute for Hospital Management, Tsing Hua University, Shenzhen Campus, China

³Shanghai Bluecross Medical Science Institute, Shanghai, China

⁴Evidence-based Medicine Center, Taizhou Hospital of Zhejiang Province Affiliated to Wenzhou Medical University, Linhai, Zhejiang Province, China

Correspondence to

Dr Tao-Hsin Tung, Taizhou Hospital of Zhejiang Province, Linhai 317000, Zhejiang, China; ch2876@gmail.com

Received 9 November 2021

Accepted 8 February 2022

Published Online First

23 February 2022

ABSTRACT

Background It remains unknown whether child-oriented asthma education is associated with better health outcomes. This meta-analysis investigated the effects of asthma education on hospitalisation and emergency department and clinic visits.

Methods We searched the Cochrane Library, PubMed and EMBASE for relevant studies from inception to 4 July 2021, and selected studies that reported hospitalisation or emergency department or clinic visits as outcomes. The participants were only children. Two authors independently selected the studies, assessed the quality of the included studies and retrieved the data. A third senior author was engaged to resolve disagreements. Fifteen longitudinal studies were included for the systematic review and meta-analysis. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 was used as the standard of reporting (PRISMA registration ID is 284509).

Findings Compared with the control group, the asthma education group had 54% lower hospitalisation risk (95% CI 0.32 to 0.66), and 31% lower emergency department visit risk (95% CI 0.59 to 0.81). Sensitivity analysis showed that the asthma education group had a reduced clinic visit risk (risk ratio (RR)=0.80, 95% CI 0.67 to 0.97). Subgroup analysis showed that asthma education involving both children and parents/guardians was associated with fewer hospitalisations (RR=0.38, 95% CI 0.24 to 0.59) and emergency department visits (RR=0.69, 95% CI 0.57 to 0.83). Asthma education in hospitals or non-hospitals can reduce the risk of hospitalisation and emergency department visits. However, only education in the hospitals was associated with the reduction of clinical visits (RR=0.45, 95% CI 0.22 to 0.92).

Interpretation Education is effective for controlling asthma, especially for reducing hospitalisation and emergency department and clinic visits. Education involving both children and parents/guardians is more effective than that involving only children. The setting of asthma education does not impact its effect to a large extent.

INTRODUCTION

Asthma is a common chronic condition in children with symptoms such as shortness of breath, oppression in the chest, coughing and wheezing, as well as episodes of sudden aggravation.^{1 2} It is widespread and affects 6.1 million children globally, which has a large impact on the quality of life and results in significant death.^{2 3} Asthma-related hospitalisation may also have an impact on educational achievements of children,⁴ and asthma in children is significantly associated with later risk of

becoming obese,⁵ which is a risk factor of several chronic diseases.⁶⁻⁸ In the context of COVID-19, being alert and following the treatment guidelines, as well as implementing preventive measures, are of great importance for improving the outcomes among children with asthma.⁹ Asthma education is one of the preventive measures.¹⁰ The participants and the settings of asthma education vary; some sessions may include only children,¹¹ while some include both children and parents/guardians.¹² The setting of asthma education also differs.^{13 14} Some prior studies have shown that asthma education targeted at children can reduce unscheduled visits and hospitalisations.¹⁵⁻¹⁷ One study found that asthma education was a useful tool for controlling asthma. However, it is not significantly effective in reducing healthcare utilisation when compared with usual care.¹⁸ Another study found no change in emergency department (ED) visits and hospitalisations after paediatric asthma education.¹⁹

As a result, it is still unclear whether asthma education is useful for controlling asthma, and the impact of participants and the setting has also not been established. We conducted this systematic review and meta-analysis to assess the overall effects of child-centred asthma education on health outcomes, including hospitalisations and ED and clinic visits.

MATERIALS AND METHODS

Literature search

We performed this meta-analysis to study the effect of asthma education on hospitalisation and emergency room and clinic visits of children. The Cochrane Library, PubMed and EMBASE were searched for relevant studies from inception to 4 July 2021. The search string was “(child OR pediatric OR kid) AND (asthma) AND education AND (hospitalization OR emergency department visit OR urgent physician visit OR outpatient)” for all three databases (online supplemental table 1). The language was not restricted. Based on the PRISMA 2020 statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses),²⁰ we also conducted additional research on relevant studies (figure 1). The protocol for this systematic review was recorded in PROSPERO with identification number 284509.

Inclusion criteria and exclusion criteria

Types of participants

The participants were children. Studies that recorded the health outcomes of children and adults were not included. The participants had to



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Liu W-Y, Jiesisibieke ZL, Tung T-H. *Arch Dis Child* 2022;**107**:1100–1105.

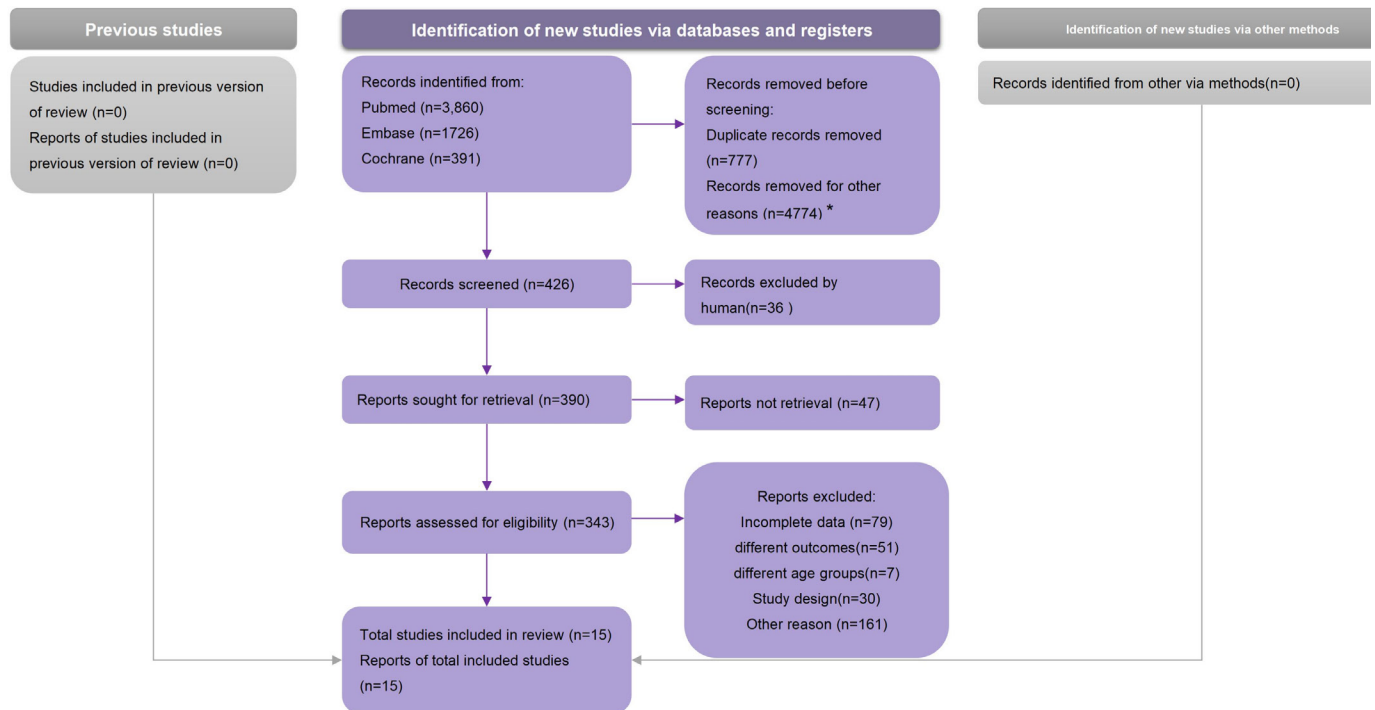


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart.

be diagnosed with asthma, but hospitalisation in the past was not a restriction.

Asthma education intervention

We did not limit the tools, settings and instructors for asthma education. Some of the included studies focused on drugs, and others focused on the triggers of asthma in the environment. All the included studies assessed the basic information of asthma, such as causes and treatment. The education could involve just children, caregivers, or both children and caregivers.

Outcomes

We generally included three outcomes, which are hospitalisation, emergency room visits and clinic visits. The outcomes were recorded as frequency instead of the number of patients. The clinic visit could be either routine or urgent.

Study design

To investigate the causal relationship between asthma education and health outcomes, longitudinal studies were included. Thus, the outcomes before and after the intervention were collected.

Data extraction and quality assessment

Two independent reviewers, Wen-Yi Liu and Zhu Liduzi Jieshibieke, screened the studies for inclusion. Finally, 15 studies met the criteria. Author, study year, country, interventions, tools, outcomes, sample, educators, setting and outcomes were extracted from the 15 included studies. The Newcastle–Ottawa Scale was applied to analyse the quality of the included studies. For cohort studies, the selection of study groups (S), comparability (C) and outcome assessment (O) were used.²¹ For case-control studies, apart from the selection of participants (S) and comparability (C), exposure (E) was also used.²² We used funnel plots and Egger's test to assess the publication bias of the included studies.

Characteristics of the excluded studies

During the screening, some studies were excluded because of incomplete data, and others were excluded for their study design^{23–28}; we only included longitudinal studies. Some studies were excluded because the participants of asthma education were not only children.^{29–31} We just included studies that met our inclusion criteria.

Statistical analysis

Stata V.16.0 SE was used for the statistical analysis, and we presented the risk of health outcomes as risk ratio (RR) with 95% CI and analysed heterogeneity using the I^2 statistic. The I^2 statistic is an analytical test that measures the degree of variation between studies due to heterogeneity rather than by chance alone. I^2 values of 50% or more represent substantial heterogeneity.³²

RESULTS

Characteristics of the included studies

The screening process is illustrated in figure 1. After removing the duplicates, 5200 studies were identified. We referred to the newest checklist of PRISMA to investigate whether the studies met our inclusion criteria. Overall, this study included 15 longitudinal studies, and after detailed analysis, their characteristics are shown in online supplemental table 2. These papers were published between 1991 and 2020, and 10 of them had been conducted in the USA. The outcomes of 12 papers included hospitalisations, and those of 13 papers were emergency visits as suitable outcomes; only six studies were related to the change in clinic visits. There were two main settings: medical establishments, such as hospitals and clinics, and other places. In the early studies, the most common teaching tools were sessions and handouts, so the asthma education all given face to face. Later, technological advancements enabled the internet and videos as useful tools, some of the education courses were online. The

Table 1 GRADE summary of findings

Effect of asthma education on health outcomes in children						
Patient or population: children with asthma						
Setting: USA, France, Spain						
Intervention: asthma education						
Comparison: not receiving asthma education						
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Risk in control	Risk in experiment				
Risk of hospitalisation	814 per 1000	360 per 1000	RR 0.46 (0.32 to 0.66)	2122	⊕⊕⊕○ Low	NA
Risk of ED visits	1462 per 1000	864 per 1000	RR 0.69 (0.59 to 0.81)	2040	⊕⊕⊕○ Moderate	NA
Risk of clinic visits	1043 per 1000	1004 per 1000	RR 0.79 (0.67 to 0.97)	438	⊕⊕⊕○ Low	NA

GRADE Working Group grades of evidence:
 High quality: we are very confident that the true effect lies close to that of the estimate of the effect.
 Low quality: our confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect.
 Very low quality: we have very little confidence in the effect estimate. The true effect is likely to be substantially different from the estimate of effect.
 *The risk in the intervention group (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
 ED, emergency department; GRADE, Grades of Recommendation, Assessment, Development, and Evaluation; RR, risk ratio.

risks of bias and supporting evidence are shown in [table 1](#) and online supplemental figure 1. All of these studies are longitudinal; thus, time and other factors may affect the outcomes, which is a bias that cannot be ignored.

Assessment of the effect of asthma education on hospitalisation

Thirteen studies reported on this outcome ([figure 2A](#)). The study by Taggart *et al* included 40 participants, and they discovered that asthma education could enlighten children on asthma, perceptions of asthma and the use of health services.³³ Shelledy *et al* conducted a pilot study and included 18 participants; they found a reduction in school days missed and healthcare utilisation.³⁴ Shaak *et al* included 81 patients and investigated the impact of asthma education on asthma knowledge test results, asthma control test results, healthcare use and Pediatric Asthma Caregiver's Quality of Life scores, and they suggested that the community should employ asthma education.³⁵ The study by Safi *et al* found that asthma education was effective in reducing hospitalisation utilisation.³⁶ Riera *et al* analysed the effect of an asthma education fair and concluded that hospitalisations remained unchanged.¹⁹ In the study of Montalvo *et al*, an education programme, Children's RESPIRA Education Program, was successful in reducing hospitalisation visits.³⁷ Marshall *et al* organised a multicomponent programme called Reducing Ethnic/Racial Asthma Disparities in Youth and found a positive effect on hospitalisations.³⁸ Lebras-Isabet *et al* conducted a retrospective study and found that asthma education for children was useful in reducing hospitalisation.³⁹ Condren and Boger found that multidisciplinary asthma education reduced hospitalisation by 82% and ED visits by 81%.⁴⁰ Davis *et al* found that asthma education for children could help with improving the knowledge of parents and guardians on asthma, and at the same time, it could reduce inpatient admissions.⁴¹ Espinoza-Palma *et al* conducted full education, as well as implemented a self-management plan, which could reduce hospitalisation and further rehospitalisations.⁴² Broquet *et al* conducted a prospective study and found that interactive asthma education could improve clinical outcomes, including reducing hospitalisations.⁴³ Johnson *et al* conducted a library-site asthma education programme that decreased asthma-related ED visits and hospitalisations.⁴⁴ This study showed that the asthma education group had a decreased risk of hospitalisation than the other two groups (RR=0.46, 95% CI

0.32 to 0.66). The study by Condren and Boger had a significantly different result; thus, we conducted a sensitivity analysis, and the result did not change (RR=0.41, 95% CI 0.29 to 0.58).

Assessment of the effect of asthma education on emergency room visits

Thirteen studies reported on this outcome ([figure 2B](#)). Apart from the above-mentioned studies, Julian *et al* organised therapeutic education programmes and found that ED visits decreased significantly.⁴⁵ This study showed that the asthma education group had a decreased risk of ED visits than the other two groups (RR=0.69, 95% CI 0.59 to 0.81).

Assessment of the effect of asthma education on clinic visits

Six studies reported on this outcome ([figure 2C](#)). The study by Calvo *et al* found no reduction in hospitalisation, but the number of annual clinic visits decreased.⁴⁶ This result showed that the asthma education group had a decreased risk of clinic visits than the other two groups (RR=0.79, 95% CI 0.58 to 1.09), but the result was not significant. The study by Shelledy *et al* had a significantly different result; thus, we conducted a sensitivity analysis, and the result showed that asthma education could reduce the number of clinic visits significantly (RR=0.80, 95% CI 0.67 to 0.97).

Assessment of the impact of participants and setting on hospitalisation

As shown in online supplemental figure 2, asthma education targeted at both children and parents/guardians could significantly reduce hospitalisation (RR=0.38, 95% CI 0.24 to 0.59), while asthma education targeted at only children or parents/guardians did not result in a significant change (RR=0.69, 95% CI 0.32 to 1.48). The result also showed that asthma education held in hospital (RR=0.49, 95% CI 0.29 to 0.82) or in non-hospital settings (RR=0.41, 95% CI 0.23 to 0.73) did not affect hospitalisation.

Assessment of the impact of participants and setting on ED visits

As shown in online supplemental figure 2, asthma education targeted at both children and parents/guardians (RR=0.69, 95% CI 0.57 to 0.83) or just children or parents/guardians (RR=0.68,

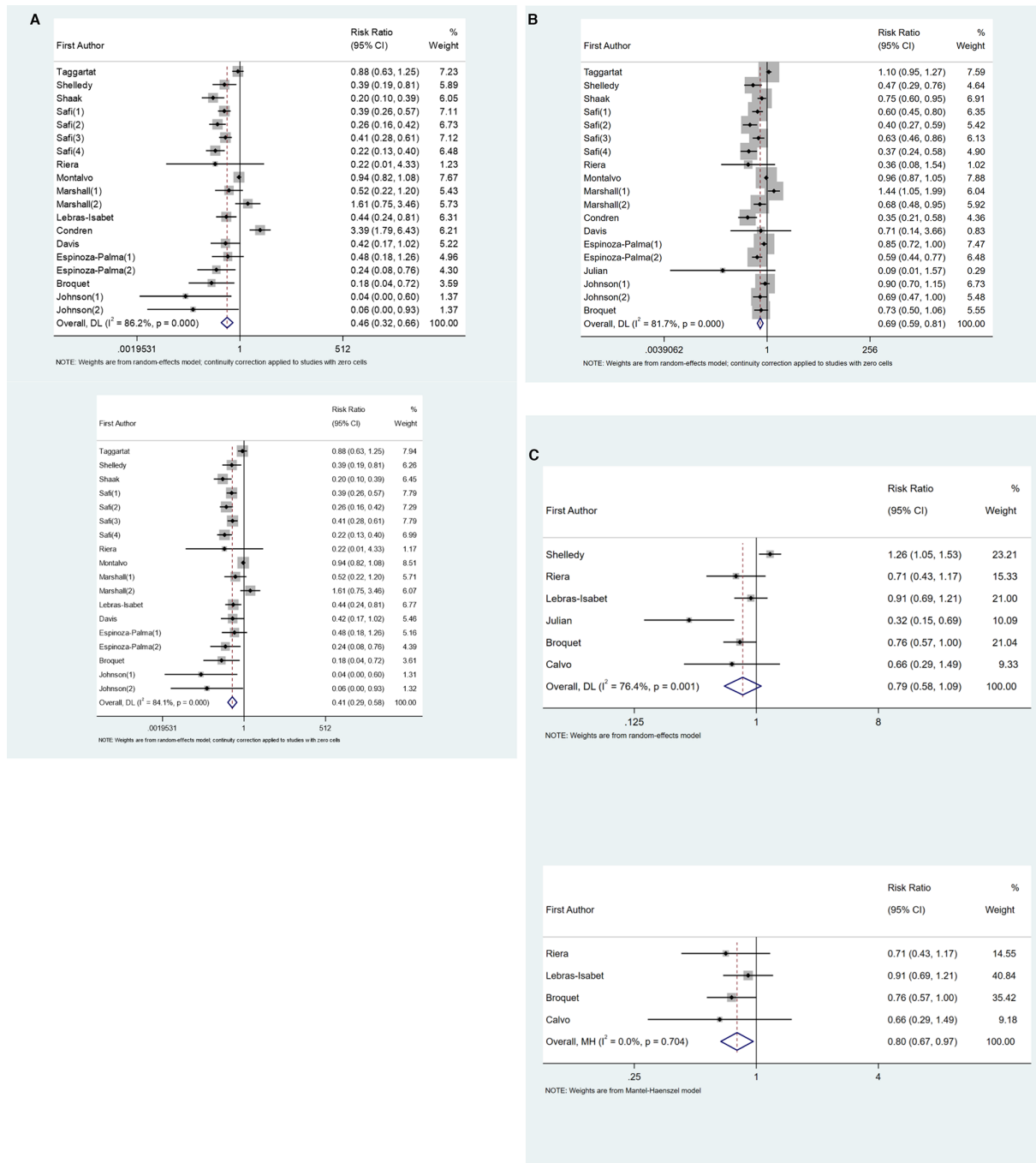


Figure 2 (A) The results of the forest plot of the effect of asthma education on hospitalisation. (B) The results of the forest plot of the effect of asthma education on emergency department visits. (C) The results of the forest plot of the effect of asthma education on clinic visits.

95% CI 0.48 to 0.97) can significantly reduce ED visits. The result also showed that asthma education held in hospital (RR=0.58, 95% CI 0.44 to 0.77) or non-hospital settings (RR=0.81, 95% CI 0.68 to 0.97) may significantly reduce the number of ED visits.

Assessment of the impact of participants and setting on clinic visits

As shown in online supplemental figure 2, asthma education targeted at both children and parents/guardians (RR=0.74, 95% CI 0.45 to 1.22) or just children or parents/guardians (RR=0.86, 95% CI 0.67 to 1.10) was not significantly associated with a reduction in clinic visits. The result also showed that asthma

education held in hospitals (RR=0.45, 95% CI 0.22 to 0.92) can significantly reduce clinic visits, while that held in non-hospital settings (RR=0.92, 95% CI 0.69 to 1.23) may not significantly reduce clinic visits. Because there were only 6 studies out of 15 which included this outcome, hence sample size was too small to detect a difference.

Publication bias

The funnel plot is shown in online supplemental figure 1. Egger's test was used to assess the publication bias of the included studies. The results indicated a substantial publication bias for included studies related to hospitalisations ($p=0.023$), ED visits ($p=0.005$) and clinic visits ($p=0.004$).

GRADE summary of findings table

Table 1 presents a summary of the findings and an assessment of GRADE (Grades of Recommendation, Assessment, Development, and Evaluation) for each outcome. The quality of evidence from the included studies was rated as moderate overall.

DISCUSSION

Clinical implications

To the best of our knowledge, this is the first systematic review and meta-analysis to investigate the associations between asthma education and hospitalisation, ED visits and clinic visits of children. The study results suggested that asthma education was associated with 54% lower hospitalisation risk (95% CI 0.32 to 0.66) and 31% lower ED visit risk (95% CI 0.59 to 0.81) than usual care. Sensitivity analysis showed that the asthma education group had a lower clinic visit risk (RR=0.80, 95% CI 0.67 to 0.97). This decrease suggested that asthma was better controlled after an educational intervention.

Asthma is burdensome for children globally, and better diagnostics and management are needed particularly in low/middle-income countries, due to the growing prevalence of asthma.⁴⁷ The content of asthma education is related to inhaler technique assessment, written asthma treatment plans, self-monitoring of symptoms and regular medications.^{48–50} Poor compliance is a major obstacle to the treatment of any chronic disease.⁵¹ There are mainly two reasons behind the poor compliance: the first one is the poor understanding of the disease due to lack of knowledge or lack of communication between the doctors and patients, and the other is the deliberate decision by the patient to not follow the treatment or find an alternative method of treatment.⁵² Through asthma education, children can overcome poor compliance related to the first reason; this result was inconsistent with the results of the study by Ng *et al.*⁵¹ While asthma education can help control asthma in several cases, it still cannot achieve the desired result if it fails to consider the real-life scenario due to non-adaptation to targeted participants or the enrolment of several children with moderate or severe asthma.⁵³

The asthma education intervention may be limited to children or both children and their parents or guardians. Educational interventions can take place in hospitals, at home and in the community. The subgroup analysis of our study showed that asthma education involving both children and parents/guardians was associated with decreased hospitalisations (RR=0.38, 95% CI 0.24 to 0.59) and ED visits (RR=0.69, 95% CI 0.57 to 0.83). Asthma education carried out in a hospital or non-hospital setting can reduce hospitalisations and ED visits. However, for clinic visits, only asthma education carried out in hospital settings could reduce the risk (RR=0.45, 95% CI 0.22 to 0.92). Parent involvement in education is good for the learning behaviour and emotional health of children⁵⁴; thus, based on our findings, asthma education involving both children and parents can increase compliance to asthma guidelines.

Methodological considerations

The findings were limited because of the following: first, the children could learn how to deal with asthma through some other sources of information over time; it is a kind of Hawthorne effect, and the findings of this study should be interpreted cautiously. Second, we did not conduct subgroup analysis according to different teaching tools, content, frequency and educators, and it is important to conduct further analysis about these factors to get a better understanding of asthma education. Third, the outcome for this review is on reduction of hospitalisation, ED

and clinic visits hence it is about asthma exacerbation which can be objectively identified in studies in the systematic review; however, not all of the included studies described adherence to therapy after education, what daily symptoms were after education and how this translated to quality of life; the future studies about these topics are also needed. Finally, further studies on different stages of asthma are needed in the future.

CONCLUSION

Asthma education is effective for controlling asthma; in particular, it is effective for reducing hospital admissions, ED visits and clinic visits. Education involving both children and parents/guardians works better than that involving only children. The setting of asthma education has no significant impact on the effect, especially for hospitalisation and ED visits. Clinically, understanding the effect of education on asthma is critical for applying adequate preventive measures to control the prevalence of asthma in children. Furthermore, the subgroup analysis of the participants and the context of education is also useful in understanding the overall impact of education on asthma.

Contributors W-YL, ZLJ and T-HT conducted the study and drafted the manuscript. W-YL and ZLJ participated in the design of the study and performed data synthesis. W-YL and T-HT conceived the study and participated in its design and coordination. All of the authors read and approved the final manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval This study does not involve human participants.

Provenance and peer review Not commissioned; externally peer reviewed.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Tao-Hsin Tung <http://orcid.org/0000-0003-2097-8375>

REFERENCES

- Royal College of Physicians. Why asthma still kills: the national review of asthma deaths (NRAD)/confidential enquiry report. RCP 2015 <https://www.rcplondon.ac.uk/projects/outputs/why-asthma-still-kills>
- American Lung Association. Asthma and children fact sheet. American lung association, 2020. Available: <https://www.lung.org/lung-health-and-diseases/lung-disease-lookup/asthma/learn-about-asthma/asthma-children-facts-sheet.html>
- Kearney J, Everson L, Coppel J, *et al.* Incorporating medical students into school-based asthma education improves asthma knowledge in children. *J Asthma* 2021;58:1407–13.
- Mitchell RJ, McMaugh A, Homaira N, *et al.* The impact of childhood asthma on academic performance: a matched population-based cohort study. *Clin Exp Allergy* 2022;52:286–96.
- Stratakis N, Garcia E, Chandran A. The role of childhood asthma in obesity development: a nationwide U.S. multi-cohort study. *Epidemiology* 2021.
- Yu S, Guo X, Li G, *et al.* Gender discrepancy in the predictive effect of metabolic syndrome and its components on newly onset cardiovascular disease in elderly from rural China. *BMC Geriatr* 2021;21:505.

- 7 Henning RJ. Obesity and obesity-induced inflammatory disease contribute to atherosclerosis: a review of the pathophysiology and treatment of obesity. *Am J Cardiovasc Dis* 2021;11:504–29.
- 8 Ookeditse O, Motswakadikwa TR, Ookeditse KK, et al. Healthcare professionals' knowledge of modifiable stroke risk factors: a cross-sectional questionnaire survey in greater Gaborone, Botswana. *eNeurologicalSci* 2021;25:100365.
- 9 Navalpakam A, Secord E, Pansare M. The impact of coronavirus disease 2019 on pediatric asthma in the United States. *Pediatr Clin North Am* 2021;68:1119–31.
- 10 Jové Blanco A, González Roca I, Corredor Andrés B, et al. Impact of an asthma education program during admission. *Hosp Pediatr* 2021;11:849–55.
- 11 Bruzzese J-M, Sheares BJ, Vincent EJ, et al. Effects of a school-based intervention for urban adolescents with asthma. A controlled trial. *Am J Respir Crit Care Med* 2011;183:998–1006.
- 12 Guarnaccia S, Quecchia C, Festa A, et al. Evaluation of a diagnostic therapeutic educational pathway for asthma management in children and adolescents. *Front Pediatr* 2020;8:39.
- 13 Fleming M, Fitton CA, Steiner MFC, et al. Educational and health outcomes of children treated for asthma: Scotland-wide record linkage study of 683 716 children. *Eur Respir J* 2019;54:1802309.
- 14 Harish Z, Bregante AC, Morgan C, et al. A comprehensive inner-city asthma program reduces hospital and emergency room utilization. *Ann Allergy Asthma Immunol* 2001;86:185–9.
- 15 Davis J, Fitzmaurice L. Providing individualized written asthma action plans during the pediatric emergency department visit. *J Asthma* 2021;58:819–24.
- 16 Wang L, Timmer S, Rosenman K. Assessment of a University-Based outpatient asthma education program for children. *J Pediatr Health Care* 2020 ;34:128–35.
- 17 Eakin MN, Zaeh S, Eckmann T, et al. Effectiveness of a Home- and school-based asthma educational program for head start children with asthma: a randomized clinical trial. *JAMA Pediatr* 2020;174:1191–8.
- 18 Arkan-Ayyıldız Z, Işık S, Çağlayan-Sözmen Şule, et al. Efficacy of asthma education program on asthma control in children with uncontrolled asthma. *Turk J Pediatr* 2016;58:383–8.
- 19 Riera A, Ocasio A, Goncalves P, et al. Findings from a community-based asthma education fair for Latino caregivers. *J Asthma* 2015;52:71–80.
- 20 Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Syst Rev* 2021;10:89.
- 21 Chi C-C, Chen T-H, Wang S-H, et al. Risk of suicidality in people with psoriasis: a systematic review and meta-analysis of cohort studies. *Am J Clin Dermatol* 2017;18:621–7.
- 22 Wells GA, Shea B, O'Connell D. The Newcastle-Ottawa scale (NOS) for assessing the quality of Nonrandomised studies in meta-analysis. Available: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp [Accessed 24 Mar 2015].
- 23 Horner SD, Brown A, Brown SA, et al. Enhancing asthma self-management in rural school-aged children: a randomized controlled trial. *J Rural Health* 2016;32:260–8.
- 24 Suwannakeeree P, Deerojanawong J, Prapphal N. School-Based educational interventions can significantly improve health outcomes in children with asthma. *J Med Assoc Thai* 2016;99:166–74.
- 25 Velsor-Friedrich B, Militello LK, Richards MH, et al. Effects of coping-skills training in low-income urban African-American adolescents with asthma. *J Asthma* 2012;49:372–9.
- 26 Clark NM, Feldman CH, Evans D, et al. The impact of health education on frequency and cost of health care use by low income children with asthma. *J Allergy Clin Immunol* 1986;78:108–15.
- 27 Kelly CS, Morrow AL, Shults J, et al. Outcomes evaluation of a comprehensive intervention program for asthmatic children enrolled in Medicaid. *Pediatrics* 2000;105:1029–35.
- 28 Sockrider MM, Abramson S, Brooks E, et al. Delivering tailored asthma family education in a pediatric emergency department setting: a pilot study. *Pediatrics* 2006;117:5135–44.
- 29 Brown MD, Reeves MJ, Meyerson K, et al. Randomized trial of a comprehensive asthma education program after an emergency department visit. *Ann Allergy Asthma Immunol* 2006;97:44–51.
- 30 Garvey NJ, Stukel TA, Guan J, et al. The association of asthma education centre characteristics on hospitalizations and emergency department visits in Ontario: a population-based study. *BMC Health Serv Res* 2014;14:561.
- 31 Gaudreau K, Stryhn H, Sanford C, et al. Use of emergency departments and primary care visits for asthma related conditions in the 3 years following an asthma education program. *J Asthma* 2014;51:288–93.
- 32 Higgins JPT, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ* 2003;327:557–60.
- 33 Taggart VS, Zuckerman AE, Sly RM, et al. You can control asthma: evaluation of an asthma education program for hospitalized inner-city children. *Patient Educ Couns* 1991;17:35–47.
- 34 Shelledy DC, McCormick SR, LeGrand TS, et al. The effect of a pediatric asthma management program provided by respiratory therapists on patient outcomes and cost. *Heart Lung* 2005 ;34:423–8.
- 35 Shaak S, Brown K, Reichart C, et al. Community health workers providing asthma education. *J Asthma* 2020;22:1–13.
- 36 Safi KH, Stoermer-Grossman KJ, Kidwell KM, et al. A comprehensive pediatric asthma management program reduces emergency department visits and hospitalizations. *Pediatr Allergy Immunol Pulmonol* 2016;29:17–23.
- 37 Montalvo Stanton E, Suarez B, Martinez E. Quality of life assessment after completion of a community based inner city latino asthma program: The children's respiratory education program. *American Journal of Respiratory and Critical Care Medicine* 2011;183.
- 38 Marshall ET, Guo J, Flood E, et al. Home visits for children with asthma reduce Medicaid costs. *Prev Chronic Dis* 2020;17:E11.
- 39 Lebras-Isabet MN, Beydon N, Chevreul K. Impact de l'action éducative des enfants asthmatiques: l'expérience de l'hôpital Robert-Debré [Outcome evaluation of education in asthmatic children: the Robert-Debré hospital's experience]. *Arch Pediatr* 2004;11:1185–90.
- 40 Condren M, Boger JA. Impact of a pediatric clinic-based multidisciplinary asthma education and management program. *J Pediatr Pharmacol Ther* 2005;10:254–8.
- 41 Davis L, Kreshko LM, Allison V, Developing AV. Developing, implementing, and evaluating personalized education for pediatric patients diagnosed with asthma on an observation unit. *J Pediatr Health Care* 2019;33:72–9.
- 42 Espinoza-Palma T, Zamorano A, Arancibia F, et al. Effectiveness of asthma education with and without a self-management plan in hospitalized children. *J Asthma* 2009;46:906–10.
- 43 Broquet Ducret C, Verga ME, Stoky-Hess A. Impact d'une école de l'asthme sur la consommation en soins et la qualité de vie des enfants âgés de 4 à 12 ans et de leurs parents [Impact of a small-group educational intervention for 4- to 12-year-old asthmatic children and their parents on the number of healthcare visits and quality of life]. *Arch Pediatr* 2013;20:1201–5.
- 44 Johnson CE, Johnson T, Clark H, et al. A library-site asthma education program for inner-city communities. *J Asthma* 2006 ;43:9–18.
- 45 Julian V, Amat F, Petit I, et al. Impact of a short early therapeutic education program on the quality of life of asthmatic children and their families. *Pediatr Pulmonol* 2015;50:213–21.
- 46 Calvo Rey C, Albañil Ballesteros R, Sanchez Martín M. Educación grupal para niños asmáticos: nuestra experiencia [Group education for asthmatic children: our experience]. *An Esp Pediatr* 1998;49:353–8.
- 47 Szeffler SJ, Fitzgerald DA, Adachi Y, et al. A worldwide charter for all children with asthma. *Pediatr Pulmonol* 2020;55:1282–92.
- 48 Velsor-Friedrich B, Pigott TD, Louloudes A. The effects of a school-based intervention on the self-care and health of African-American inner-city children with asthma. *J Pediatr Nurs* 2004;19:247–56.
- 49 Butz A, Pham L, Lewis L, et al. Rural children with asthma: impact of a parent and child asthma education program. *J Asthma* 2005;42:813–21.
- 50 Yildirim M, Griffin P, Keskinocak P, et al. Estimating the impact of self-management education, influenza vaccines, nebulizers, and spacers on health utilization and expenditures for Medicaid-enrolled children with asthma. *J Asthma* 2021;58:1637–47. doi:10.1080/02770903.2020.1821056
- 51 Ng DKK, Chow P-Y, Lai W-P, et al. Effect of a structured asthma education program on hospitalized asthmatic children: a randomized controlled study. *Pediatr Int* 2006;48:158–62.
- 52 Hussey LC, Gilliland K. Compliance, low literacy, and locus of control. *Nurs Clin North Am* 1989;24:605–11.
- 53 Shields MC, Griffin KW, McNabb WL. The effect of a patient education program on emergency room use for inner-city children with asthma. *Am J Public Health* 1990;80:36–8.
- 54 Zhang X. Barriers and benefits of primary caregivers' involvement in children's education during COVID-19 school closures. *Int J Disaster Risk Reduct* 2021;66:102570.