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Family caregivers' reported nonadherence to the controller medication of asthma in children in Casablanca (Morocco): Extent and associated factors

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ABSTRACT

Objective: Recent statistics show a relatively high prevalence of asthma among Moroccan children and a weak control over their symptoms. To our knowledge, no research has been carried out to document adherence to the controller treatment in this population. This study aims 1) to assess the extent of children's nonadherence to the controller treatment of asthma in an urban region of Morocco as reported by a family caregiver, and 2) to identify the associated factors. **Methods:** We conducted a cross-sectional study among caregivers of asthmatic children (2–12 years old) in different health and education facilities of Casablanca-Settat. We administered face-to-face questionnaires incorporating validated instruments (*Medication Adherence Rating Scale-Asthma* (MARS-A), *Beliefs about Medicines Questionnaire* (BMQ), *Asthma Knowledge Questionnaire*). Univariate and multivariate log-binomial regressions evaluating the association between several factors and reported nonadherence were performed (prevalence ratios (PR) and 95% confidence intervals (CI)). **Results:** Through two public hospitals, three private medical clinics, and one private school, 103 caregivers were recruited. Low adherence to the controller treatment of asthma was reported by 48% of the caregivers (MARS-A <45). In the multivariate model, caregivers with the lowest level of knowledge about asthma were almost three times more likely to report low adherence compared to caregivers with the highest level (PR = 2.93; 95% CI: 1.14–7.52). **Conclusions:** This study highlights the finding that low adherence is widespread in this context and also the importance of targeting caregivers' knowledge of asthma for interventions.

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Introduction

Although asthma is found around the world, more than 80% of asthma-related deaths happen in low- or middle-income countries (1), such as Morocco. Prevalence of asthma in Morocco is estimated at 4.4% among children ≤15 years old and as high as 14.7% in Casablanca (95% confidence interval (CI): 14.0–15.3) among children aged 12 to 15 (2,3). In Morocco, Casablanca is distinguishable by its high economic activity (heavy industrialization and dense population), and its climate (high levels of humidity and atmospheric pollution) (3). In this country, it has also been reported that 60.9% of asthmatic children ≤15 years old do not have well-controlled asthma (2).

Morocco does not have national guidelines for asthma treatment. However, according to the Ministry of Health (4), physicians are expected to follow the guidelines of the Global Initiative for Asthma (GINA). These guidelines recommend the prescription of emergency medication and, according to the child's age and asthma symptoms, a controller treatment. The prescription of a controller

treatment for children of ≤5 years old should be based “upon the frequency and severity of symptoms and of wheezing episodes” (5). For children from 6 to 11 years old, once an asthma diagnosis has been established, an initial controller treatment of a low dose of mainly inhaled corticosteroids (ICS) is recommended (6). Through employment, most people receive health insurance; this, in turn, either partly or fully covers healthcare, such as medication and medical consultation. However, if economically disadvantaged families have free access to public healthcare facilities through a public insurance, they still have to pay for their medication. Consequently, accessibility to medication still remains a challenge for a considerable number of Moroccans.

Adherence—“the extent to which a person's behaviour-taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider” (7)—may be challenging regarding controller treatment among asthmatic patients. Indeed, unlike emergency treatment, controller

treatment has no expected immediate benefits. Suboptimal adherence to the controller treatment of asthma is highly prevalent in different populations (8). A systematic review published in 2015 found that adherence to this treatment among asthmatic children is often low (8); on average, children take less than 50% of the prescribed doses of ICS (9). Studies tend to confirm that adherence to the proper controller treatment combined with an adequate inhalation technique (ICS), dosage, and frequency contribute to good control of the disease and its symptoms (10–12). Conversely, nonadherence to the controller treatment is associated with decreased pulmonary function, an increased use of emergency medication, a higher risk of severe asthma exacerbations (8), and other asthma-related symptoms (12).

Many studies have sought to identify the factors associated with adherence to the controller treatment among asthmatic children (12,13). When the parents' belief that their child needs medication outweighs their concerns about the medication, adherence appears to be higher (14). A higher family income (15), coverage by health insurance (16), and a high level of knowledge about the disease and its treatment (13,17) are some of the variables often associated with high adherence to the controller treatment of asthma among children. However, the variables associated with adherence differ from one cultural and social environment to another (18–20).

Assessing and understanding nonadherence to the controller treatment appear essential in the Moroccan context considering the relatively high prevalence of asthma and the poor control over the symptoms. The objectives of this study were 1) to assess the extent of nonadherence to the controller treatment of asthma among children of the Casablanca-Settat region (Morocco) and 2) to identify (sociodemographic, clinical, and psychosocial) factors associated with nonadherence.

Methods

Design and study population

This was a cross-sectional study. The population of our study was the family caregivers of asthmatic children aged 2–12 years old who had a prescription for a controller treatment of asthma. Caregivers were asked to participate through health and educational institutions. The recruitment was held in a total of six institutions located in the administrative region of Casablanca-Settat: public hospitals ($n = 2$), private clinics ($n = 3$), and a private school ($n = 1$).

Selection criteria and recruitment

To be eligible, the caregiver had to be 1) aged ≥ 18 years old; 2) a family member responsible for the care of an

asthmatic child aged 2–12 years old, who had received a diagnosis of asthma by a doctor, and a prescription for a controller treatment ≥ 1 -month prior inclusion in the study; and 3) able to communicate in either French or Moroccan Arabic.

Recruitment was performed from February 18, 2016 to June 23, 2016 using convenience sampling. The staffs from the six participating institutions were responsible for the first screening of the child's medical record and for the first contact with potentially eligible caregivers to present the purpose of the study. The staff member then verified inclusion criteria. Later, a member of the research team would meet the eligible and interested caregivers for further explanations about the study.

Data collection and measures

Eligible caregivers who agreed to participate were interviewed by a member of the research team in French or in Moroccan Arabic in accordance with the caregivers' preference. The dependent variable, self-reported adherence to the controller treatment of asthma, was assessed by the *Medication Adherence Report Scale for Asthma* (MARS-A) (21). The parental version (13) of the MARS-A was translated (forward and backward-translations) from English to French and to Moroccan Arabic and then integrated into our questionnaire. The MARS-A includes 10 items, with a 5-point Likert scale (always to never) with a total score from 10 to 50. Nine questions assess intentional nonadherence and one question assesses unintentional nonadherence (22). The total score can be dichotomized between high adherence (≥ 45) and low adherence (< 45) (23). The MARS-A shows good construct validity and internal consistency in English (Cronbach $\alpha = 0.85$) (21,23). Cohen et al. (23) found that high adherence on the MARS-A correlated with an electronic measure of adherence to ICS of $\geq 70\%$ of days. Additionally, the questionnaire was developed to reduce social desirability bias by setting a tone of normality around nonadherence (23).

The selection of factors that could potentially be associated with caregivers reported nonadherence to controller treatment of asthma was guided by the conceptual model developed by Drotar and Bonner (2009) (24) that synthesizes 27 articles assessing factors influencing adherence to asthma treatment among children and by other individual studies (12,18,25). As the conceptual model of Drotar and Bonner is quite comprehensive, it was not possible in this study to assess all the variables it includes. The variables included in our study were grouped into three important dimensions: 1) child and caregiver sociodemographic characteristics, 2) child clinical and health-related characteristics, and 3) the psychosocial factors of caregivers. However, some other

variables presented in the model of Drotar and Bonner were excluded: those that have a potential bidirectional relationship with nonadherence (e.g., symptom control), psychological variables directly related to the child (since the caregivers were the subjects of the study), and measures of some clinical and family dynamics variables (for feasibility reasons). To measure retained variables, we selected validated measurement instruments when available. Sociodemographic factors included the child's age, child's gender, family monthly income (MAD = Moroccan Dirham; <MAD 2,500, MAD 2,500–8,499, ≥MAD 8,500 monthly), health insurance coverage (none, compulsory insurance, professional mutual/private insurance), family history of asthma (yes, no), caregiver's age, and caregiver education (no high-school diploma, completed high-school diploma).

Clinical and health-related factors included the type of facility attended by the child (private or public—caregivers recruited through the private school were hypothesized to visit private healthcare facilities), the presence of comorbidities (yes, no), length of time since the present controller treatment was first prescribed (months), the type of controller treatment prescribed (ICS, antileukotrienes), the autonomy of the child in the administration of the medication (autonomous is defined as the child often or always takes his treatment on his own without reminder, partially autonomous is defined as rarely or sometimes taking the treatment on one's own, and not autonomous is defined as never taking the treatment on one's own), and the use of complementary and alternative medicine (CAM) (resorting or not to health care practices that are not usually included in conventional biomedical systems) such as administering products like honey, olive oil, garlic, and medicinal herbs to the asthmatic child (26). Clinical variables involving data collection in the medical files of the children or specialized medical tests were excluded on grounds of feasibility. However, for descriptive purposes, asthma control was estimated, based on an adaptation of Boulet et al. (1999) and GINA (2015) (5,27), by the presence and frequency during the last three months of specific symptoms. A “not well-controlled” asthma was defined by the presence of a minimum of one symptom, but school absence and limitations in physical activity had to be combined with another symptom: 1) daytime symptoms (≥4/week), 2) night-time symptoms (≥1/week), 3) unplanned visits to a doctor (≥2/last 3 months), 4) school absence (≥1/week), and 5) limitations in physical activity (≥1/week).

Psychosocial factors included the caregiver's perceived stigma of asthma based on the study of Smeeton et al. (28) (“at ease for my friends to know about the child's asthma,” “to mind if the child uses an inhaler in public”), caregivers' beliefs about medications, and caregivers' knowledge about asthma. The beliefs were assessed by the

disease-specific part of the *Beliefs about Medicines Questionnaire* (BMQ) (29). We used a parental version of the BMQ (30), which was translated (forward and backward translations) from English to French and to Moroccan Arabic. The BMQ (disease-specific) includes 10 items, with a 5-point Likert scale (strongly disagree to strongly agree). Five questions assess the perceived necessity for the medication by the caregiver (score from 5 to 25), and five questions assess their concerns about the medication (score from 5 to 25). Based on the use of the scale by Horne et al. (29), we used the midpoint as the cut-off between high and low beliefs (>18, ≤18 for the necessity, and >16, ≤16 for the concerns). We also calculated the differential score (necessity-concerns) (ranging from –20 to 20). When positive, this differential score expresses that the caregiver's beliefs in the necessity of the medication outweigh his or her concerns; when negative, it expresses that the concerns are greater or equal to the perceived necessity of the medication. The specific part of the BMQ demonstrated a good internal consistency in its English version (Cronbach $\alpha = 0.8$ and $\alpha = 0.75$ for necessity and concerns, respectively) (29). Initially developed for Colombian parents of asthmatic children, the 17-item knowledge instrument was also integrated into our questionnaire (31). With its 5-point Likert scale (strongly agree to strongly disagree), parents with a good knowledge of asthma would score higher (score from 17 to 85). A test-retest conducted by the instrument developers had a correlation coefficient of 0.92 between the two administration times (32), and the differences in the score of this instrument between two groups of parents with different levels of knowledge had been shown to be statistically significant ($p < 0.01$) (31). In our analyses, we based the cut-offs on the quartiles of our sample to determine different knowledge levels (≥65, 60–64, 55–59, and <55).

Statistical analyses

Descriptive statistics (mean, standard deviation, median, range) were computed to describe the caregivers' and the children's characteristics and the extent of nonadherence. Our analyses aimed to identify factors associated with nonadherence. Caregivers' reported adherence was dichotomized according to a cut-off used in other studies (MARS-A: high adherence ≥45; low adherence <45) (23). Prevalence ratios (PRs) and their 95% confidence intervals were computed using log-binomial regression models (the GENMOD procedure). Univariate models for each potential factor were first conducted. Then, factors with a p -value ≤0.1 were included in the same model. In the multivariable model, a $p < 0.05$ was considered statistically significant. All analyses were performed using SAS University Edition (SAS Institute Inc., Cary, NC).

Ethical approval

All participants gave their verbal informed consent. This study was approved by the Laval University Ethics Committee (2015-316 A-4/18-04-2016).

Results

A total of 103 eligible caregivers agreed to participate and completed questionnaires. Tracking the total number of caregivers approached by the staff of the participating institutions and those who declined to participate was not feasible. When a member of the research team met the eligible and interested caregivers for further explanations about the study, three caregivers declined to participate in our study.

Children's characteristics

Characteristics of the 103 children included in this study are presented in Table 1. Almost half ($n = 47$, 45.6%) of the children were attending a public healthcare facility. On average, children were 6.2 (SD = 3.0) years old, 70.9% were boys ($n = 73$) and 92.2% lived in the city of Casablanca itself ($n = 95$). Most of the children were covered by health insurance ($n = 76$), which was for 21.4% of them compulsory health public insurance ($n = 22$), with the remaining children covered by professional mutual/private health insurance ($n = 54$). For 20.4% ($n = 21$) of the children, the present controller treatment was prescribed for the first time less than 1 year ago and ≥ 3 years ago for 31.1% of them ($n = 32$). Corticosteroids were the main controller treatment prescribed for 85.4% of the children ($n = 88$). Well-controlled asthma was found in 58.3% of the children ($n = 60$). Of the 53 of the children who used a CAM (51.5%), 48 used it as a complement to the prescribed treatment. Among the 103 children, 76.7% were considered not autonomous ($n = 79$) in their medication intake.

Caregivers' characteristics

Characteristics of the caregivers are presented in Table 2. Caregivers were mostly women (89.3%) and the mothers of the asthmatic child (83.5%). A majority of caregivers were involved in taking the child to the medical appointments, buying the medication, and being responsible for the administration of the medication at home (86.4%; $n = 89$). The mean age of the caregivers was 39.4 years old (SD = 7.7). Almost half of the caregivers (43.7%) held a high school diploma ($n = 45$). Almost a third of the caregivers reported that they perceived a stigma associated with asthma (29.1%; $n = 30$). The mean score on

Table 1. Characteristics of the children with asthma ($n = 103$).

Characteristics	<i>n</i>	(%)
Sociodemographic factors		
Age (years)		
2–4	36	(35.0)
5–8	42	(40.8)
9–12	25	(24.2)
Mean (SD)	6.2	(3.0)
Gender		
Male	73	(70.9)
Female	30	(29.1)
Number of siblings		
0	23	(22.3)
≥ 1	80	(77.7)
Family monthly income (MAD = Moroccan Dirham)		
<MAD 2,500	20	(19.4)
2,500–8,499	27	(26.2)
$\geq$ MAD 8,500	27	(26.2)
Missing data	29	(28.2)
City of residence		
Casablanca	95	(92.2)
Outside Casablanca	8	(7.8)
Health Insurance		
No	27	(26.2)
Compulsory health insurance	22	(21.4)
Professional mutual/Private health insurance	54	(52.4)
Family history of asthma		
Yes	65	(63.1)
No	38	(36.9)
Clinical and health-related factors		
Type of healthcare facility attended by the child		
Private	56	(54.4)
Public	47	(45.6)
Presence of comorbidity		
Yes	9	(8.7)
No	94	(91.3)
Length of time since asthma was diagnosed (years)		
<1	8	(7.8)
1–2	39	(37.9)
≥ 3	55	(53.4)
Missing data/information unknown	1	(1.0)
Mean (SD)	3.6	(2.9)
Length of time since the present controller treatment was first prescribed (years)		
<1	21	(20.4)
1–2	38	(36.9)
3	32	(31.1)
Missing data/information unknown	12	(11.7)
Mean (SD)	2.3	(2.2)
Type of controller treatment at time of the study		
Corticosteroids	88	(85.4)
Antileukotrienes	10	(9.7)
Missing data/information unknown	5	(4.9)
Level of autonomy in their daily medication intake		
Autonomous	12	(11.7)
Partially autonomous	12	(11.7)
Not autonomous	79	(76.7)
Complementary and alternative medicine (CAM)		
Use of a CAM	53	(51.5)
Complement only	48	
Complement and replacement (alternate)	4	
Replacement only	1	
No use	50	(48.5)
MARS-A score (self-reported by the caregiver)		
High adherence (≥ 45)	54	(52.4)
Low adherence (< 45)	49	(47.6)
Mean (SD)	43.1	(5.7)
Control		
Well-controlled	60	(58.3)
Not well-controlled	43	(41.7)

Note. CAM = Complementary and alternative medicine; MAD = Moroccan Dirham; SD = Standard deviation.

Table 2. Characteristics of the caregivers ($n = 103$).

Characteristics	<i>n</i>	(%)
Sociodemographic factors		
Relationship between the child and the caregiver		
Mother	86	(83.5)
Father	10	(9.7)
Grandmother	5	(4.9)
Grandfather	1	(1.0)
Sister	1	(1.0)
Involvement in the child healthcare		
Taking the child to the medical appointments only	3	(2.9)
Taking the child to the medical appointments and buying the medication	3	(2.9)
Taking the child to the medical appointments and responsible for the administration of the medication at home (including autonomous child)	8	(7.8)
Taking the child to the medical appointments, buying the medication, and responsible for the administration of the medication at home (including autonomous child)	89	(86.4)
Gender		
Female	92	(89.3)
Male	11	(10.7)
Age		
<30	7	(6.8)
30–39	46	(44.7)
40–49	36	(35.0)
≥50	12	(11.6)
Missing data	2	(1.9)
Mean (SD)	39.4	(7.7)
Education		
No schooling	6	(5.8)
Some elementary or secondary studies	50	(48.5)
High school diploma completed	9	(8.7)
Post-secondary education or diploma	36	(35.0)
Missing data	2	(1.9)
Psychosocial factors		
Perceived stigma		
Yes	30	(29.1)
No	73	(70.9)
BMQ-Necessity		
>18 (high belief in the necessity of the medication)	46	(44.7)
≤18 (low belief in the necessity of the medication)	57	(55.3)
Mean (SD)	18.5	(4.1)
BMQ-Concerns		
>16 (high concerns about medication use)	51	(49.5)
≤16 (low concerns about medication use)	52	(50.5)
Mean (SD)	16.3	(4.2)
BMQ Necessity–concerns differential		
Positive score (necessity > concerns)	55	(53.4)
Negative score (necessity ≤ concerns)	48	(46.6)
Mean (SD)	2.2	(5.3)
Asthma Knowledge Questionnaire (based on quartiles)		
≥65 (high knowledge)	26	(25.2)
60–64	32	(31.1)
55–59	28	(27.2)
<55 (low knowledge)	17	(16.5)
Mean (SD)	60.4	(6.4)

the BMQ necessity was 18.5/25 (SD = 4.1) and of 16.3/25 (SD = 4.2) for the BMQ concerns score. For 53.4% of the caregivers ($n = 55$), the necessity of medication outweighed the concerns about the medication (positive score on the Necessity–Concerns Differential). The mean score for the Asthma Knowledge Questionnaire was 60.4/85 (SD = 6.4).

Prevalence of low adherence

The overall reported adherence level was an average of 43.1 out of 50.0 (SD = 5.7) on the MARS-A. The dichotomous scoring reveals that 47.6% of caregivers reported a low adherence to the controller treatment (score <45) ($n = 49$). Only eight caregivers reported complete adherence (score of 50/50).

Factors associated with reported low adherence to a controller treatment of asthma

Results for univariate models are shown in Table 3. In univariate models, caregivers with the lowest level of knowledge about asthma (<55/85) were three times more likely to report low adherence than the caregivers with the highest level of knowledge (≥65/85) (PR = 3.11; 95% CI: 1.28–7.55).

The following variables with p -values of ≤0.1 in the univariate analyses were integrated in the multivariate model: child's gender, family monthly income, level of autonomy of the child, and level of knowledge of the caregiver. The level of knowledge was the only factor that remained significantly associated with low adherence in the multivariate analysis ($p = 0.009$). Caregivers with the lowest level of knowledge (<55/85) about asthma were 2.9 times more likely to report low adherence (<45) than caregivers with the highest level of knowledge about asthma (≥65/85) (PR = 2.93; 95% CI: 1.14–7.52).

Since knowledge appeared to be an important factor for the reported adherence by caregivers, a post hoc investigation was conducted for each of the 17 items of the Asthma Knowledge Questionnaire, through univariate log-binomial regressions comparing the children with high and low levels of adherence (Table 4). The caregivers who correctly answered the statement, “Children with asthma should use asthma medications only when they have symptoms (coughing, congestion or wheezing)” were less likely to report low adherence (PR = 0.47; 95% CI: 0.33–0.66) than the caregivers who incorrectly answered this statement. “It is better to use inhalers directly, without a holding chamber, so the medication can go directly to the lungs” were also less likely to report low adherence (PR = 0.57; 95% CI: 0.39–0.83) as well as those who correctly answered the statement, “When a child has an asthma attack, it is best to go to the emergency room even if symptoms are mild” (PR = 0.55; 95% CI: 0.38–0.79).

Discussion

In this study of more than 100 Moroccan children with asthma living in a heavily urbanized area, nearly half of

Table 3. Factors associated with reported low adherence ($n = 103$).

	High adherence (≥ 45) $n = 54$		Low adherence (< 45) $n = 49$		Univariate			Multivariate		
	n	(%)	n	(%)	PR	95% CI	p-value	PR	95% CI	p-value
Sociodemographic factors										
Child's age (years)										
2–4	20	(37.0)	16	(32.6)	0.79	(0.47–1.35)	0.37			
5–8	23	(42.6)	19	(38.8)	0.80	(0.48–1.35)	0.39			
9–12	11	(20.4)	14	(28.6)	1					
Child's gender										
Male	42	(77.8)	31	(63.3)	0.71	(0.48–1.05)	0.10	0.69	(0.42–1.13)	0.13
Female	12	(22.2)	18	(36.7)	1			1		
Family monthly income										
<MAD 2,500	10	(18.5)	10	(20.4)	1.41	(0.85–2.33)	0.16	1.51	(0.90–2.52)	0.13
MAD 2,500–8,499	13	(24.1)	14	(28.6)	1.46	(0.92–2.32)	0.10	1.46	(0.93–2.28)	0.09
$\geq$ MAD 8,500	19	(35.2)	8	(16.3)	1			1		
Health insurance										
No	12	(22.2)	15	(30.6)	1.24	(0.78–1.99)	0.33			
Yes	42	(77.8)	34	(69.4)	1					
Family history of asthma										
Yes	37	(68.5)	28	(57.1)	0.78	(0.52–1.16)	0.23			
No	17	(31.5)	21	(42.9)	1					
Caregiver's age (years)										
<30	4	(7.4)	3	(6.1)	1.29	(0.40–4.15)	0.68			
30–39	23	(42.6)	23	(46.9)	1.50	(0.64–3.51)	0.30			
40–49	19	(35.2)	17	(34.7)	1.42	(0.59–3.39)	0.40			
≥ 50	8	(14.8)	4	(8.2)	1					
Caregiver's schooling										
No high school diploma	28	(51.9)	28	(57.1)	1.13	(0.74–1.71)	0.58			
High school diploma completed	25	(46.3)	20	(40.8)	1					
Clinical and health-related factors										
Type of healthcare facility attended by the child										
Public	25	(46.3)	22	(44.9)	0.97	(0.65–1.46)	0.89			
Private	29	(53.7)	27	(55.1)	1					
Presence of comorbidity										
Yes	5	(9.3)	4	(8.2)	0.93	(0.43–1.99)	0.84			
No	49	(90.7)	45	(91.8)	1					
Length of time since the present controller treatment was first prescribed (years)										
<1	8	(14.8)	13	(26.5)	1.24	(0.76–2.01)	0.39			
1–2	24	(44.4)	14	(28.6)	0.74	(0.43–1.27)	0.27			
≥ 3	16	(29.6)	16	(32.7)	1					
Type of controller treatment										
Corticosteroids	47	(87.0)	41	(83.7)	0.93	(0.48–1.8)	0.84			
Antileukotrienes	5	(9.3)	5	(10.2)	1					
Level of autonomy in their daily medication intake										
Autonomous	9	(16.7)	3	(6.12)	0.64	(0.42–0.96)	0.10	0.92	(0.58–1.46)	0.73
Partially autonomous	6	(11.1)	6	(12.2)	0.93	(0.55–1.56)	0.78	1.10	(0.68–1.77)	0.70
Not autonomous	39	(72.2)	40	(81.6)	1			1		
Use of a CAM										
Yes	27	(50.0)	26	(53.1)	1.07	(0.71–1.6)	0.76			
No	27	(50.0)	23	(46.9)	1					
Psychosocial factors										
Perceived stigma in public										
Yes	13	(24.1)	17	(34.7)	1.29	(0.86–1.94)	0.24			
No	41	(75.9)	32	(65.3)	1					
BMQ-Necessity										
>18 (high belief in the necessity of the medication)	22	(40.7)	24	(49.0)	1.19	(0.80–1.78)	0.40			
≤ 18 (low belief in the necessity of the medication)	32	(59.3)	25	(51.0)	1					
BMQ-Concerns										
>16 (high concerns about medication use)	27	(50.0)	24	(49.0)	0.98	(0.65–1.47)	0.92			
≤ 16 (low concerns about medication use)	27	(50.0)	25	(51.0)	1					
BMQ Necessity–concerns differential										
Negative score (necessity $\leq$ concerns)	26	(48.1)	22	(44.9)	0.94	(0.65–1.36)	0.74			
Positive score (necessity $>$ concerns)	28	(51.9)	27	(55.1)	1					
Asthma Knowledge Questionnaire										
<55 (low knowledge)	4	(7.4)	13	(26.5)	3.11	(1.28–7.55)	*0.001	2.93	(1.14–7.52)	*0.009
55–59	15	(27.8)	13	(26.5)	1.36	(0.90–2.07)	0.14	1.56	(0.89–2.72)	0.10
60–64	16	(29.6)	16	(32.7)	1.46	(0.96–2.22)	0.07	1.41	(0.90–2.20)	0.13
≥ 65 (high knowledge)	19	(35.2)	7	(14.3)	1			1		

Note. CAM = Complementary and alternative medicine; MAD = Moroccan Dirham; PR = Prevalence ratio; 95% CI = 95% Confidence Interval.

*p-value <0.05.

Table 4. Knowledge items associated to reported low adherence ($n = 103$).

		High adherence (≥ 45)		Low adherence (< 45)		Univariate		
		n	(%)	n	(%)	PR	95% CI	p-value
1. Inhaler use can lead to dependence or addiction.	Correct answer	25	(46.3)	22	(44.9)	0.97	(0.65–1.46)	0.89
	Wrong answer	29	(53.7)	27	(55.1)	1		
2. Inhalers can affect or damage the heart.	Correct answer	20	(37.0)	15	(30.6)	0.86	(0.55–1.35)	0.49
	Wrong answer	34	(63.0)	34	(69.4)	1		
3. It is not good for children to use an inhaler for too long.	Correct answer	14	(25.9)	12	(24.5)	0.96	(0.60–1.55)	0.87
	Wrong answer	40	(74.1)	37	(75.5)	1		
4. After a child's asthma attack, once the coughing is over, the use of the inhaler and medications should stop.	Correct answer	47	(87.0)	37	(75.5)	0.7	(0.46–1.06)	0.13
	Wrong answer	7	(13.0)	12	(24.5)	1		
5. Children with asthma should use asthma medications only when they have symptoms (coughing, congestion, or wheezing).	Correct answer	49	(90.7)	29	(59.2)	0.47	(0.33–0.66)	*0.0001
	Wrong answer	5	(9.3)	20	(40.8)	1		
6. It is better to use inhalers directly, without a holding chamber, so the medication can go directly to the lungs.	Correct answer	45	(83.3)	29	(59.2)	0.57	(0.39–0.83)	*0.006
	Wrong answer	9	(16.7)	20	(40.8)	1		
7. The main cause of asthma is airway inflammation.	Correct answer	24	(44.4)	30	(61.2)	1.43	(0.94–2.19)	0.09
	Wrong answer	30	(55.6)	19	(38.8)	1		
8. Parents should ask a doctor to tell the school that an asthmatic child should not exercise or participate in physical education classes.	Correct answer	28	(51.9)	17	(34.7)	0.69	(0.44–1.06)	0.08
	Wrong answer	26	(48.2)	32	(65.3)	1		
9. Children who have asthma should not participate in sports that make them run too much.	Correct answer	18	(33.3)	8	(16.3)	0.58	(0.31–1.07)	0.05
	Wrong answer	36	(66.7)	41	(83.7)	1		
10. When a child has an asthma attack, it is best to go to the emergency room even if symptoms are mild.	Correct answer	50	(92.6)	36	(73.5)	0.55	(0.38–0.79)	*0.008
	Wrong answer	4	(7.4)	13	(26.5)	1		
11. Asthma attacks can be prevented if medications are taken even when there are no symptoms between attacks.	Correct answer	46	(85.2)	45	(91.8)	1.48	(0.65–3.39)	0.29
	Wrong answer	8	(14.8)	4	(8.2)	1		
12. Flu infections are the main causes or triggers of asthma attacks.	Correct answer	43	(79.6)	43	(87.8)	1.42	(0.72–2.79)	0.26
	Wrong answer	11	(20.4)	6	(12.2)	1		
13. It is best not to smoke or let anyone else smoke near a child who has asthma.	Correct answer	54	(100)	45	(91.8)			
	Wrong answer	0	(0.0)	4	(8.2)			
14. If the parents of a child with asthma smoke outside the house, it will not affect the child.	Correct answer	28	(51.9)	19	(38.8)	0.76	(0.49–1.15)	0.18
	Wrong answer	26	(48.2)	30	(61.2)	1		
15. If an asthmatic child gets the flu, inhalers should be used even if there is coughing or wheezing.	Correct answer	17	(31.5)	17	(34.7)	1.08	(0.71–1.64)	0.73
	Wrong answer	37	(68.5)	32	(65.3)	1		
16. Asthmatic children might have attacks that are severe enough to require hospitalization in an intensive care unit or might even die from an attack.	Correct answer	43	(79.6)	41	(83.7)	1.16	(0.66–2.05)	0.60
	Wrong answer	11	(20.4)	8	(16.3)	1		
17. Some medications for asthma do not work unless they are administered every day.	Correct answer	44	(81.5)	39	(79.6)	0.94	(0.57–1.54)	0.81
	Wrong answer	10	(18.5)	10	(20.4)	1		

Note. PR = Prevalence ratio; 95% CI = 95% Confidence Interval.

*p-value < 0.05.

them had low adherence to their controller treatment as reported by their caregivers. Among the numerous factors potentially associated with low adherence that we assessed, general knowledge about asthma was identified as a key factor. Our in-depth analyses indicate that certain information is likely to be important for adherence, such as knowing that controller treatment should be used even when the child has no symptoms, that the use of a holding chamber contributes to optimal intake, and when to consult emergency services in case of asthma attack.

To the best of our knowledge, this study is the first that investigated the extent of nonadherence and the factors associated with nonadherence to the controller treatment of asthma among children in Maghreb—a region where relatively high asthma prevalence and poor symptom control have been documented (2). Since similar studies have been conducted in other settings that may differ with regards to pediatric asthma management, health systems, and social dynamics, a comparison of our results with those of other studies is rather difficult.

However, with 47.6% of children with low adherence, our results are similar to those obtained in studies using different MARS self-reported measures. For example, in two studies led in the Netherlands, one revealed that low adherence was reported by 54.7% of 170 parents of 8-year old asthmatic children (5-item MARS score <21) (33), while the other showed that 43.6% of 149 parents reported that their 8-year-old child did not use the controller treatment everyday (one item of the MARS-A) (13). Furthermore, in two American studies using other self-reported measures, low adherence was reported by 34.9% of 435 caregivers (children aged <18 with suboptimal control over asthma symptoms) (34) and by 72.9% of 1,083 parents (children aged 2–16 insured by Medicaid) (35). These estimates of low adherence are usually lower than those calculated in administrative databases (36) or by electronic devices (30,37–39). For instance, in studies using the medication possession ratio (MPR), 61–85% of the children had $\leq 80\%$ of the days covered by their prescribed medication (40,41). The level of low adherence

observed in our study may have been influenced by the use of a self-reported measure, but also by individual and organizational factors.

Participating caregivers had a relatively high level of asthma knowledge (60.4/85), a mean score higher than other studies using the same questionnaire before any intervention (31,42). In our study, reported low adherence was significantly associated with a lower score on the Asthma Knowledge Questionnaire in a multivariate log-binomial regression. Our result that a lower level of knowledge is associated with low adherence is consistent with studies conducted in other settings and using other instruments (13,17,43).

Our detailed analysis allowed us to gain a better understanding of key knowledge in terms of low adherence. There were three answers to statements on the Asthma Knowledge Questionnaire that were scored as wrong and these were associated with low adherence. First, a wrong answer to the statement, “Children with asthma should use asthma medications only when they have symptoms (coughing, congestion or wheezing)” was associated with low adherence. In its study, BinSaeed (42) found that Saudi caregivers who had a wrong answer for this statement were also nearly two times more likely to have a child with uncontrolled asthma. This result might illustrate some confusion between different types of medication, but also a belief that asthma is rather a short-term condition than a chronic disease. Nevertheless, knowing this information is crucial to understand the importance of adherence to a controller treatment of asthma. Second, in our study, 29 caregivers answered the statement “It is better to use inhalers directly, without a holding chamber, so the medication can go directly to the lungs” incorrectly. In our context, holding chambers appeared to be a known device among caregivers. Yet, some caregivers might not be knowledgeable about their use because of the child’s age or of the type of controller treatment prescribed. Finally, the belief that it is better to go to the emergency room when a child has an asthma attack even if symptoms are mild was associated with a low adherence level. Even if only 17 caregivers had a wrong answer to this statement, it is possible that some individuals feel ill prepared to react in the case of an asthma attack. Incidentally, Ftouh et al. (2) revealed that only 17.4% of 74 Moroccan asthmatic children had received an action plan for the management of their asthma.

Strengths and limitations

This study has several strengths. First, this pioneering exploration of the extent and factors associated to low adherence to the controller treatments of pediatric

asthma in Maghreb was based on the use of validated questionnaires (21,29,31) that were rigorously translated. In addition to lessening the likelihood of misclassification, use of these instruments will make it easier to compare results across studies conducted in different settings and countries. Second, we were able to recruit participants in public and private locations, and important socioeconomic variables were taken into account in our analyses. In the context of an urban area of Morocco, this is particularly important considering the disparity between economic classes and the differences between the types of treatment prescribed and the care offered in the private and the public sectors. Third, the association of several factors previously identified as potentially influencing adherence to the controller treatment of asthma (9,24) was explored. Finally, further analyses on the caregivers’ knowledge allowed us to gain a better understanding of the key information regarding asthma that could be determinants for adherence in this context.

This study also has limitations. First, the cross-sectional design used in this first exploration could be used to generate hypotheses to be tested in future studies, but does not allow the conclusion of any causal relationship between the factors explored and reported adherence. Second, the variables of interest were assessed through the reports of caregivers, which may create a social desirability bias and lead to an over-estimation of adherence. It should be noted that our study was introduced to the participants as one on the use of controller treatment instead of one on adherence for the explicit purpose of limiting this bias. Still, low adherence may be more common than what our results show. Third, even though several facilities participated and the data collection was done over a period of four months, generalizations about the results need to be conjectural due to our use of convenience sampling. Fourth, information about clinical status of the children was not collected for feasibility reasons. Clinical data would have increased the accuracy of the data about the children’s health related to asthma. Finally, our limited sample size may have jeopardized the detection of some possible associations. Indeed, factors sometimes found in other studies were not associated with low adherence to the controller treatment in our study. In addition, the potentially modifier effect of some factors such as the socioeconomic status and the type of controller treatment could not be explored due to the number of participants in each category.

Potential contributions

From a clinical practice perspective, our results raise an important public health problem in showing that low

adherence is rather common in this population. Additionally, our results highlight the importance of deconstructing false beliefs and of gaining knowledge about a child's chronic disease and appropriate medication. Even if knowledge gained is not sufficient to change behaviors, a better understanding of how, why, and when to use a specific treatment is crucial to increase adherence. In Casablanca, caregivers can already find weekly parental education sessions about pediatric asthma offered by a public university hospital. It may be especially important to provide these sessions to mothers since they play a substantial role in the daily management of asthma among children. Indeed, children included in our study were accompanied by a woman nearly 9 times out of 10 to their medical consultation.

From a research perspective, we would suggest that future studies use longitudinal research designs with a larger sample of participants to explore the effect of potentially important determinants such as knowledge, socioeconomic factors, type of prescribers, and type of treatments on adherence. Also, it is necessary to use qualitative studies in order to reach an in-depth understanding of adherence to the controller treatment of asthma in an urban Moroccan community and to develop appropriate measurement instruments for this population.

Conclusions/key findings

This study illustrates that in our sample, reported low adherence is rather prevalent. Adherence was strongly associated with knowledge, a variable that physicians can see as a lever for action. We hypothesize that increasing caregivers' knowledge about asthma as well as about doctor-recommended medications could strengthen adherence to the controller treatment among asthmatic children.

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Declaration of interest

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

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