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The effect of a coaching program on asthma control and health care utilization in children with asthma

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ABSTRACT

Objective: Poor adherence to asthma therapy is a major problem in the management of asthma. We aimed to assess if a designed coaching program in children with asthma, coming from low socioeconomic background, will reduce respiratory morbidity and health care utilization.

Methods: A prospective interventional pilot study enrolling children aged 3–18 years, admitted to Soroka University Medical Center (SUMC) between October 2015 and May 2016 due to asthma exacerbation. The intervention group was part of a coaching program, which was conducted by medical and paramedical personnel and included a diagnostic and personal educational office visit and a house visit by a nurse educator for asthma. The control group comprised of demographically matched children with asthma, who were admitted to the SUMC, but did not go through any intervention. Medications purchase and health care utilization were extracted from the participants' HMO databases, during 1-year of follow-up.

Results: 41 children were enrolled to the intervention group, with 63 children as a control group. No differences were found in asthma-related drugs purchase, number of clinic visits, ER admissions and hospitalizations during the follow-up year, although the intervention group showed a trend towards having a shorter length of stay (2.3 vs. 4.5 days, Cohen's $D = 0.44$, $p = 0.06$). The intervention group demonstrated subjective improvement in asthma control, as reflected in Asthma Control Test questionnaires.

Conclusions: In this pilot study of coaching program for children with asthma coming from low income families, no decrease in health care utilization was shown. Larger and longer intervention programs are needed.

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Introduction

Asthma is one of the most prevalent chronic inflammatory diseases in children and is considered to have a high financial burden (1). Patient adherence for using long-term controller medications for asthma is one of the key ways to improve asthma management in patients with persistent asthma. In the pediatric population, caregivers play a pivotal role in fostering and monitoring adherence to asthma medications and should be an essential part of the any intervention. Multiple studies have found significant improvements with the use of controller medications, including fewer emergency room visits and hospitalizations for asthma exacerbations, more asthma episode-free days and fewer

courses of systemic corticosteroids (2). Unfortunately, patient adherence for asthma treatment is commonly poor, ranging between 56% among secondary school children (>12 y) (3), up to 75% in children aged 5–12 years, when adherence to ICS was measured objectively (4), despite many interventions which attempted to overcome the issue (5). Furthermore, a correct inhaler technique is a prerequisite of successful asthma control and involves using an age appropriate device, handling the device correctly and performing an adequate breathing maneuver. It is also important to regulate environmental factors such as eliminating exposure to relevant allergens and irritants (6), especially parental smoking which

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has been shown to increase the incidence of asthma in children by at least 20% (7). Strega et al. (8) conducted a single environmental intervention (video, workbook, minimal counseling) in children with asthma from low income minority, in order to reduce second hand smoke. They reported no different outcomes between the groups and high attrition rate.

Results from other previous interventional programs are promising and suggest that providing outreach to patients in their homes can be beneficial (9). Moreover, educational programs have shown to improve lung function and self-perception of asthma control as well as reduce absenteeism from school (10). Although educational interventions, including house visits, have been done in the past, most of them were focused on urban populations (11,12). Welker et al. reviewed 23 interventional studies, focusing on school-based educational interventions and home-based environmental interventions in low-income families from urban areas. They found evidence for positive impact of those interventions, but some of the interventions did not reduce emergency department visits (13). On the other hand, Turcotte et al. (14) demonstrated improvement in measures of asthma severity and decrease in health care utilization among 116 low-income urban households with children with asthma, by providing multicomponent interventions such as pest management, commercial cleaning and cleaning equipment.

To our knowledge, this is the first interventional study regarding adherence to treatment in children with asthma that has been performed in the Bedouin population. This population is the majority in our medical center, in south of Israel. This is a distinct population, not only because most of them belong to a low socioeconomic status, but also in its different culture and habitation in remote rural settlements. We believe that reaching out to children with asthma from low-income minority household, residing in rural areas, will eliminate health care disparities, improve asthma management and hopefully will reduce health care utilization.

Our hypothesis was that by educate and instruct children with asthma and their caregivers at their homes, we will improve adherence to preventive asthma therapy, and therefore we will reduce asthma-related drugs purchase, number of clinic visits, ER admissions and hospitalizations.

Therefore, we designed a community coaching program for children with asthma in their homes, in order to provide asthma self-management education

to the children and their caregivers. The possible implementation of educational program in a relatively low socioeconomic population was assessed in this prospective and interventional pilot study.

Methods

Intervention

This was a prospective and interventional pilot study, which included children aged 3–18 years that were referred to the emergency room (ER) at the Soroka University Medical Center (SUMC) between October 2015 and May 2016 due to asthma exacerbation (intervention group). The control group included children with asthma who were treated in the ER or in the pediatrics department between October 2014 and May 2016 at our center; however they were not enrolled in the study. The control group was demographically matched to the intervention group, based on age, gender, ethnicity and the decision to admit or to discharge them from the ER during the exacerbation, in order to ensure similar asthma's severity between groups. For the intervention group, informed consent was obtained from at least one caregiver on behalf of each child upon enrollment (children younger than 18 years do not sign any forms, according to our IRB). Informed consent was not obtained for the control group, as their details were taken retrospectively and anonymously by searching in the clalit HMO data base.

The intervention included four sessions: educational meeting one month after enrollment, comprehensive house visit two months after enrollment and two more telephone sessions, at 6 and 12 months during the following year. Our intervention program goals were: providing information about the disease, acknowledgment and elimination of risk factors and discussing possible treatment strategies during an educational meeting. Then, the treatment was personalized with a house visit to educate the child and his/her caregivers in their own home with an emphasis on the following subjects: (1) examination of the available medications at the child's house, (2) instruction of proper inhaler technique, (3) verification of the adherence to controller medication treatment and discussion about possible reasons for noncompliance, (4) identification and elimination of potential triggers for exacerbation and (5) discussion with the caregivers about what should be done at times of asthma exacerbations.

This intervention included three major stages; first, a month after the enrollment, 3–5 children and their caregiver/s attended a 30 min educational meeting with a pediatric pulmonologist at the SUMC clinic

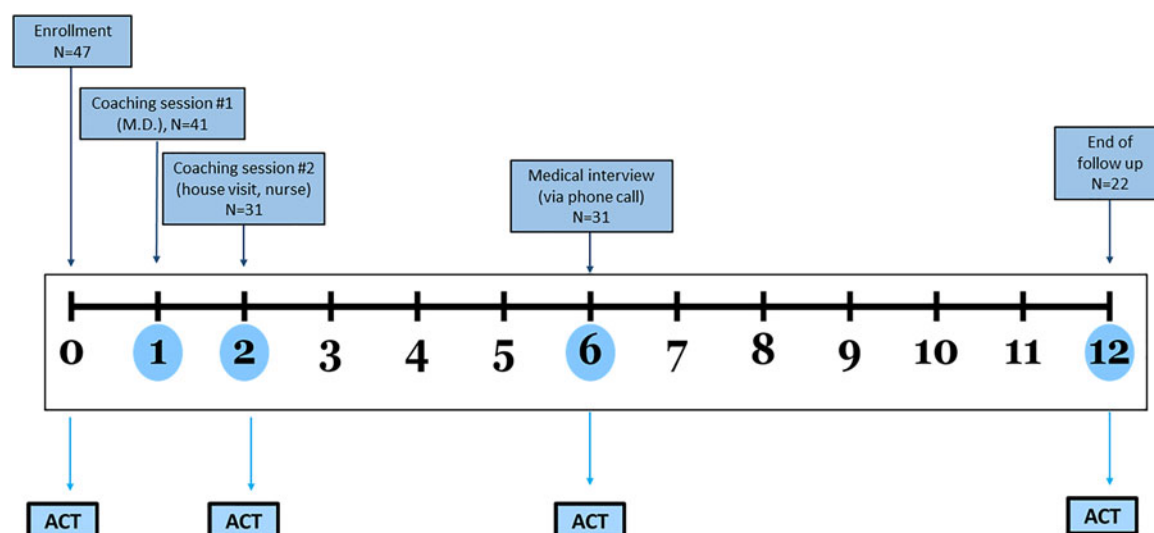


Figure 1. Timeline for the intervention program during 12 months' follow-up.

which included an explanation about the causes, clinical signs and treatment of asthma, with emphasis on the importance of adherence to medical treatment and adjustment of environmental factors. To ensure standardization, a Power Point presentation was used by the same pediatric pulmonologist in all the educational meetings. Then, individual adjustments of the treatment regime were made for each child according to his baseline asthma status (controlled/poorly controlled/uncontrolled) and to the recommendations of the Global Initiative for Asthma (GINA)-2015 guidelines.

Second, one month later, a trained asthma nurse educator visited each child at his home. During the house visit, which lasted approximately one hour, the nurse examined the house and its surroundings to identify potential injurious environmental factors such as exposure to passive smoking or exposure to inhaled allergens, checked the asthma medications that were stored in the house (including dosage and expiry dates) and made sure that the child was using the inhaler properly. In addition, the nurse addressed concerns of caregivers that could lead to non-adherence, such as adverse effects of asthma medications, controller medication dependency, effect on the child's growth and cost of medications (15). Finally, the nurse inquired if the child and his caregiver are familiar with signs of exacerbation, have an asthma action plan in place and know when and where to seek medical assistance.

Third, the children and their caregivers in the intervention group were asked to fill out self-questionnaires in order to assess asthma control. The Asthma Control TestTM was used for ages 12–18 and the Childhood Asthma Control Test* for ages 3–12. The questionnaires collected information about the subjective assessment of disease control at different stages

throughout the follow-up year. The questionnaires were filled out four times during the trial: one month from enrollment (before intervention); two months after the enrollment (during the house visit, mid-intervention); and six months and 12 months after enrollment (after intervention via telephone) (Figure 1). A higher score indicates a better sense of control of the disease. The control group didn't complete the ACT questionnaires, since their data were analyzed retrospectively.

Health care utilization during 1-year follow-up was estimated for both groups using the 'Clalit' HMO databases. The data included number of purchased prescriptions for controller and reliever asthma medications, the number of clinic visits for a respiratory complaint, number of ER visits due to asthma exacerbation and number of asthma related hospitalizations and their length of stay.

Statistical analysis

Variables are shown as mean $\pm$ standard deviation [SD] for continuous variables that met parametric assumptions or as median and interquartile range [IQR] for continuous variables that did not meet parametric assumptions or ordinal variables, and percentage for categorical variables. Comparison between the intervention and control groups for clinical and demographic characteristics was performed with Student's *T*-test for continuous variables that met parametric assumptions, Mann-Whitney *U* test for continuous variables that did not meet parametric assumptions, and Pearson's Chi-square test for categorical variables. Because of the varying normal ranges of vital signs between different age groups, we stratified the data according to age groups, thus

Table 1. Population characteristics, socioeconomic status, asthma risk factors and co-morbidities of the intervention group.

Population characteristics, <i>n</i> = 41		
Age		7 ± 3 (years)
Gender (male)		24 (59%)
Ethnicity (Jewish)		22 (54%)
Socioeconomic status		
Residence	City	32 (78%)
	Village	5 (11%)
	Bedouin Diaspora	5 (11%)
Years of education (mother)	<8	8 (20%)
	8–12	20 (49%)
	>12	13 (31%)
Years of education (father)	<8	3 (7%)
	8–12	24 (60%)
	>12	13 (33%)
Employment status (mother)	Salaried	18 (45%)
	Self employed	4 (10%)
	Unemployed	18 (45%)
Employment status (father)	Salaried	19 (50%)
	Self employed	11 (29%)
	Unemployed	8 (21%)
Residents to rooms ratio ≥1	32 (75%)	
Asthma risk factors		
Gestational age weeks (mean ± SD)		39 ± 2
Gestational age ≤37 weeks		8 (20%)
Allergic rhinitis		9 (22%)
Atopic dermatitis		8 (20%)
Cow's milk allergy		4 (10%)
First degree asthmatic relatives ≥1		16 (39%)
Previous use of bronchodilators		40 (98%)
Previous use of systemic steroids (times / year) ≥3		22 (54%)
Previous use of ICS		5 (12%)
ICU admissions		3 (7%)
Exposure to passive smokers ≥1		26 (63%)
Exposure to animals		10 (24%)

Note. ICU = intensive care unit, ICS = inhaled corticosteroids. It shows descriptive statistics of the intervention group. Population characteristics, socioeconomic status parameters and asthma risk factors were assessed.

creating a group of young children (aged 3–12) and adolescents (aged 13–18). The older group was too small in order to perform statistical comparison analysis. The difference in outcomes between the groups was assessed via Student's *t*-test for variables that met parametric assumptions and via Mann-Whitney U test for nonparametric variables. For the number of referrals to the ED, the number of admissions, and the length of stay per admission, we calculated Cohen's D to measure the exact effect size between groups. The ACT questionnaire results were analyzed with the Wilcoxon signed-rank test for each question separately and also the sum of the responses. The comparisons were performed between the first questionnaire and each of the other three. Statistical tests were two-sided with an *a priori* significance level of $P < 0.05$. All statistical analysis was performed with IBM SPSS version 23.

Results

The intervention group consisted of 41 children enrolled between October 2015 and May 2016. Table 1 represents their demographics and asthma risk factors. The majority of the study's population

belongs to a low socioeconomic status; twenty percent of the patients live in villages or in Bedouin settlements where unemployment rates are high. In addition, 70% of these patients' parents have only primary or secondary education. Twenty percent of the children in the intervention group were born before the 37th gestational week, which is a known risk factor for asthma in preadolescent children (16). Around twenty percent reported co-morbidities such as allergic rhinitis and atopic dermatitis. Forty percent have at least one first degree asthmatic relative. A notable observation was that 63% of the children had been exposed to passive smoking. The control group consisted of 63 children that were matched for age, gender, ethnicity and the decision to admit or to discharge them from the ER during the exacerbation. They were hospitalized between October 2014 and May 2016. The data was extracted from the HMO 'Clalit.' Vital signs were collected on admission to the ER, and included heart rate, body temperature, respiration rate per minute and room air oxygen saturation. Comparing the vital signs on admission of the two groups, there was no significant difference with the exception of body temperature (Table 2).

Table 2. Comparison of population characteristics and vital signs between the intervention and control groups, at admission.

	Intervention group, <i>n</i> = 41		Control group, <i>n</i> = 63		<i>p</i> -value
Gender (male)	24 (59%)		41 (65%)		0.50
Ethnicity (Jewish)	22 (54%)		26 (41%)		0.22
Age (years), (mean $\pm$ SD)	7 $\pm$ 3		7 $\pm$ 3		0.60
Vital sign parameter	Intervention group		Control group		<i>p</i> -value
Age group	3–12 <i>n</i> = 38	13–18 <i>n</i> = 3	3–12 <i>n</i> = 62	13–18 <i>n</i> = 1	
Heart rate (bpm)	128 $\pm$ 18		131 $\pm$ 20		0.426
Temperature (PO)	37.0 $\pm$ 0.7		37.3 $\pm$ 0.8		0.03
Respiratory rate	39 $\pm$ 10		39 $\pm$ 14		0.97
O ₂ Sat. (in room air)	90 $\pm$ 15		93 $\pm$ 4		0.2
Admitted at index	32 (78%)		45 (71%)		0.45

Note. Bpm = breaths per minute; PO = per oss.

Table 3. Assessment of respiratory morbidity in the two groups during the year of follow-up.

Clinical outcome	Intervention group <i>N</i> = 41(39%)	Control group <i>N</i> = 63 (61%)	<i>p</i> -value	Cohen's D (effect size)
Number of ER admissions; median (IQR)	1 (1–2)	1 (1–2)	0.60	–0.10
Number of hospitalizations; median (IQR)	1 (1–2)	1 (1–2)	0.98	–0.03
LOS; median (IQR)	2 (1–2.5)	2 (1–4)	0.06	0.44
LOS; mean $\pm$ SD	2.3 $\pm$ 1.8	4.5 $\pm$ 7.2		
Number of clinic visits; median (IQR)	5 (3.5–8)	6 (2.5–9)	0.76	–0.13
Number of clinic visits; mean $\pm$ SD	6.5 $\pm$ 6	7 $\pm$ 5		
Reliever medication; median (IQR)	3 (2–5)	2 (1–4)	0.13	0.22
Reliever medication; mean $\pm$ SD	3 $\pm$ 2.2	3 $\pm$ 2.3		
Controller medication; median (IQR)	4 (2–7.5)	3 (2–5)	0.39	0.21
Controller medication; mean $\pm$ SD	5 $\pm$ 4	3 $\pm$ 3		

Note. ER = emergency room, IQR = inter quartile range, LOS = length of stay. It shows comparative analysis for clinical outcomes throughout the year of follow up between the intervention and control group. Continuous variables were compared via Mann-Whitney U's test and nominal variables via Pearson's Chi square test. Cohen's D was calculated to measure the effect size between groups. Cohen's D shows the number of standard deviations of difference between groups. 0.2 is a small effect size, 0.5 a medium effect size, and 0.8 a high effect size.

Unfortunately, 47 caregivers signed an informed consent, but only 41 came to the first educational meeting. 10 out of 41 children and their caregivers dropped out from the study after the educational meeting and before the house visit. Five caregivers preferred to meet in the hospital than at their home, limiting the ability to recognize environmental triggers. The nurse visited 26 children and their caregivers at their home (Figure 1). On the house visits, which took place in urban and rural areas in the south of the country, few problems were revealed. First of all, the nurse re-explained about the course of asthma, common triggers, and the need for preventive care at all visits. Improper inhaler use defined as missing at least one crucial step in inhaler technique occurred in 17 out of 31 (55%) patients. Four of them did not use a spacer device. Confirmation of proper use of inhaler and prescription of spacer device were completed during these visits. Six out of 31 (19%) children were closely exposed to injurious environmental factors such as olive trees around the house, carpets and dusty curtains in the house. The nurse educated the family about how to eliminate these factors, when possible. Considering environmental factors, education on the importance of smoking cessation was a fundamental part of the house visit.

Unfortunately, none of the caregivers quit smoking, but they all agreed to smoke far from the child and change their clothes while interacting with the child. Two out of 31 (6%) children had an inhaler with an expired date and were provided with a new prescription. One caregiver did not buy the inhaler because of financial issues. A social worker was involved in this case.

During the last six months of the follow up, nine more families dropped out of the study since they did not answer phone calls to fill out the last ACT questionnaire. There were no differences between the children that dropped out and those that completed the 1- year follow-up, in terms of age, gender and ethnicity.

Assessment of respiratory morbidity and health care utilization was completed during the year following the enrollment, through the medical records of the 'Clalit' HMO. No significant statistical differences were found between the two groups in regard to number of clinic visits, ER visits, and hospitalizations due to respiratory causes (Table 3). Moreover, no statistical significance was demonstrated between the groups in purchase of asthma medication when analyzed as total medication or when divided into controllers and relievers anti-asthmatic medications. The intervention group showed a non-statistically significant trend towards having a shorter duration of

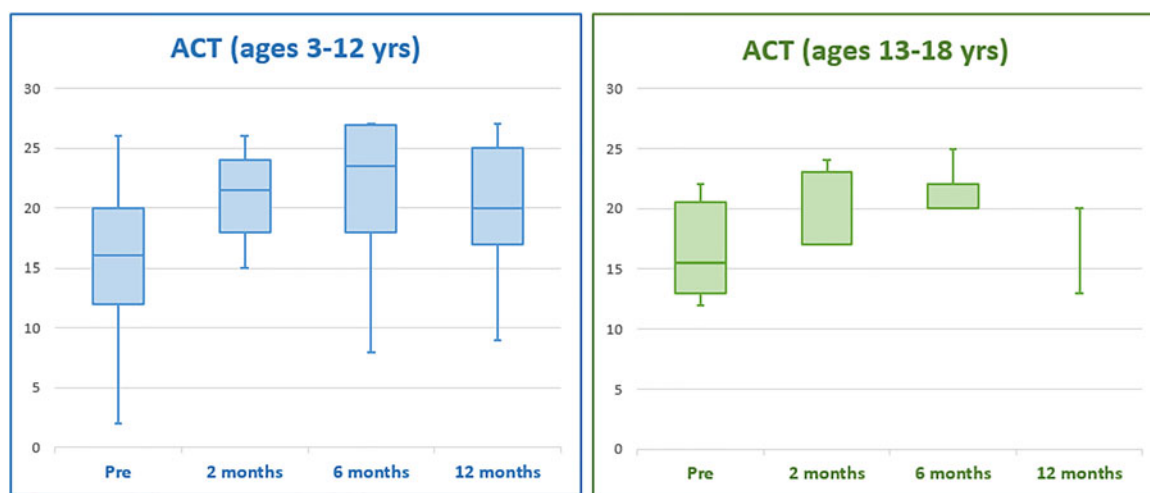


Figure 2. Box plot for ACT questionnaire results representing minimum, maximum, median and IQR values for pre-intervention and two, six and twelve months post intervention time periods.

hospitalization. Average length of hospitalization during the follow-up year was shorter by approximately two days in the intervention group than in the control group (2.3 vs. 4.5 days, $p = 0.06$). Cohen's D for the length of stay showed that the intervention group had on average a LOS that was 0.44 standard deviations shorter than the control group, meaning the effect size of LOS between groups was small (Cohen's $D = 0.44$, $p = 0.06$).

The ACT questionnaires filled out by the children and their caregivers, collected information about the subjective assessment of disease control at different time stages during the follow-up year, and are graphically illustrated in Figure 2. A significant improvement was found regarding the subjective assessment of asthma control level before and after intervention. As stated previously, a higher score represents better control. Paired comparison between questionnaire scores in the younger group (ages 3–12) showed an improvement in subjective asthma assessment over time, with a median and [IQR] score of 21.5 (17–23) at two months compared to 16 (12–19, 24) at initiation of trial ($p = 0.001$), 23.5 (17–23, 25–27) at 6 months compared to initiation ($p < 0.001$), and a non-statistically significant trend toward improvement with 20 (17–25) at 12 months compared to initiation ($p = 0.16$). In the older age group (ages 12–18) there was no significant difference between any pair of questionnaires, though it was assessed at a small sample size.

Discussion

In this prospective pilot study we designed a coaching program for children with asthma and their caregivers, in order to assess possible implementation of

educational program, aimed to decrease health care utilization.

Our results demonstrated similar asthma medication purchase and health care utilization in the intervention group, comparing to the control group. The mean LOS during the follow up year showed a non-statistically significant trend toward a shorter time period, in the intervention group ($p = 0.06$). Non-significance is possibly due to a small sample size. Nonetheless, Cohen's D for length of stay demonstrated a small effect size between groups, thus meaning that even if a trend favors the intervention group for a shorter admission, it is a small effect. An improvement in self-perception of asthma control before and after the intervention was demonstrated in the intervention group, but this may also be related to the natural course of the disease.

Previous randomized trials using home-educational programs for children with asthma demonstrate, in some aspects, similar results; however, it is important to note that these trials used different outcomes to define their intervention as successful. For example, Williams et al. (17) reported an improvement in daily function with fewer symptoms, among children with severe asthma. Evans et al. (11) demonstrated fewer days with asthma symptoms and fewer hospitalizations, and Butz et al. (12) showed improvement in asthma symptom identification and self-management skills. The educational programs, when evaluated by Cochrane systemic review, were associated with modest reductions in days of school absence, days of restricted activity, and emergency room visits, with greater effect in moderate-severe asthma (18). Their conclusion may indicate that home-visit programs are indeed cost-effective for the sub-group of severe

asthma. Other evidence-based asthma intervention in 390 school-aged children with moderate to severe asthma led to a reduction in maximum symptom days and unnecessary health care utilization (19). Those trials reported less symptoms and improvement in quality of life during and after the intervention, resembling our improvement in the ACT questionnaires, which represent the frequency of symptoms and reflect quality of life. It is interesting to note that the major impact was in the first months following the intervention, as opposed to the last six months of the follow-up, where it was less prominent. This can probably be explained by the enhanced adherence to treatment following the intervention that regressed as time passed. This was demonstrated by Adams et al. (20), who reported a rapid decline in ICS prescribing rate 2–6 months after transition to a low-intervention phase.

Dropout from the study could be associated with poor adherence, as was shown by previous studies, which emphasized the decrease in controllers use and its relation to less perception of disease (21,22). The high dropout rate may partially be related to the distinct Bedouin population, living in remote rural settlements in south of Israel. It is important to remember that this population is usually characterized by a low socioeconomic status due to large families, overcrowding, poor accommodations/housing conditions, and limited access to health care in some of the settlements. Previous studies have shown the concerning association between parental education and the purchase of controller medication. Families with lower education levels used fewer controller medications and were associated with under treatment and higher risk of exacerbation (6,23). We followed the patients and families for one year, and we believe that the drop-out was related to this population, as we see in other studies we conduct here in the region. Although no significant difference was found in the number of hospitalizations due to respiratory exacerbations during the follow-up year, we compared the average LOS in the pediatric department and found a trend towards shorter LOS by two days in the intervention group.

Limitations

The present study has several limitations, including the relatively small number of enrolled patients, high drop-out rate and the single-center design, reflecting a specific population. As seen in the demographic characteristics above, half of the children were of Bedouin ethnicity. The dropout rate throughout the study in the assessment of the longer-term follow-up was high.

The remaining group had a small sample size, which did not allow for comparisons with statistical significance. A few of the families that did attend the first meeting, refused to attend the house visit and asked to transfer the visit to the local clinic. This prevented us from assessing adherence by one of the study's important tools, the house visit, which was intended to involve all family members in the process and to examine the house and closed environment for possible triggers. There are number of important established risk factors such as caregivers depressive or anxiety symptoms, low health literacy and poverty for contributing for poor asthma control that were not assessed in the current study, and may influence the outcomes. We plan to add an Arabic native speaker language to our pulmonary unit that will aid on the day to day basis and in such research themes in the future. Future interventions may use tele-health, by sending text messages as a reminder, in the follow up period, after the house visit.

Another limitation is the retrospective data collection in the control group that was missing certain data such as risk factors for asthma and data collected from ACT questionnaires.

We speculate that the fluctuating nature of asthma disease, which often includes periods free from symptoms, is what differentiates it from other chronic diseases and this may explain the need for tailored intervention. Future research is needed in order to assess the impact of educational house visits on the adherence to asthma care in terms of cost-effectiveness.

Conclusion

A coaching program for children with asthma, coming from low income families, didn't decrease health care utilization. The program was associated with an improvement in self-perception of asthma control and a trend for a shorter LOS. Future studies need to focus on cost benefit of such interventions and investigate other interventions that may improve the management of children with asthma.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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