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A pediatric asthma management program in a low-income setting resulting in reduced use of health service for acute asthma

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Abstract

Background: The effectiveness of pediatric asthma management programs in reducing health services utilization during exacerbations in developing countries is not widely studied. This study was carried out to assess the effectiveness of an asthma management program to reduce the overall health services utilization by acute asthma in children and adolescents.

Methods: In this historical population-based real-life cohort study, we selected 582 patients with asthma aged 4–15 living in deprived areas in the town of Itabira, Brazil, of which 470 cases were assisted by the asthma management program and 112 were controls. The end point was the first physician-diagnosed asthma exacerbation occurring after study enrollment and within 12 months after admission. All 470 cases received a written plan about exacerbation self-management, including the use of inhaled albuterol at home. Three hundred and seventeen out of 470 cases (67.4%) were also treated with beclomethasone diproprionate (BDP).

Results: Both groups were comparable regarding gender, age group, and place of residence. At the end of the study, only 5% of cases *vs* 34% of controls did seek health services because of acute asthma ($P < 0.01$). Statistical difference also remained when comparing the 112 controls with the 153 cases not treated with com BDP (Hazard Ratio = 0.04, 95% CI, 0.01–0.14, $P < 0.01$).

Conclusions: Results have demonstrated the effectiveness of the pediatric asthma management program in reducing dependence on the health services for acute asthma. Effectiveness was also observed in subjects with no use of BDP.

Asthma is a known challenge for the public health system, especially in low-middle income settings. Its costly and negative impact in childhood and adolescence often compromises quality of life (1). The prevalence rate in Brazil, as defined by the occurrence of wheezing in a period of the last 12 months, can reach up to 24.3% in children between the ages of 6 and 7, and 19.9% in adolescents between the ages of 13 and 14 (2).

The high morbidity related to asthma has motivated national, international and multilateral organizations, institutions, and governments to widely publicize its characteristics, symptoms, and management, including severity classification (intermittent and persistent asthma) (3). The literature recommends inhaled corticosteroids as the first-line treatment (3–8), as well as written plans for patients about the use of short acting beta-agonists and/or systemic steroids during exacerbations (4–10).

Despite these efforts, there is a gap between the recommendations and the real affordability and availability of inhaled anti-asthmatic drugs, particularly in both low-middle income countries and low-income areas of developed nations (11–13). In low-middle income countries, where 70–80% of worldwide asthmatics live, the implementation of asthma programs is a challenge because public health policies are limited because of financial constraints, and patients and their families often cannot afford anti-asthma drugs on their own.

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Hospitalization and emergency room visit rates because of acute asthma have been widely used in the literature as indicators of asthma morbidity control (14–17) and effectiveness of asthma management programs. In the past 20 years, hospitalizations and emergency room visits because of acute asthma were reduced in between 31–60% and 14–79% [for children, adolescents, and adults, respectively, as a result of these programs (4–7)]. In spite of the methodological differences between published studies, almost all of them conclude that the wide use of inhaled steroids leads to a reduction of episodes of acute asthma and better use of resources (10–15).

Our literature search, however, revealed that in the past 20 years, very few studies were conducted to assess the impact of asthma management programs in reducing hospitalizations by acute asthma in children and adolescents and to verify the effectiveness of both asthma medication and asthma self-management education provided by a pediatric asthma management program.

This population-based study was carried out to analyze how the use of inhaled corticosteroids and the management program affected health service utilization by children and adolescents with acute asthma.

Materials and methods

Description of the asthma management program

A pediatric asthma management program was implemented in the Municipal Public Health System in the town of Itabira (population 130 000), state of Minas Gerais in southeastern Brazil, in December 2001. The target population was comprised of children and adolescents younger than 15 years exclusively from low-income families (monthly income up to US$ 300) living in deprived areas. In that setting, the asthma prevalence rate as diagnosed by the occurrence of wheezing in the past 12 months was 14.3–9.3% in the 7–8 and 13–14 years age groups, respectively (18). This is a real-life management program in which patients are enrolled with both intermittent and persistent asthma. The initial planned coverage was 50% of the target population, but throughout the study 70% of this same population came to be assisted by the program.

Patients assisted by the program were periodically assessed in the primary health care (PHC) network and were given free of charge: inhaled albuterol and/or beclomethasone diproprionate (BDP) when needed, and pear-shaped plastic valved spacers. They also received a written action plan and were taught self-management of asthma exacerbation at home. For those with persistent asthma, the need to achieve optimal adherence rate to BDP was emphasized. Dosage of BDP was adjusted according to asthma severity or level of control per GINA recommendations (3).

Albuterol and BDP pMDIs were dispensed exclusively in the Municipal Public Health facilities where a new inhaler was given in return of an empty canister. Because of financial constraints, it is extremely unlikely that inhaled albuterol, inhaled corticosteroids or asthma self-management education could be obtained from sources other than the organization administering the intervention. The pharmacist/health worker, in turn, along with anti-asthma medicines, provided additional information about the disease to patients with suboptimal adherence rates in attempt to increase adherence. Patients were advised by the health team as to the correct use of inhalation therapy at every visit to the PHC facility. To be assisted by the program, the patient and his or her caregivers should also attend comprehensive educational activities, such as the discussion of printed educational brochures, interactive learning sessions on the characteristics of the disease, the benefits of regular BDP use, self-management of exacerbations (even at home) and the importance of avoiding triggers.

Study design

This study, a real-life historical cohort study, was carried out from 1 January 2004 to 31 December 2006, 3 years after the original implementation of the program in Itabira. Cases and controls were defined as subjects assisted (exposed) or not assisted (unexposed) by the pediatric program.

Inclusion criteria were Itabira residents aged 4–15, who in the 12 months preceding the study sought the Municipal Health with two or more episodes of acute asthma, who were diagnosed and managed by a pediatrician, and who were unequivocally responsive to short acting beta2-agonists, either in isolation or associated to oral steroids.

Operational definitions

Throughout the study period, all patients meeting the inclusion criteria were identified in the Municipal Health Authority's electronic database and selected for the study. The patients were later classified as either case or control, according to the following operational definitions: (i) cases: patients assisted by the Municipal Asthma Management Program, i.e. who obtained asthma self-management education, albuterol, or BDP; and (ii) controls: children and adolescents who were not yet assisted by the same intervention program during the study period.

Cases were classified in two mutually exclusive categories: (i) BDP nonusers, i.e. patients assisted by the management program receiving albuterol and self-management education only; and (ii) BDP users, i.e. patients assisted by the management program who received albuterol, BDP, and self-management education.

Primary end point

The primary endpoint was defined as the first physician-diagnosed exacerbation by acute asthma within the 12 months of admission. Patients not presenting any exacerbation from admission to the end of the follow-up were censored.

Data collection

For both cases and controls, information about date of birth, gender, type of health facility (inpatient, emergency department, or PHC unit) where acute asthma episode was diagnosed and treated, place of residence (rural or urban area), and

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asthma severity (3) was collected from medical charts. For both cases and controls, asthma severity was measured and classified on clinical grounds according to GINA criteria (3).

Statistics

Student's *t*, chi-square, and Mann–Whitney tests were used to compare the descriptive characteristics of the two studied groups. The probability of health services utilization because of acute asthma in the 12 months following admission was estimated by Kaplan–Meier product limit method. Univariate and multivariate analyses were performed by means of the log-rank test and the Cox proportional hazards model, respectively. The initial model contained variables, group (cases or controls), age group, type and duration of follow-up, excluded through stepwise strategy. In the multivariate analysis, the variables age, severity, and BDP use were considered, because *P*-value was <0.25 in the univariate analysis. Significance level was $P < 0.05$.

Statistical analyses were processed through R, version 2.9.0 (Free Software Foundation, Boston, MA, USA, 2009) and OPENEPI, version 2.3 (19) software.

Ethical aspects

The research protocol was approved by the Itabira Municipal Health Authority and the Ethics Committee of the Federal University of Minas Gerais.

Results

Table 1 displays the descriptive characteristics of the 470 studied patients. The predominance of cases over controls is explained by the progressive expansion of the asthma management program coverage (by 60–70%) during the study period. Both groups were comparable regarding sex, age group, and place of residence (rural or urban). The median age was 6.8 years (95% CI, 6.42–7.1) and 6.6 years (95% CI, 6.58–8.34) among controls and cases, respectively. This statistical difference, however, is not clinically relevant.

There was a predominance of patients with intermittent asthma among the controls (37.5% *vs* 24.0%), which reveals a greater coverage of the program among cases with persistent asthma, i.e. 43.9% of patients assisted by the program (cases) presented moderate or severe persistent asthma, and thus more likely to be at risk for exacerbations than controls. This reflects the program's aims of prioritizing patients who require controller medication.

As expected, the use of BDP was higher in cases than controls, and 67% of cases were classified as BDP users.

Figure 1 presents the proportion of patients that did not use the Municipal Health System network for acute asthma during the 12 months of follow-up. Kaplan–Meier estimates show that only 2% of BDP users and 6% of BDP nonusers sought health services by acute asthma during the study period. Conversely, during the same time the percentage for controls was 34%. These two differences (32 and 28%, respectively) were statistically significant (*P* log-rank <0.01).

Table 1 Descriptive characteristics of the participants

Variables	Case *N* (%)	Controls *N* (%)	*P*-value
Sex			
Male	291 (60.7)	62 (56.8)	0.20
Female	179 (39.3)	50 (43.2)	
Age group (years)			
Up to 6	250 (53.2)	53 (47.3)	0.31
Older than 6	220 (46.8)	59 (52.7)	
Residence area			
Urban	449 (95.5)	109 (97.3)	0.39
Rural	21 (4.5)	3 (2.7)	
Asthma severity			
Intermittent	113 (24.0)	42 (37.5)	<0.01
Mild persistent	151 (32.1)	38 (33.9)	0.72
Moderate persistent	145 (30.9)	17 (15.2)	0.01
Severe persistent	61 (13.0)	15 (13.4)	0.91
Beclomethasone diproprionate (BDP) prescription			
Controls	Zero	112 (100.0)	NA*
Cases/BDP nonusers†	153 (32.5)	Zero	
Cases/BDP users‡	317 (67.5)	Zero	
Exacerbations after admission			
Yes	23 (4.9)	38 (33.9)	<0.01
No (censored)	447 (95.1)	74 (66.1)	

*NA, not applicable.
†BDP nonusers: patients assisted by the asthma management program that received albuterol and self-management education.
‡BDP users: patients assisted by the program that received albuterol plus BDP and self-management education.

Additionally, the cases' survival curves showed a difference of 4% favoring BDP nonusers when compared with BDP users. This could be ascribed to the fact that 113 out of 470 cases (24.0%) had intermittent asthma and were at a lower risk for exacerbations.

Table 2 shows the multivariate Cox regression analysis for the first occurrence of exacerbation after admission. In the 5–6 years age group, the Hazard Ratio (HR) was five times higher than in children aged 4. As expected, the HR was 3.1–3.7 higher in patients with moderate and severe persistent asthma than to those with intermittent asthma, respectively.

In the final model, there was a statistically significant difference favoring cases, even among BDP nonusers. After adjustment, BDP nonusers had a 96% (HR = 0.04, 95% CI, 0.01–0.14) reduction in the risk for using health services because of acute asthma when compared with controls. Moreover, BDP users had 88% (HR = 0.12, 95% CI, 0.07–0.21) lower frequency of health services use because of asthma exacerbations than controls.

Discussion

In this study, 12 months after admission, the proportion of cases who sought assistance because of acute asthma was

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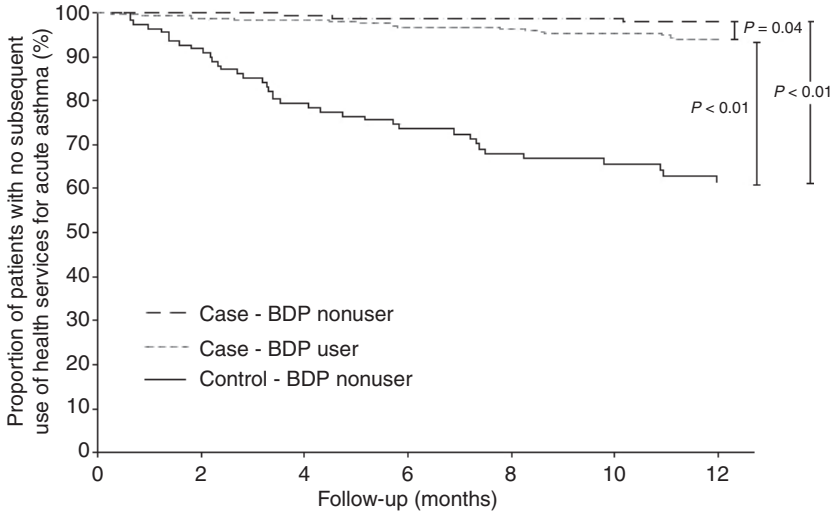

Figure 1 Health services utilization by acute asthma during the follow-up.

Table 2 Factors related to the first exacerbation after admission leading to medical assistance in the health services network for acute asthma (final model)

Co-variables	*N*	Hazard Ratio	95% CI		*P*-value
Age group (years)					
4	100	1.00	Reference group		
5–6	203	5.16	1.21	22.08	0.03
7–9	159	1.97	0.43	9.07	0.38
10–14	120	2.09	0.44	9.92	0.35
Asthma severity					
Intermittent	155	1.00	Reference group		
Mild persistent	189	2.06	0.96	4.43	0.07
Moderate persistent	162	3.11	1.40	6.93	0.01
Severe persistent	76	3.74	1.63	8.56	0.01
Beclomethasone diproprionate use/study group					
Nonuser/control	112	1.00	Reference group		
Nonuser/case	153	0.04	0.01	0.14	<0.01
User/case	317	0.12	0.07	0.21	<0.01

significantly lower than that of controls. This difference was of approximately 30%, favoring the subjects assisted by the Municipal Pediatric Asthma Management Program, even among BDP nonusers. Possible explanations for the 66% of controls who did not seek health care are the high proportion (37.5%) of intermittent asthma, which has a lower risk of exacerbation, spontaneous resolution of the acute episode, the possibility that parents only seek medical assistance during severe attacks, and self-medication with other relievers and/or controller drugs, because these can be obtained in Brazil over the counter.

Studies from the last two decades showed that the use of inhaled corticosteroids can reduce hospitalizations by acute asthma up to 80% (14). Given the ethical constraints of including a control group for which inhaled steroids and short acting beta2-agonists would not be prescribed, the authors of that review paper point out that retrospective cohort studies such as the present one are more adequate to analyze this association (14). However, retrospective cohort studies with children and adolescents comparing the effectiveness of an asthma management program in the reduction of health resource utilization by acute asthma have not been identified in the literature.

Our real-life historical cohort study differs in important aspects from those evaluated by previous studies on the effectiveness of asthma medications and asthma self-management education. Whereas most previous studies assessed either medication or education, the intervention we examined combined education with distribution of free medication following GINA recommendations (3).

The study closest to ours was carried out in Canada, with only 22.5% of the participants aged less than 15 years. The authors assessed the effectiveness of inhaled corticosteroid but not of an asthma management program. There was a difference of 45% in resource utilization by acute asthma, among users and nonusers of inhaled corticosteroids (7). Unfortunately, other comparisons with our study were not possible, because the authors failed to analyze the effects of asthma severity on the primary outcome and the overall impact of inhaled corticosteroid on health services utilization.

Among controls, this study has shown an association between the risk of exacerbation leading to resource utilization by acute asthma and asthma severity, that is, the higher the severity, the greater the risk of exacerbation. At the end of 12 months of follow-up, the protective effect among BDP user cases was eight times greater than in controls. Likewise, a similar protective effect (25 times greater) was obtained

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among BDP nonusers who received individual and group education on asthma, including self-management of exacerbations at home with rescue albuterol.

Our literature review has found a similar tendency, but in works with a different study design. In a case–control study carried out with children up to 14 years, there was a reduction in the risk of hospitalizations (OR = 0.54) and emergency room visits (OR = 0.45) with the adoption of practices that supported early intervention for asthma flare-ups, particularly written management plans (4). A before and after trial that enrolled 53 patients up to 17 years of age concluded that the adoption of action plans, either verbal or written, could lead to a reduction of 22% in hospital readmissions and 30% of emergency room visits because of acute asthma (10). Another before and after trial reported that in 381 patients aged 2–56, a plan of action based on home orientations reduced hospitalizations in 50% and emergency room visits in 25% (9).

Moreover, in a meta-analysis that included studies carried out with children aged 2–17 specifically to assess the effects of pediatric asthma education on resource utilization because of asthma, the authors concluded that educational interventions contributed in reducing emergency room visits, but not the risk of hospitalizations or nonscheduled medical appointments (20).

However, to date, there is no adequately powered population-based study assessing the effectiveness of asthma control programs exclusively in children and adolescents, such as the present one. Our sample size is large enough to demonstrate the study aim: considering that 4.9% of 470 cases and 33.9% of 112 controls have utilized resources because of acute asthma (Table 1), i.e. a difference of 29% between the two groups, and assuming an alpha and beta error equal to 5% and 10%, respectively, it would be necessary only 85 cases and 20 controls (19), a much smaller sample size than the one actually studied. Moreover, to ensure an unequivocal asthma diagnosis only children older than 4 years old that have had two acute asthma episodes were admitted.

The study design of this historical real-life cohort study, while constrained by the ethical consideration of enrolling a control group with placebo, nevertheless sought to overcome this recognized limitation by following rigorous asthma diagnostic criteria and high study power.

Our results show a statistically significant, as well as clinical and epidemiological relevant, reduction in health services utilization because of acute asthma by children and adolescents assisted by the Municipal Asthma Management Program. The effectiveness herein described is noteworthy because hospitalizations, emergency room visits, and nonscheduled visits to a PHC facility by acute asthma patients implicates in high expenses for the health system and are also related to undesirable and preventable psychosocial effects in childhood and adolescence. Similar asthma programs seem to be feasible in low-middle income settings and should provide anti-asthmatic reliever and controller medicines (free, when possible) as well as a comprehensive educational framework because of their synergistic effect in reducing the burden on health services by acute asthma.

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