



Determinants for asthma control, quality of life and use of complementary and alternative medicine in asthmatic pediatric patients in four cities

Kam Lun Hon¹ · Yan Min Bao² · Kate C. Chan¹ · Kin Wai Chau^{3,4} · Rong-Shan Chen⁵ · Kun Tat Gary Cheok⁶ · Wa Keung Chiu⁷ · Li Deng⁵ · Chun-Hui He⁵ · Kin Mui Ieong⁸ · Jeng Sum C. Kung¹ · Ping Lam⁹ · Shu Yan David Lam¹⁰ · Qun Ui Lee¹¹ · So Lun Lee^{12,13} · Ting Fan Leung¹ · Theresa N. H. Leung^{13,14,15} · Lei Shi¹⁴ · Ka Ka Siu¹⁵ · Wei-Ping Tan¹⁶ · Maggie Haitian Wang^{17,18} · Tak Wai Wong¹⁹ · Bao-Jing Wu¹⁷ · Ada Y. F. Yip¹⁶ · Yue-Jie Zheng² · Daniel K. Ng¹⁶

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Abstract

Background Asthma is a significant chronic health problem worldwide. Management aims at disease control by reducing functional impairment and exacerbations and improving quality of life (QoL). We report a multi-center study to survey asthma control and QoL in four cities in the Pearl River Delta.

Methods The conjoint survey involved ten Hong Kong pediatric hospitals/units, two Shenzhen hospitals, two Macau hospitals, and two Guangzhou hospitals on asthma control (using Asthma Control Test) and QoL (Pediatric Allergic Disease Quality of Life Questionnaire, PADQLQ). Acceptability of a treatment is graded as very good/good/fair/poor.

Results Good asthma control was only reported in 80% subjects in Hong Kong, but higher in sister cities (85–94%, $P < 0.001$). Allergic rhinitis, “incense burning”, and “smoker in family” were prevalent among the four cities. Logistic regression showed better control of asthma was associated with better PADQLQ ($B = -0.029$, $P < 0.001$), better acceptability of bronchodilator ($B = -1.488$, $P = 0.025$), negatively with “smoker in family” ($B = -0.83$, $P = 0.015$) and various PADQLQ domains. Conversely, worse PADQLQ was associated with allergic rhinitis severity ($B = 4.77$, $P < 0.001$), poor control of asthma ($B = 7.56$, $P < 0.001$), increased frequency of traditional Chinese medicine use ($B = 1.7$, $P < 0.05$), increased frequency of bronchodilator usage ($B = 1.05$, $P < 0.05$), “smoker in family” ($B = 4.05$, $P < 0.05$), and incense burning at home ($B = 3.9$, $P < 0.05$).

Conclusions There are some clinical and cultural differences among the four southern Chinese cities within the Guangdong province. This study identifies potentially modifiable environmental and treatment factors associated with poor asthma control and QoL for health-care interventions. Having a smoker in the family is independently associated with poor asthma control and QoL.

Keywords Asthma · Complementary and alternative medicine · Control · Inhaled bronchodilator · Inhaled corticosteroid · Pediatric Allergic Disease Quality of Life Questionnaire · Smoking · Traditional Chinese medicine

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✉ Kam Lun Hon
ehon@hotmail.com; ehon@cuhk.edu.hk

Extended author information available on the last page of the article

Introduction

Asthma is a significant chronic health problem worldwide [1]. The prevalence of asthma has increased two- to three-fold over the past three decades in industrialized countries and there is evidence to suggest that this prevalence continues to increase [2]. According to the Global Initiative for Asthma (GINA), it is estimated that around 300 million people in the world had asthma in 2004 and the number will increase to 400 million by 2025 [3]. Asthma affects

9–20% of children and 1–3% of adults in the USA [3–5]. It is a leading cause of hospitalization in the pediatric age group. In Chinese cities, the prevalence is approximately 5% [6, 7]. In a recent review, the global prevalence of self-reported, doctor-diagnosed asthma in adults was 4.3% [8]. The prevalence is highest in developed countries (Australia, 21.0%) and lowest in developing countries (China, 0.2%). Greater variation is seen in asthma symptoms of children, ranging from 2.8% (Indonesia) to 37.6% (Costa Rica), aged 6–7 years, and from 3.4% (Albania) to 31.2% (Isle of Man) in children aged 13–14 years. Wide variations exist in the symptom prevalence of childhood asthma worldwide. Although asthma symptoms tend to be more prevalent in more affluent countries, they appear to be more severe in less affluent countries [9].

Good disease control is necessary to minimize suffering and improve quality of life (QoL) in these patients and their families. In asthma management, it is important for the physician to determine if the child's asthma treatment plan is working or if it might be time for an adjustment of medications. Asthma control can be conveniently evaluated with tools. The Asthma Control Test (ACT) and the children ACT (CACT) are such tools that are commonly used in clinic settings [10–13]. ACT > 19 implies asthma control is good [14, 15]. Like many chronic and atopic illnesses, QoL of patients with asthma and their families can be affected. Nowadays, a number of validated disease-specific or generic measures to evaluate QoL of children with asthma and associated atopic diseases have been developed. One tool that has been widely used is the Pediatric Allergic Disease Quality of Life Questionnaire (PADQLQ) [16, 17]. PADQLQ is a disease-specific questionnaire including both asthma and rhinitis symptoms with good cross-sectional and longitudinal validity [16, 17]. Ng et al. have validated a Chinese version of PADQLQ. The internal consistency (Cronbach α) and repeatability (intraclass correlation) for PADQLQ were 0.92 and 0.75, respectively [18].

As with many other chronic diseases, there is no definite curative treatment for asthma. In Western medicine, the goal of management mainly aims at control by reducing functional impairment and exacerbations [1, 19–21]. Complementary and alternative medicine (CAM) is popular and the management of asthma may be suboptimal, especially among many Asian cities. Myths and fallacies on Western medicine and corticosteroid phobia are prevalent and often lead to non-adherence to treatment, poor disease control, and impaired QoL [22–28]. Recently, Ip et al. explored factors associated with asthma control at a pediatric asthma clinic and concluded that corticosteroid fear and Chinese medicine usage are prevalent [13]. Parents with corticosteroid fear were also more likely to have children with poorer asthma control and use of Chinese medicine [13]. Nevertheless, the

effects of these factors on QoL were not investigated in-depth in the study.

This was a multi-center study to survey asthma control and QoL in four cities in the Pearl River Delta. The four cities are of close proximity within the geographic distribution in Guangdong province of China with the population mainly of southern Chinese. Nevertheless, cultural beliefs and clinical practice vary due to the differences in the historical background and environmental and socioeconomic factors. The southern cities are remarkably similar in terms of climacteric factors, yet culturally diverse. Hong Kong has been a British colony, Macau a Portuguese colony, and Shenzhen a special administration region. All these cities have been under the influences of Western medicine, but have variable beliefs in traditional Chinese medicine (TCM) [29].

The aim of the study was to assess asthma control, QoL, and use of alternative medicine in asthmatic pediatric patients in four cities and to identify their determinants.

Methods

The survey consisted of a Chinese questionnaire with three parts: 1) 6 questions on conventional and alternative asthma treatment; 2) 26-questions validated PADQLQ [18]; and 3) the ACT for children and adolescents [12].

Study population

The survey was performed in four cities in the Pearl River Delta region of China consisting of 16 centers (10 from Hong Kong, 2 from Macau, 2 from Shenzhen, and 2 from Guangzhou). The specialties involved ranged from general, respiratory, asthma and allergy, and dermatology.

This is not a randomized trial and each participating center contributed data from a convenience sample of asthmatic children over a 3-month period in 2016. The participants were aged 4–18 years, with a definite physician-diagnosed asthma and no history of prematurity (gestation $\geq$ 37 weeks). Children with mental disability or unable to complete the QoL survey, uncertain asthma diagnosis, comorbidity such as immunodeficiency, TB, chronic lung disease, miscellaneous lung disease, history of congenital heart or congenital lung disease or severe organ dysfunction were excluded.

Instruments

ACT is a simple questionnaire already in use in many clinics to assess asthma control [10–12].

The ACT is a patient-completed questionnaire of five items with five response options investigating limitations at work or school due to asthma, the presence of daytime or

nighttime symptoms, the use of rescue medications, and the subjective perception of the level of asthma control during the previous 4 weeks [10–15]. The sum of the scores allows asthma control to be categorized as noncontrolled asthma (5–19 points), controlled asthma (20–24 points), and optimal disease control (25 points). Minimal clinically important differences of the three has been established.

The CACT is a seven-item questionnaire validated in children from 4 to 11 years of age [30]. It evaluates asthma symptoms during the day and night, effects of asthma on daily life, and use of rescue medications in the preceding 4 weeks. The first four questions, each with a picture of a face representing a child's mood to facilitate comprehension, were answered by the children and the last three by the caregiver in a Likert-type rating scale. The total score ranges from 0 to 27, with higher scores indicating better asthma control. The questionnaire uses a single cut point of a score of 19 to identify children whose asthma is not well controlled.

Ng et al. has validated a Chinese version of QoL for local use (PADQLQ) [18]. Both tools are symptom based. Together, these two simple scores form the two primary parameters evaluated in our region. Patients with allergic rhinitis were not excluded. ACT assessed control independent of allergic rhinitis, whereas 6 of the 26 questions of PADQLQ assessed severity of allergic conjunctivorhinitis symptomatology [16, 17].

Primary outcome measures were ACT, PADQLQ, and various clinical factors listed in the questionnaire [18]. Internal consistency (Cronbach α) and repeatability (intraclass correlation) for PADQLQ were 0.92 and 0.75, respectively. Adherence to inhaled corticosteroid (ICS), bronchodilator (BD), CAM, primarily acupuncture, cupping, moxibustion, and traditional Chinese herbal medicine were qualitatively measured with a four-point Likert scale as very good, good, fair, or poor. Usage was defined as never, sometimes, often, or always. The survey on incense burning, smoking, cat, and dog was defined as “ever” and “now”. The response was “yes” or “no” to each question.

Statistics

Spearman's correlation was used to assess the association between different questionnaires. Comparisons between different hospitals on categorical data were performed by Wilcoxon signed rank test. Multinomial logistic regression was used to identify the risk factors of poor asthma control. Stepwise multivariate linear regression was used to identify risk factors of poor QoL and usage of CAM. Collinearity statistics was performed to ensure variables were independent in the regression model. All reported *P* values were based on two-sided tests and compared to a significance

Table 1 Distribution of questionnaires

Variables	Frequency (%)
Hong Kong	
AHNNH	35 (2.3)
CMC	100 (6.6)
TMH	192 (12.7)
KWH	126 (8.4)
PMH	224 (14.9)
PWH	100 (6.6)
PYNEH	139 (9.2)
QMH	72 (4.8)
UCH	137 (3.7)
Private	48 (3.2)
Macau	
CHCSJ	51 (3.5)
MKWH	28 (1.9)
Guangzhou	
GZH	89 (5.9)
SYSH	50 (3.3)
Shenzhen	
SZCH	145 (9.6)
HKU-SZH	51 (3.4)
Total	1507 (100)

AHNNH Alice Ho Miu Loing Nethersole Hospital, CMC Caritas Medical Center, TMH Tuen Mun Hospital, KWH Kwong Wah Hospital, PMH Princess Margaret Hospital, PWH Prince of Wales Hospital, PYNEH Pamela Youde Nethersole Eastern Hospital, QMH Queen Mary Hospital, UCH United Christian Hospital, CHCSJ Centro Hospitalar Conde de São Januário, GZH Guangzhou Women and Children's Medical Center, SYSH Sun Yat-Sen Memorial Hospital, SZCH Shenzhen Children's Hospital, HKU-SZH The Hong Kong University-Shenzhen Hospital

level of 5%. SPSS 21.0 (IBM Corp, Armonk NY) was used for all analyses.

Participating centers obtained ethical approval from their respective ethics committees. Written informed consents were obtained from the parents and older patients. Parents answered the questions. ACT or CACT and PADQLQ were primarily answered by the patients with assistance from the parents if necessary.

Results

In total, 1600 questionnaires were distributed over a 3-month period in 2016 in 16 centers (Table 1) and 1507 questionnaires were returned (total response rate 94.2%). The contribution from each center is presented in Table 1.

There were similarities and differences among these centers in the four cities of the Pearl River Delta region. Overall, 85% of subjects reported that asthma control was good (ACT > 19); good control was only reported in 80%

subjects in Hong Kong, but higher in sister cities ($P < 0.001$). Acceptability and usage of ICS were highest, and bronchodilator lowest in Guangzhou ($P < 0.001$). Comorbidity of allergic rhinitis was lowest in Hong Kong, and incense burning lowest in Shenzhen. There was no difference in cat keeping, dog keeping, and smokers in the family among the four cities (Table 2).

Asthma control

ACT correlated weakly with ICS acceptability (Spearman's correlation 0.076, $P = 0.01$) and bronchodilator acceptability (Spearman's correlation 0.081, $P = 0.01$). ICS acceptability correlated with bronchodilator acceptability (Spearman's correlation 0.68, $P = 0.01$), but inversely correlated with the use of CAM (Spearman's correlation -0.081 , $P = 0.01$). Good asthma control (ACT score > 19) was associated with better QoL in all the 26 PADQLQ domains (Table 3).

Logistic regression showed that poor control was associated with worse PADQLQ ($B = 0.029$, 95% CI 1.03–1.04, $P < 0.01$), poorer bronchodilator acceptability ($B = -1.488$, 95% CI 0.06–0.83, $P = 0.025$), “smoker at home” ($B = -0.833$, 95% CI 1.10–1.94, $P = 0.015$), and PADQLQ domains, including “not hearing well” ($B = -0.326$, 95% CI 0.52–0.60, $P = 0.028$), “cough during running or play” ($B = -0.479$, 95% CI 0.48–0.59, $P < 0.001$), “coughing at night” ($B = -0.712$, 95% CI 0.42–0.52, $P < 0.001$), and “difficulty breathing” ($B = -0.363$, 95% CI 0.43–0.53, $P = 0.011$) (Table 4). All variables in the regression model were confirmed to be independent by co-linearity test.

Quality of life

Multivariate linear regression showed that QoL (as evaluated with PADQLQ score) was associated with increased severity of allergic rhinitis ($B = 4.769$, 95% CI 4.26–7.25,

Table 2 Demographics of patients among the four cities

Variables	Description	Hong Kong (<i>n</i> =966)	Macau (<i>n</i> =79)	Shenzhen (<i>n</i> =193)	Guangzhou (<i>n</i> =139)	<i>P</i>
Gender, %	Male	63.7	63.8	64.3	70.5	0.474
BMI, mean $\pm$ SD (range)		18.5 $\pm$ 6.9 (11.1–39.2)	17.7 $\pm$ 4.2 (10.9–31.9)	17.4 $\pm$ 3.7 (11.8–36.2)	17.0 $\pm$ 3.2* (8.7–27.4)	0.011
Age (y), mean $\pm$ SD (range)		10.7 $\pm$ 4.6 (3.1–19.2)	9.2 $\pm$ 3.2* (2.9–17.1)	9.5 $\pm$ 2.6* (4.3–18.6)	6.5 $\pm$ 2.9* (0.8–14.2)	< 0.001
Age on diagnosis of asthma (y), mean $\pm$ SD (range)		4.7 $\pm$ 3.3 (0.5–18.0)	4.3 $\pm$ 2.5 (0.5–11.0)	6.0 $\pm$ 2.9* (1.0–16.0)	6.3 $\pm$ 2.7* (1.0–14.0)	< 0.001
ACT > 19 , %	Good control	73.8	78.8*	89.8*	83.5*	< 0.001
ACT score, mean $\pm$ SD		21.4 $\pm$ 5.0	22.2 $\pm$ 4.0	24.1 $\pm$ 3.4*	22.1 $\pm$ 4.7	< 0.001
PADQLQ score, mean $\pm$ SD		32.6 $\pm$ 25.9	30.5 $\pm$ 23.1	17.4 $\pm$ 12.6*	19.7 $\pm$ 19.1*	< 0.001
Allergic rhinitis, %	Yes	53.4	83.9*	80.3*	77.7*	< 0.001
Cat, %	Yes	5.4	8.8	3.6	7.2	0.293
Dog, %	Yes	11.3	12.5	6.7	15.1	0.096
Incense burning, %	Yes	35.0	51.3*	12.2*	55.2*	< 0.001
Smoking, %	Yes	41.4	43.8	45.9	34.5	0.210
ICS acceptability, %	Good/very good	63.3	73.7*	74.7*	80.0*	< 0.001
	None	42.5	45.0	26.5*	23.7*	< 0.001
ICS usage, %	Sometimes	19.4	12.5*	5.1*	5.8*	
	Daily	36.4	42.5*	62.7*	66.2*	
BD acceptability, %	Good/very good	67.2	83.3*	76.4*	66.7	< 0.001
	None	47.3	48.8	41.2	63.3*	< 0.001
BD usage, %	Sometimes	33.5	26.3*	7.7*	9.4*	
	Daily	17.1	23.9*	46.4*	26.5*	

Demographics of the four studied cities are described. Kruskal–Wallis ANOVA was used to test the difference in distribution of the data when compared with Hong Kong. Data flagged with “*” suggest a significant difference in distribution to Hong Kong data. Mainland cities including Shenzhen and Guangzhou had a significantly higher age of asthma diagnosis when compared with Hong Kong and Macau. In addition, a higher proportion of subjects had better control of asthma in mainland cities compared to Hong Kong. PADQLQ-measured quality of life was better in mainland cities in general. In terms of possible aeroallergens, all cities had a low pet-keeping prevalence, with Macau and Guangzhou having a higher rate of incense-burning practice; smoking was relatively common in all cities. Medication usage was higher in the mainland cities, with a higher medication acceptability. Bold values indicate significant *P* values. ACT asthma control test, ICS inhaled corticosteroid, BD bronchodilator, PADQLQ Pediatric Allergic Disease Quality of Life Questionnaire, SD standard deviation

Table 3 PADQLQ aspects

Variables	All subjects	ACT ≤ 19 need improvement	ACT > 19 good control	<i>P</i>
Being unable to concentrate?	1.24 ± 1.45	2.02 ± 1.57	1.02 ± 1.32	< 0.001
Being unable to remember things learned at school?	0.85 ± 1.26	1.44 ± 1.50	0.68 ± 1.12	< 0.001
Being unable to get to sleep or have a good night's sleep?	1.38 ± 1.59	2.31 ± 1.73	1.10 ± 1.42	< 0.001
Not hearing well?	0.53 ± 1.01	1.01 ± 1.36	0.38 ± 0.83	< 0.001
Needing to carry or use medicines, inhalers, or creams?	1.07 ± 1.36	1.92 ± 1.67	0.82 ± 1.13	< 0.001
Coughing or wheezing while running or playing a game?	1.39 ± 1.43	2.44 ± 1.67	1.08 ± 1.18	< 0.001
Unable to play sports outside?	0.57 ± 1.06	1.25 ± 1.41	0.37 ± 0.84	< 0.001
Coughing at night	1.23 ± 1.39	2.38 ± 1.55	0.89 ± 1.14	< 0.001
Coughing or wheezing?	0.93 ± 1.19	1.76 ± 1.36	0.68 ± 1.01	< 0.001
Feeling out of breath or tightness in your chest	0.96 ± 1.29	1.98 ± 1.53	0.66 ± 1.04	< 0.001
Needing to rub your eyes?	1.77 ± 1.67	2.30 ± 1.76	1.61 ± 1.61	< 0.001
Swollen or puffy eyes?	1.01 ± 1.44	1.60 ± 1.75	0.84 ± 1.28	< 0.001
Itchy nose?	1.97 ± 1.60	2.56 ± 1.77	1.79 ± 1.50	< 0.001
Blocked or stuffy nose?	2.20 ± 1.64	2.93 ± 1.75	1.99 ± 1.55	< 0.001
Needing to rub your nose?	2.02 ± 1.61	2.69 ± 1.73	1.82 ± 1.52	< 0.001
Needing to blow your nose?	2.02 ± 2.17	2.71 ± 1.80	1.81 ± 2.23	< 0.001
Rashes on your skin?	0.96 ± 1.53	1.43 ± 1.85	0.81 ± 1.39	< 0.001
How your skin looks?	0.79 ± 1.37	1.23 ± 1.66	0.66 ± 1.24	< 0.001
Being tired or worn out?	1.29 ± 1.88	2.38 ± 2.90	0.98 ± 1.30	< 0.001
Feeling thirsty?	0.98 ± 1.29	1.70 ± 1.59	0.77 ± 1.10	< 0.001
Dry, itchy, or sore throat?	1.02 ± 1.30	1.73 ± 1.61	0.81 ± 1.11	< 0.001
Having a headache?	0.82 ± 1.27	1.52 ± 1.61	0.61 ± 1.08	< 0.001
Feeling irritable or frustrated?	1.00 ± 1.44	1.69 ± 1.78	0.80 ± 1.26	< 0.001
Being different from your friends?	0.62 ± 1.21	1.15 ± 1.58	0.47 ± 1.02	< 0.001
Feeling frightened by the thought of an asthma attack?	0.60 ± 1.16	1.18 ± 1.47	0.43 ± 0.98	< 0.001
Think about all the activities that you have done during the past week. How much have you been troubled by your allergies when you had been doing those activities?	1.13 ± 1.36	1.93 ± 1.67	0.90 ± 1.16	< 0.001

0–6 point scale was used in this questionnaire: 0, not bothered; 1, hardly bothered; 2, somewhat bothered; 3, moderately bothered; 4, quite bothered; 5, very bothered; 6, extremely bothered. PADQLQ provides a measure of the effect of allergy symptoms including conjunctivitis, rhinitis, asthma, dermatological conditions, and how these diseases affect emotion and activities. The highest scored aspect was rhinitis related, including symptoms of blocked nose and running nose. The least concerned aspect was hearing problems. When compared with the “good control” group and “need improvement” group, Mann–Whitney test demonstrates a significant difference in the PADQLQ scores, with a higher score in the need improvement group. In the need improvement group, the most concerned symptoms were rhinitis related, disturbed sleep, and coughing; on the other hand, the rhinitis scores were lower in the good control group, yet still the most concerned symptoms for the group. Data are expressed as mean ± SD. Bold values indicate significant *P* values

$P < 0.001$), poor control of asthma ($B = -7.557$, 95% CI $-25.50-18.20$, $P < 0.001$), increased frequency of TCM use ($B = 1.712$, 95% CI $2.30-9.80$; $P = 0.001$), increased frequency of bronchodilator usage ($B = 1.046$, 95% CI $0.83-2.70$, $P < 0.001$), smoker in family ($B = 4.046$, 95% CI $0.95-7.00$, $P = 0.010$), and incense burning at home ($B = 3.911$, 95% CI $0.11-9.3$, $P = 0.045$) (Table 4). Linear regression analysis also showed that the usage frequency of ICS was dependent on the extent to which the patient was affected or bothered by “poor sleep quality” ($B = -0.129$, 95% CI $-0.18-0.54$, $P = 0.002$), “needing medications” ($B = 0.243$, 95% CI $0.15-0.31$, $P < 0.001$), “skin appearance” ($B = -0.142$, 95% CI $-0.18-0.03$, $P = 0.034$), and

“afraid of asthma attack” ($B = 0.190$, 95% CI $0.10-0.27$, $P = 0.001$). The use of BD was dependent on “poor concentration” ($B = -0.166$, 95% CI $-0.14-0.01$, $P < 0.001$), “needing medications” ($B = 0.273$, 95% CI $0.28-0.36$, $P < 0.001$), “coughing at night” ($B = 0.122$, 95% CI $0.08-0.21$, $P = 0.007$), “needing to blow the nose” ($B = -0.096$, 95% CI $-0.10-0.02$, $P = 0.031$), and “activity affected by allergies” ($B = 0.088$, 95% CI $0.04-0.18$, $P = 0.030$).

Use of complementary and alternative medicine

Usage of CAM was common in asthmatic children in the four Chinese cities. TCM was the most common type of

Table 4 Multivariate regressions for Asthma Control Test and PADQLQ

Variables	<i>B</i> logistic regression	95% CI	<i>P</i>
ACT (good control > 19)			
Bronchodilator acceptability	− 1.488	0.06, 0.83	0.025
Smoker in family	− 0.830	1.10, 1.94	0.015
PADQLQ	− 0.029	1.03, 1.04	<0.001
PADQLQ domains			
Not hearing well	− 0.326	0.52, 0.60	0.028
Coughing during running or playing	− 0.479	0.48, 0.59	<0.001
Coughing at night	− 0.712	0.42, 0.52	<0.001
Difficulty breathing	− 0.363	0.43, 0.53	0.011
PADQLQ Linear regression			
Allergic rhinitis severity	4.769	4.26, 7.25	<0.001
Asthma control (ACT)	− 7.557	− 25.50, − 18.20	<0.001
Bronchodilator usage	1.046	0.83, 2.70	<0.001
Traditional Chinese medicine usage	1.712	2.30, 9.80	0.001
Smoker in family	4.046	0.95, 7.00	0.010
Incense burning	3.911	0.11, 9.30	0.045

Using a multivariate backward stepwise regression model, the factors contributing to good control were tested as follows: bronchodilator acceptability ($B = -1.488$, 95% CI 0.06–0.83, $P = 0.025$), smoker at family ($B = -0.830$, 95% CI 1.10–1.94, $P = 0.015$) and various PADQLQ domains. A higher ACT score indicates better control of asthma. For PADQLQ, a higher score indicates a worse quality of life. The factors contributing to poorer quality of life include: allergic rhinitis severity ($B = 4.769$, 95% CI 4.26–7.25, $P < 0.001$), smoker in family ($B = 4.046$, 95% CI 0.95–7.00, $P = 0.01$), incense burning ($B = 3.911$, 95% CI 0.11–9.30, $P = 0.045$) and medication usage. A better control of asthma will contribute to better quality of life ($B = -7.557$, 95% CI − 25.5–18.2, $P < 0.001$). *PADQLQ* Pediatric Atopic Disease Quality Life Questionnaire, *ACT* asthma control test, *CI* confidence interval

CAM used in these cities, followed by cold moxibustion. Over one in five subjects reported use of TCM. In particular, use of acupuncture and cupping was significantly more prevalent in Guangzhou. The subjects who attended a private clinic in Hong Kong had a significantly higher portion of patients who tried CAM. Patients attending one Hong Kong hospital and one Shenzhen hospital, both promoting Chinese medicine usage, more often reported moxibustion. Linear regression showed that subjects who used CAM were dependent on the extent that the patient was affected or bothered by “symptoms of stuffy nose” ($B = 0.082$, 95% CI 0.02–0.10, $P = 0.046$) and “eczema skin condition” ($B = 0.079$, 95% CI 0.02–0.10, $P = 0.017$), but not with asthma symptomatology and control. When controlled for symptoms, Spearman’s correlation ($\rho = -0.081$, $P = 0.004$) and logistic regression ($B = 1.547$, 95% CI 1.85–11.9, $P = 0.001$) demonstrated that the use of CAM correlated with fair or poor acceptability of ICS.

Discussion

ACT is a measure of disease control. The majority of subjects have good control of asthma, and good control correlated with BD inhaler acceptability. In the city of Hong Kong, 20% patients reported that their asthma control was

poor, acceptability of ICS and bronchodilator was poor/fair, and many patients resorted to TCM usage. It may be unacceptable that one in five children reported suboptimal disease control for such a prevalent condition. There are rooms for improvement in asthma care and education for these patients in Hong Kong. Nevertheless, logistic regression showed that bronchodilator acceptability and smoker in family appeared to be the only modifiable factors for good ACT, and other factors such as cat keeping, dog keeping, and CAM usage were non-contributive.

In a recent Hong Kong study, poorer asthma control was associated with fear of steroid usage and usage of Chinese medicine [13]. These psychosocial factors are complex and need to be further studied in the Asian and Chinese populations. Health-care providers should invest time and efforts to discourage smoking and to ensure that patients and parents comply with bronchodilator usage [31, 32].

We also demonstrated several factors that influence QoL, namely worse PADQLQ was associated with increased severity of allergic rhinitis, poor control of asthma, increased frequency of Chinese medicine use, increased frequency of bronchodilator usage, history of smoker in family, and incense burning at home. Health-care providers should address these factors and issues to improve the QoL of these patients. PADQLQ is a general measure of QoL for atopic disease, and relevant atopic conditions such as allergic

rhinitis and eczema were taken into consideration [16–18, 33]. Usage of both asthma control and PADQLQ scores has been described in another study [34]. Importantly, our study demonstrates that having a smoker in the family is adversely associated with worse ACT and PADQLQ.

The GINA 2014 report provides updated and implementable recommendations on optimal asthma management [35]. ICS and bronchodilator remain the mainstay of treatment [36]. We demonstrated that use of inhalers (bronchodilator and ICS) was associated with specific symptoms that affect QoL, such as poor sleep quality and nocturnal cough. Traditionally, inhaled selective short-acting β_2 agonists such as salbutamol are a mainstay of treatment of an acute asthmatic attack [37]. Administration of an inhaled β_2 agonist via a spacer with a metered-dose inhaler is equally as effective as nebulized treatment. The frequency of treatment varies according to the patient's response. ICS are the preferred first-line controller therapy for chronic or persistent asthma [37–43]. Steroid phobia in atopic diseases has been a major factor limiting the efficacy of corticosteroid usage, which should be adequately addressed to alleviate parental anxiety associated with its usage. Asthma management includes not only medications but also non-pharmacological therapies and strategies, in a coordinated and personalized approach to individual patient care. Steroid phobia is generally a common phenomenon among parents looking after children with atopic diseases [44]. This multi-center survey did not specifically measure steroid phobia, which needs detailed psychologic evaluations. Instead, we evaluated general steroid acceptability with Likert scale as very good, good, fair, or poor, and steroid usage as none, sometimes, or daily [13, 44]. Steroid fear is addressed in a separate study by the Hong Kong group [13]. Steroid fear or concern may not approach the intensity of phobia, but is a very common issue in Chinese community.

Our regression analysis demonstrated subjects who have poor asthma control and poor or fair acceptability of ICS tend to use CAM more often. CAM has been popular for treatment of chronic and atopic diseases. Complementary medicine refers to the use of treatment together with conventional treatment, whereas alternative medicine refers to the use of treatment instead of conventional treatment. Usage of CAM was common in asthmatic children in the four Chinese cities. TCM was the most common type of CAM used in these cities, followed by cold moxibustion. Linear regression showed that subjects who used TCM were affected or bothered by the comorbidity of atopic symptoms of allergic rhinitis and eczema, but not with asthma symptomatology and control. The use of CAM correlated with fair or poor acceptability of ICS.

Usage of CAM in chronic diseases such as childhood asthma is prevalent [45–49]. In Europe, about 30% of the population has tried CAM, with the percentage ranging

from 20 to 50% among different countries (20–30% in the Netherlands, Sweden, Denmark, and the UK, 46% in Germany, and 49% in France) [50]. Specifically for treatment of asthma, a questionnaire survey of 4741 members of the National Asthma Campaign in the UK revealed half of them used CAM as treatment [51]. While in Germany, 26.5% of 351 individuals with allergies (including hay fever, asthma, atopic eczema, and food allergy) used CAM at least once, and CAM was used to treat asthma in 13% of all the CAM users [52]. There was an increasing trend of CAM use, the number increased from 33.8% in 1990 to 42.1% in 1997, from a parallel nationally representative survey. Herbal medication is the most common kind of CAM used by asthma patients [53]. In Asia, CAM usage is more popular than in the West. Approximately, 62.5% Taiwan, China patients used CAM within a 6-year period, according to the complete record of TCM outpatient services [54]. In a survey of 3000 subjects conducted in South Korea, 74.8% of the subjects reported using CAM in the past 12 months; each subject on average tried 2.5 types of CAM [55]. In Japan, the use of CAM is even more prevalent than that of conventional medicine (76.0% versus 65.6%) [56]. Similarly, the prevalence of CAM use in Singapore is 76% [57]. Our findings on CAM and TCM usage concur with these observations worldwide. The concept of integrative medicine principally favors the complementary instead of alternative medicine approach [49, 58, 59]. It is risky to adopt alternative treatment that is often of unproven therapeutic value in place of conventional treatment of proven efficacy [60]. Physicians and health-care provide must educate parents to caution the use of unproven, often expensive, and risky CAM usage.

The achievement of asthma control is the result of the interaction among different variables concerning the disease pattern, patients' and physicians' knowledge and behavior [61]. The failure in asthma control can be considered as the result of the complex interaction among different variables, namely, the role of guidelines diffusion and implementation, disease-related factors, or patient-related factors. Asthma control may be reached through a tailored treatment plan taking into account the complexity of factors that contribute to achieve and maintain this objective.

Logistic regression in our study showed that better control of asthma was associated with better PADQLQ, better acceptability of bronchodilator, and negatively with "smoker in family". Implications for clinical practice would include enhanced education on bronchodilator usage and discouragement of smoking among family members. Parents and patients should understand that bronchodilator is an efficacious treatment medication that acts fast to relieve the symptoms and discomfort associated with asthma attacks. It is associated with minimal side effects when used appropriately as an inhaler therapy. There is no need for delay of its usage. Inhaler technique should be regularly reviewed. Many

parents may think (as an excuse) that smoking is acceptable if they do not smoke in front of asthmatic child. Health-care givers should decisively advise that having a family member as smoker is a risk factor for poor asthma control and reduced QoL. The family member should quit smoking for the sake of themselves and their child with asthma.

Furthermore, worse PADQLQ was associated with allergic rhinitis severity, poor control of asthma, increased frequency of TCM use, increased frequency of bronchodilator usage, smoker in family, and incense burning at home. A number of implications for clinical practice are recommended. Co-existing allergic rhinitis should be managed and duly treated. Chinese medicine and various complementary medicine usages are popular among patients with asthma and fallacies on Western medicine prevalent. Parents should be advised that inhaled treatment is still the conventional treatment and should not be forsaken. Incense burning is a popular religious practice in Asia. Freedom of religious practice is revered, but should not be at the expense of the child's respiratory health. Parents should be advised to adapt alternative non-incense-burning practice.

The limitation of the present study is that it relies on a self-responded questionnaire. Recruitment strategy is a limitation to generalizability of results since it is a convenience sample and results should be interpreted adequately.

The frequency of usage of ICS, BD, and PADQLQ symptoms was by recall. Objective measurement of asthma severity, such as by FEV₁, was not performed. The majority of patients were from hospital-based Hong Kong clinics. Lastly, social and economic data were not collected. Objective measurement of pulmonary functions is very important. Some of the centers involved in this project did not collect these data at the time of the study, rendering analyses impossible. Pulmonary functions should be monitored routinely and longitudinally.

In conclusion, better control of asthma is associated with better QoL. There are clinical and cultural differences among the four southern Chinese cities. This study identified potentially modifiable environmental (e.g., smoking, incense burning) and treatment (ICS, bronchodilator, Chinese medicine) factors associated with poor asthma control and QoL.

Author contributions KLH is the principal author who coordinated this survey. All co-authors obtained ethical approval from their respective centers and collected and contributed data to this survey. JSCK and MHW were involved in statistical analysis.

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Compliance with ethical standards

Ethical approval Ethical approval was obtained from NTEC CREC for the principal author and the respective ethics committees of all participating centers.

Conflict of interest The authors report no conflicts of interest.

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Affiliations

Kam Lun Hon¹  · Yan Min Bao² · Kate C. Chan¹ · Kin Wai Chau^{3,4} · Rong-Shan Chen⁵ · Kun Tat Gary Cheok⁶ · Wa Keung Chiu⁷ · Li Deng⁵ · Chun-Hui He⁵ · Kin Mui leong⁸ · Jeng Sum C. Kung¹ · Ping Lam⁹ · Shu Yan David Lam¹⁰ · Qun Ui Lee¹¹ · So Lun Lee^{12,13} · Ting Fan Leung¹ · Theresa N. H. Leung^{13,14,15}  · Lei Shi¹⁴ · Ka Ka Siu¹⁵ · Wei-Ping Tan¹⁶ · Maggie Haitian Wang^{17,18} · Tak Wai Wong¹⁹ · Bao-Jing Wu¹⁷ · Ada Y. F. Yip¹⁶ · Yue-Jie Zheng² · Daniel K. Ng¹⁶

- ¹ Department of Pediatrics, The Chinese University of Hong Kong 6/F Prince of Wales Hospital, Room 84042, Shatin, N.T, Hong Kong SAR, China
- ² Department of Respiratory Diseases, Shenzhen Children's Hospital, Shenzhen 518026, China
- ³ Hong Kong Society of Pediatric Respiriology and Allergy, Hong Kong SAR, China
- ⁴ Pediatric Respiratory and Sleep Disorders Center, Room 1315D, Argyle Centre Phase 1, 688 Nathan Road, Mongkok, Kowloon, Hong Kong SAR, China
- ⁵ Department of Respiration, Guangzhou Women and Children's Medical Center, Guangzhou 510623, China
- ⁶ Department of Pediatrics, Kiang Wu Hospital, Macau, China
- ⁷ Department of Pediatrics and Adolescent Medicine, United Christian Hospital, 130, Hip Wo Street, Kwun Tong, Hong Kong SAR, China
- ⁸ Department of Pediatrics, Central Hospital Conde S. Januario, Macau, China
- ⁹ Department of Pediatrics and Adolescent Medicine, Caritas Medical Center, 111, Wing Hong Street, Sham Shui Po, Hong Kong SAR, China
- ¹⁰ Department of Pediatrics and Adolescent Medicine, Tuen Mun Hospital, 23 Tsing Chung Koon Road, Tuen Mun, New Territories, Hong Kong SAR, China

- ¹¹ Department of Pediatrics and Adolescent Medicine, Princess Margaret Hospital, 2-10 Princess Margaret Hospital Road, Lai Chi Kok, Kowloon, Hong Kong SAR, China
- ¹² Department of Pediatrics and Adolescent Medicine, Queen Mary Hospital, 102, Pokfulam Road, Hong Kong SAR, China
- ¹³ Department of Pediatrics and Adolescent Medicine, The University of Hong Kong, Hong Kong SAR, China
- ¹⁴ Department of Pediatrics and Adolescent Medicine, Pamela Youde Nethersole Eastern Hospital, 3, Lok Man Road, Chaiwan, Hong Kong SAR, China
- ¹⁵ Department of Pediatrics, The University of Hong Kong-Shenzhen Hospital, 1, Haiyuan 1st Road, Futian, Shenzhen, China
- ¹⁶ Department of Pediatrics and Adolescent Medicine, Kwong Wah Hospital, 25 Waterloo Road, KLN Hong Kong SAR, China
- ¹⁷ Department of Pediatrics, Sun Yat-sen Memorial Hospital, Sun Yat-sen University, Guangzhou 510120, China
- ¹⁸ JC School of Public Health and Primary Care, Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong SAR, China
- ¹⁹ Department of Pediatrics and Adolescent Medicine, Alice Ho Miu Ling Nethersole Hospital, 11, Chuen On Road, Tai Po, Hong Kong SAR, China