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Development and validation of the family management scale for children with asthma (FMSCA)

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ABSTRACT

Objective: This study aims to develop and validate the Family Management Scale for Children with Asthma (FMSCA) in China context. **Methods:** Based on the Family Management Style Framework (FMSF) model, an original 89 items were generated from literature review and interviews with 15 caregivers of children with asthma. The preliminary scale was refined to 82 items through two rounds of experts' evaluation and a pilot study, then administered to 329 caregivers of children with asthma for testing between April and July 2013. Item analysis and exploratory factor analysis were performed to screen the items, reliability and validity analysis were tested using psychometric techniques (internal consistency, split-half reliability, test-retest reliability, content validity, and construct validity). Confirmatory factor analysis was adopted to further evaluate the construct validity of the scale in an additional 600 children with asthma and their parents from August 2014 to December 2015. **Results:** A final 57-item FMSCA from 8 subscales (children identity, view of condition, management mindset, parental mutuality, parenting philosophy, management approach, family focus, and future expectation) were generated. The excellent internal consistency (Cronbach's $\alpha = 0.918$), very good split-half reliability ($r = 0.802$, $p < 0.01$) and test-retest reliability ($r = 0.857$, $p < 0.01$) indicate a satisfactory reliability of the FMSCA. The Item Content Validity Index (I-CVI) of the scale ranged 0.83 ~ 1.00, Scale Content Validity Index (S-CVI) was 0.807, indicating a good content validity. Construct validity was established by accepted correlation coefficient of item-to-subscale (r range = 0.513–0.865, $P < 0.01$), intersubscale (r range = 0.195–0.604, $p < 0.01$), and subscale-to-total (r range = 0.408–0.876, $p < 0.01$), respectively. Additionally, the factors accounted for 51.586%~74.063% of the variance in each subscale, confirmatory factor analysis indicated the confirmatory model fitted data well and the scale had adequate construct validity. **Conclusions:** The study demonstrates FMSCA can serve as a valid and reliable measure of family management level for Chinese children with asthma.

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Introduction

Asthma is the most common chronic respiratory disease in children, affecting 1–18% of the population in different countries [1]. Consistent with increasing prevalence worldwide, the overall current prevalence of childhood asthma in mainland China was 3.02%, which has been increasing remarkably since 1998 [2,3]. Recurrent attacks of asthma may lead to irreversible lung function damage, activity impairment, and poor quality of life. Furthermore, more emergency room visits, direct medical costs, productivity loss, absence from school, and days lost from work

due to asthma are substantial social and economic burden to the whole society [4,5]. Data released from a retrospective study recently showed that the median hospitalization costs due to asthma exacerbations in China during 2013–2014 was 9045 RMB per patient, much higher than the yearly cost of maintenance therapy, representing an increased proportion of healthcare costs in China [6]. Caregivers of children with asthma face numerous barriers to effective management of the illness, involving provider, condition-related, socioeconomic and environmental factors [7].

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The Global Initiative for Asthma (GINA) demonstrates that asthma can be controlled greatly by effective management although it cannot be cured. However, uptake of treatment and management for childhood asthma remains disappointing, only 14.2% of patients were well controlled according to GINA criteria in major cities of China [8]. Because of the particularity of children, there is an increasingly essential role for family in the asthma ongoing monitoring and management. Notably, there is evidence that the severity of childhood asthma could be greatly controlled by family management level [9], and suboptimal family management was associated with worse biological outcomes in children over time [10]. Therefore, family management is vital to effective disease management for children with asthma and should be involved in an asthma management program.

The family management style (FMS) emerged in the field of childhood chronic illness in 1990 and refers to how the family as a unit responds to a child's chronic illness [11]. In 1996, through interviews with families of children with chronic illness, five FMSs (thriving, accommodating, enduring, struggling, and floundering) were identified. In subsequent years, based on a large number of qualitative and quantitative studies, Knafl et al. [12–14] further refined the Family Management Style Framework (FMSF) in 2003 and 2012, respectively. The latest FMSF specified three major components: definition of the situation, management behaviors, and perceived consequences, mainly applied for researchers and professionals to assessing how families and their individual members respond to childhood chronic illness as a whole and how they incorporate chronic condition management into family daily life. In addition, Ying Zhang, a Chinese scholar, who first proposed and applied the FMSF in her research in 2009, confirmed that it was also applicable to Chinese chronically ill children [15].

As previous studies have shown, family asthma management mainly involves asthma knowledge, environmental control, medication adherence, collaboration with health care providers, symptom assessment, and deal with exacerbations of asthma [1,16–20]. In the 1990s, Klinnert et al. [21] developed the Family Asthma Management System Scale (FAMSS), McQuaid et al. [17] then revised it, which demonstrated a good internal consistency and relevant associations with asthma management criteria for low-income African-American family [22]. Subsequently, da Silva et al. [23] further applied the FAMSS in Portuguese population, which demonstrated good

psychometric properties too. However, thus far this scale hasn't been applied in China.

Considering the high prevalence, morbidity, and costs associated with childhood asthma, a valuable scale to quantify the concept of family management in China is strongly necessary and crucial. Nevertheless, to our knowledge, there is not yet a reliable and meaningful evaluation tool available that specifically applicable to Chinese family. The family management level is reflected and evaluated mainly through indirect indexes such as disease knowledge level, number of emergency and outpatient visits, clinical effect, and quality of life of children in China. Therefore, the aim of this study is to develop and validate the Family Management Scale for Children with Asthma (FMSCA) in the local context.

Methods

Item generation

The items for the FMSCA were generated from literature review and in-depth, semistructured interviews identifying the family asthma management experience of caregivers of children with asthma. A purposive sample of 15 parents of children with asthma from the Beijing Children's Hospital between April and July 2013 enrolled in the study. Children who met the diagnosis of asthma and were 18 years and under were included. Children with other cardiopulmonary diseases or whose parents had severe cognitive impairments were excluded from the study. The following questions were used to guide this interview: "What are your views of your child suffering from asthma?" "What do you think of the impact of asthma on your child and family life?" "What measures do you take to manage your child's asthma? What difficulties have you encountered?" "What beliefs support you in your child's entire treatment process?" "How do you balance your child's asthma and family life?" Interviews were recorded, transcribed, and thematically analyzed, which was published previously [24]. FMSF [11–14] model was used as the conceptual framework for the FMSCA, which demonstrates three major components (Definition of the Situation, Management Behaviors, and Perceived Consequences) and eight dimensions. According to conceptual framework, item pool was formed by referring to relevant mature guidelines, scales, and interviews as following. As a result, an original 89 item pool was identified from interviews (23 items), 2011 edition of GINA guideline (26 items) [25], Chinese Guideline of Childhood Asthma (11 items) [26], the Chinese version of the Family

Management Measure (FaMM) scale for chronically ill children translated by Ying Zhang (20 items) [15], and the Self-Management Scale for Children with Asthma developed by Ping Hu (9 items) [27]. In order to minimize the socially desirable responses, some negative entries were set in the scale. The items of scale are shown in [appendices](#).

Scale refinement

Scale refinement was addressed through expert reviews and pilot study. Six experts (three respiratory therapists specializing in childhood asthma, a pediatric respiratory nurse, a pediatric health educator, and a researcher specially focus on scale study) were invited to evaluate the representability, relevancy, and word clarity of subscales and items with a standardized form. After two rounds of expert reviews and modifications, 3 confusing items were reworded, 10 duplicated, redundant or unsuitable items were removed and 4 additional items were added, finally formed a scale containing 83 items.

Next, we conducted a small pilot test on 20 parents of children with asthma from the Beijing Children's Hospital for the scale's language debugging. In this process, we further revised inappropriate items, eventually, the preliminary scale was accomplished including 82 items, in which 8 items of Children Identity, 12 items of View of Condition, 7 items of Management Mindset, 8 items of Parental Mutuality, 7 items of Parenting Philosophy, 27 items of Management Approach, 6 items of Family Focus, and 7 items of Future Expectation subscale, respectively.

Scale administration

A convenience sample consisting of 329 parents of children with asthma was recruited from Beijing Children's Hospital between April and July 2013. The sample size was appropriate according to recommendations that included 5–10 participants per item on the scale [28]. Parents and children were invited to the study if they met the following criteria: (a) child aged 18 years and under; (b) child was diagnosed with asthma according to the Chinese Guideline of Childhood Asthma published in 2008[26]; (c) child had experienced asthma symptoms or taken asthma-controlling medicines in the past year; and (d) the adult informant was required to be a parent of child, specifically the main caregiver. Children with other cardiopulmonary diseases, mental disabilities, or whose parents had severe cognitive impairments were

excluded from the study. Parents and children who met inclusion criteria completed the preliminary FMSCA and demographic questionnaire. This study was approved by the Medical Ethics Committee of Beijing University of Chinese Medicine, China, and all parents and children provided informed consent. The flowchart of this study is shown in [Figure 1](#).

Validation of the FMSCA

The validation of the scale had two phases. First, item analysis and screening was adopted to evaluate the distinctiveness, representativeness, independence and consistency of the items[29], the critical ratio (CR), correlation coefficient, Cronbach's α coefficient, and exploratory factor analysis (EFA) methods were performed to remove inappropriate items. Then, reliability and validity analysis were examined using recommended psychometric techniques (internal consistency, split-half reliability, test-retest reliability, content validity, and construct validity). Further details are provided in the statistical analysis section.

The second phase further evaluated the construct validity of the scale in a second population by the method of confirmatory factor analysis (CFA). In this process, an additional convenience sample of 600 parents of children with asthma in four hospitals of northern China (The children's Hospital, Capital Institute of Pediatrics in Beijing; Qilu Children's Hospital of Shandong University; Gansu Provincial Maternity and Child-care Hospital; and Gansu Provincial Hospital) were enrolled from August 2014 to December 2015. Inclusion criteria for children with asthma and their parents were the same as the above.

Statistical analysis

All statistical analyses were carried out using AMOS version 21.0 and SPSS version 19.0 for Windows, descriptive statistics were computed for the study data, and a p values of <0.05 was considered significant.

Item analysis and screening

First, we analyzed items according to the CR. Subjects scoring in the top and bottom 27% of the distribution scores on the scale were divided into the high score group and low score group. Items which did not differentiate between the two groups ($p > 0.05$) or the t value of the CR < 3 were removed. Then we deleted the items that correlated poorly with the total scale (item-to-total correlation coefficient < 0.4) or not

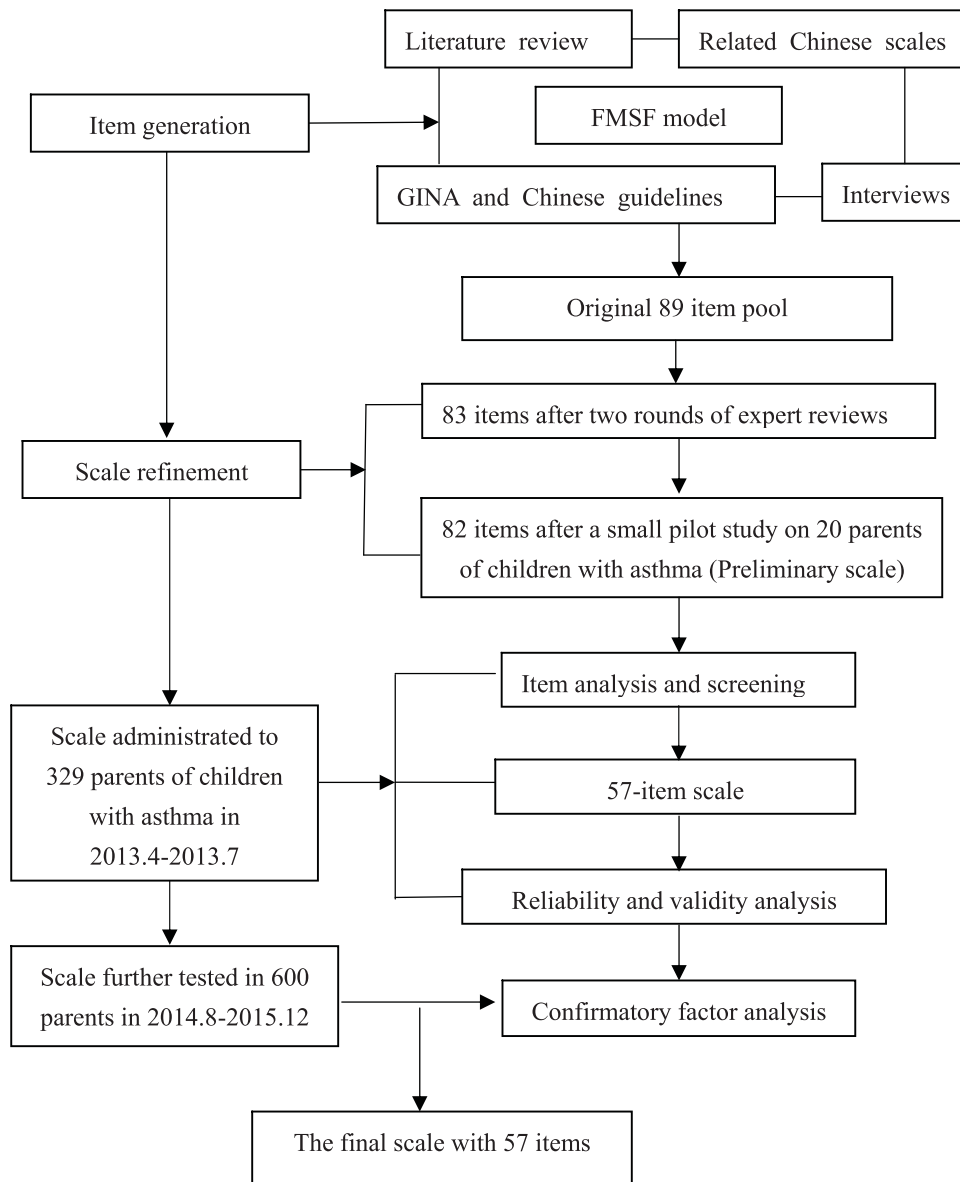


Figure 1. Flowchart of the study process.

reach the significant ($p > 0.05$). In addition, Cronbach's α coefficient increased after deleting any item, indicating the item was not highly homogeneous with the other and may be considered for removal. Furthermore, EFA was performed to screen items, principal components analysis (PCA) and orthogonal rotation were also used. Items were identified according to the following criteria: (1) eigenvalue > 1 ; (2) factor loading ≥ 0.4 ; (3) each factor includes ≥ 3 items; (4) there is no cross-loadings exist, or the difference value of factor loadings in each item > 0.15 ; and (5) factor is easily named [29].

Reliability analysis

Internal consistency or homogeneity of the FMSCA was measured by Cronbach's α coefficient, which was

usually deemed acceptable if it exceeded 0.7 [30]. The split-half reliability coefficient was calculated, which should be at about 0.80 [28]. To study reproducibility, test-retest reliability was performed using the Pearson correlation coefficients with 15 respondents, between the two occasions at a 2-week interval. Correlation coefficient > 0.7 usually indicates good test-retest reliability [28].

Validity analysis

Content validity index (CVI) was achieved with the assistance of six experienced experts to evaluate the content validity of the scale. They were invited to make choices on the relevance of each item to the corresponding dimension, with responses ranging from 1 (*irrelevant*) to 4 (*very relevant*). Item-level CVI

(I-CVI) and Scale-level CVI (S-CVI) were computed, respectively. It suggested that I-CVI should be ≥ 0.78 when the number of experts is ≥ 6 , and the scale would have a better content validity when S-CVI ≥ 0.80 [29]. Construct validity was established by correlation coefficient of item-to-subscale, intersubscale, and subscale-to-total. In addition, construct validity of the scale was tested by PCA to extract common factors, the varimax method was used for orthogonal rotation analysis. The variance explained by common factors $> 50\%$, and all items had factor loadings ≥ 0.4 , suggesting a good construct validity of the scale [29].

Confirmatory factor analysis

The following model fit indexes were used to assess the appropriateness of the model. (a) Chi-square(χ^2) test: it is thought that the model fits well when $\chi^2/df < 2$; (b) the Root mean square Residual (RMR) < 0.05 indicates a good fitting model; (c) the Root mean square Error of Approximation (RMSEA) < 0.08 provides an acceptable fit and below 0.05 shows a good fit of model; (d) the Goodness of fit Index (GFI), Adjusted Goodness of fit Index (AGFI), Normed fit index (NFI), Incremental Fit Index (IFI) and Comparative Fit Index (CFI) are range from 0 to 1, and values of 0.9 or greater considered well fitting model [29,31].

Results

Sample description

Table 1 presents the demographic information of the sample. A total of 345 preliminary scales were given out for the study, 329 eligible scales were returned (response rate 95.4%). The average age of the 329 children with asthma was 7.19 years (SD = 2.73), 72% were boys and 28% were girls. Among the corresponding 329 parents, 92 fathers (28%) with a mean age of 37.59 years and 237 mothers (72%) with a mean age of 35.86 years.

Item analysis and screening

The high and low-scale critical points of the top and bottom 27% respondents were 361 and 320, respectively, that is the respondents whose total score of the scale ≥ 361 were assigned to high score group, while those whose score < 320 were assigned to low score group. Critical ratio method showed that all items were significant ($p < 0.05$), but the t value of CR in item 23 and 80 < 3 , thus both 2 items were deleted. Moreover, 13 items (6, 15, 17, 24, 25, 36, 46, 51, 59, 60, 63, 71, and 75) correlated poorly with the total

Table 1. Demographic information of survey participants (N = 329).

Characteristics	N	%
Child's gender		
Boys	237	72.0
Girls	92	28.0
Child's age(years)		
1~8	224	68.1
9~15	105	31.9
Only child		
Yes	238	72.3
No	91	27.6
Years since diagnosis		
< 1	109	33.1
1~3	118	35.9
> 3	102	31.0
Child diagnosed as allergic rhinitis		
Yes	227	69.0
No	102	31.0
Family history of asthma		
Yes	28	8.5
No	301	91.5
Specialist make up a follow-up plan		
Yes	249	75.7
No	80	24.3
Number of absent from school days over past year		
< 10 days	197	60.0
10~30 days	95	28.8
> 30 days	37	11.2
Number of outpatient visits over past year		
< 4	141	42.9
4~6	154	46.8
> 6	34	10.3
Number of emergency visits over past year		
0	215	65.3
1	56	17.0
2	23	7.0
3	18	5.5
≥ 4	17	5.2
Number of hospitalizations over past year		
0	283	86.0
1	28	8.5
2	11	3.4
3	3	0.9
≥ 4	4	1.2
Father's education level		
≤ 5 th grade	3	0.9
Junior high school	61	18.5
High school degree/technical secondary school	72	21.9
junior college	55	16.7
College degree	107	32.5
Master degree or above	31	9.4
Mother's education level		
≤ 5 th grade	10	3.0
Junior high school	60	18.2
High school degree/technical secondary school	61	18.5
junior college	72	21.9
College degree	102	31.0
Master degree or above	24	7.3

scale (item-to-total correlation < 0.4) and were deleted. Additionally, the Cronbach's α coefficient of subscale increased after deleting 3 items (8, 38, and 82), which were eliminated. In total, 18 items were removed, the remaining 64 items were applied to EFA for 8 subscales, respectively.

Prior to EFA, suitability of the data for factor analysis was tested by Kaiser-Meyer-Olkin (KMO), which should at least > 0.6 [32,33] and the Bartlett's Test of

Table 2. Factor loadings and eigenvalue in exploratory factor analysis (principal component analysis with maximum orthogonal rotation).

Subscales and item	Factor 1	Factor 2	Factor 3	Factor 4
Children Identity				
7	0.774			
3	0.739			
4	0.732			
2	0.723			
1	0.708			
5	0.623			
Eigenvalue	3.095			
View of Condition				
14	0.871			
13	0.868			
12	0.857			
9		0.883		
10		0.863		
11		0.680		
Eigenvalue	3.144	1.300		
Management Mindset				
22	0.876			
21	0.855			
26	0.830			
27	0.725			
Eigenvalue	2.714			
Parental Mutuality				
30	0.810			
35	0.797			
29	0.796			
33	0.768			
31	0.748			
34	0.730			
28	0.715			
32	0.627			
Eigenvalue	4.514			
Parenting Philosophy				
41	0.859			
39	0.758			
42	0.757			
40	0.684			
37	0.509			
Eigenvalue	2.612			
Management Approach				
67	0.768			
66	0.731			
64	0.712			
69	0.699			
68	0.681			
65	0.614			
52		0.761		
53		0.757		
57		0.721		
55		0.705		
56		0.679		
58			0.786	
50			0.750	
43			0.719	
54			0.687	
47				0.738
49				0.730
48				0.699
45				0.553
Eigenvalue	6.825	1.846	1.553	1.161
Family Focus				
72	0.846			
73	0.836			
74	0.790			
70	0.653			
Eigenvalue	2.465			
Future Expectation				
76	0.830			
79	0.823			

(Continued)

Table 2. Continued.

Subscales and item	Factor 1	Factor 2	Factor 3	Factor 4
77	0.798			
78	0.794			
81	0.759			
Eigenvalue	3.211			

All factor loadings and eigenvalues are significantly at $p < 0.05$.

Sphericity, which should be significant ($p < 0.05$) [34]. As expected, the KMO reached values of 0.809, 0.841, 0.747, 0.877, 0.772, 0.906, 0.735, and 0.824, respectively, and Bartlett's Test of Sphericity was significant ($p < 0.01$) for all subscales, which were suitable for factor analysis.

First of all, when the PCA and varimax rotation were done, a factor was identified from subscales "Children Identity, Management Mindset, Parental Mutuality, Parenting Philosophy, Family Focus and Future Expectation," respectively. Our study revealed factor loadings of each item > 0.5 , eigenvalue > 1 , indicating that every item can effectively reflect its factor construction (see Table 2). Variance explained by factors after varimax rotation were reflected in Figure 2.

Moreover, in the "View of Condition" subscale, 3 factors emerged for the first time EFA, factor loadings for each item > 0.4 , but the loadings between factor 1 and 3 in item 18 were close (difference < 0.15), so item 18 was deleted. Then second EFA was performed for the remaining 9 items, and 3 factors were identified. Items 16, 19, and 20 were removed because of poor naming for factor 3. Finally, 2 factors emerged successfully for the third EFA. Additionally, in the "Management Approach" subscale, 4 factors were identified for the first time EFA. The dual difference of factor loadings for item 62, 44, and 61 on 4 factors < 0.15 , respectively, therefore, those 3 items were removed and another EFA was conducted. Then, 4 factors emerged and accounted for 59.92% of the total variance. In summary, a total of 25 unqualified items were eliminated after item analysis and screening, and finally 57-item scale was achieved.

Reliability analysis

Our study indicated that the scale had excellent internal consistency reliability (Cronbach's $\alpha = 0.918$) and very good split-half reliability ($r = 0.802$, $p < 0.01$). Besides, the coefficient of variation between the two occasions with 2 week's distance was highly correlated ($r = 0.857$, $p < 0.01$), reflecting a very good test-retest reliability and stability over time (see Table 3).

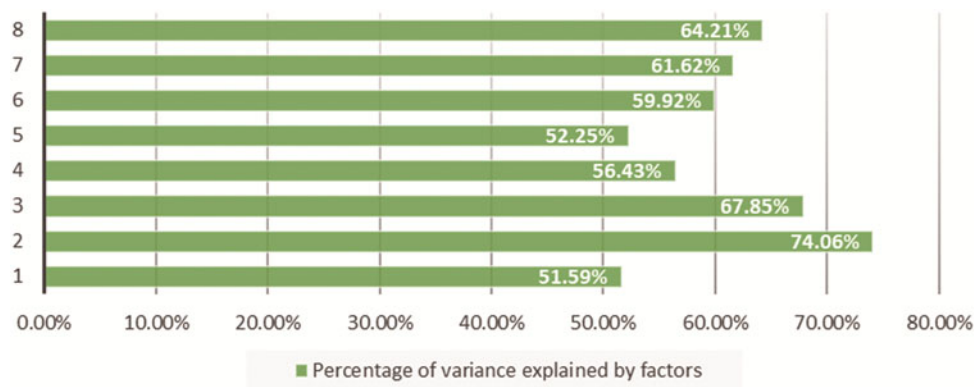


Figure 2. Analysis of PCA: percentage of variance explained by factors in each subscale. In the “View of Condition” subscale, 2 factors accounting for 74.06% of the total variance (Factor 1, 52.393%; Factor 2, 21.670%). In the “Management Approach” subscale, 4 factors accounting for 59.92% of the total variance (Factor 1, 35.920%; Factor 2, 9.718%; Factor 3, 8.172%; Factor 4, 6.111%).

Table 3. Reliability analysis of the total scale and subscales.

	Item number	Cronbach's α	Split-half reliability	Retest reliability
The total scale	57	0.918	0.802	0.857
Children identity	6	0.803	0.788	0.876
View of condition	6	0.810	0.785	0.906
Management mindset	4	0.837	0.773	0.827
Parental mutuality	8	0.883	0.788	0.948
Parenting philosophy	5	0.759	0.736	0.770
Management approach	19	0.880	0.848	0.906
Family focus	4	0.803	0.787	0.849
Future expectation	5	0.860	0.843	0.729

All data analysis is significantly at $p < 0.01$.

Validity analysis

Content validity

The study demonstrated that the I-CVI of this scale is 0.83 ~ 1.00, in which 46 items have superior content validity (CVI = 1) and 11 items have high content validity (CVI = 0.83); S-CVI of the scale is 0.807, indicating a good content validity ($p < 0.01$).

Construct validity

The Pearson correlation coefficients of item-to-subscale, intersubscale, and subscale-to-total were 0.513 ~ 0.865, 0.195 ~ 0.604, and 0.408 ~ 0.876 ($p < 0.01$), respectively, suggesting an acceptable internal consistency of the scale (Pearson correlation coefficients of intersubscale, and subscale-to-total see Table 4). EFA for the remaining items after item analysis is the most commonly used method to obtain construct validity of the scale. In this study, 57 items were applied to EFA from 8 subscale, respectively. The variances explained by factors in each subscale were illustrated in Figure 2.

Confirmatory factor analysis

In this phase, 610 children and their parents participated in the study, and 600 subjects provided valid

data (reply rate 98.36%). The mean age of the children was 7.72 years (SD = 2.97), 66.83% (401) were boys and 33.17% (199) were girls. Among these children, 56.83% were in primary schools, 65.84% had allergic rhinitis, and 21.5% had absences from school for 10–30 days over past year.

First, a CFA model was constructed based on the scale structure, fit indexes of confirmatory model were calculated. Then, this model was modified according to the Modification Indices (MI). As shown in Figure 3, this final model provided an adequate goodness index ($\chi^2/df = 1.804$, RMR = 0.049, RMSEA = 0.037, IFI = 0.938, CFI = 0.938, GFI = 0.864, AGFI = 0.847, and NFI = 0.871), indicating the model fitted data well and the scale had good construct validity.

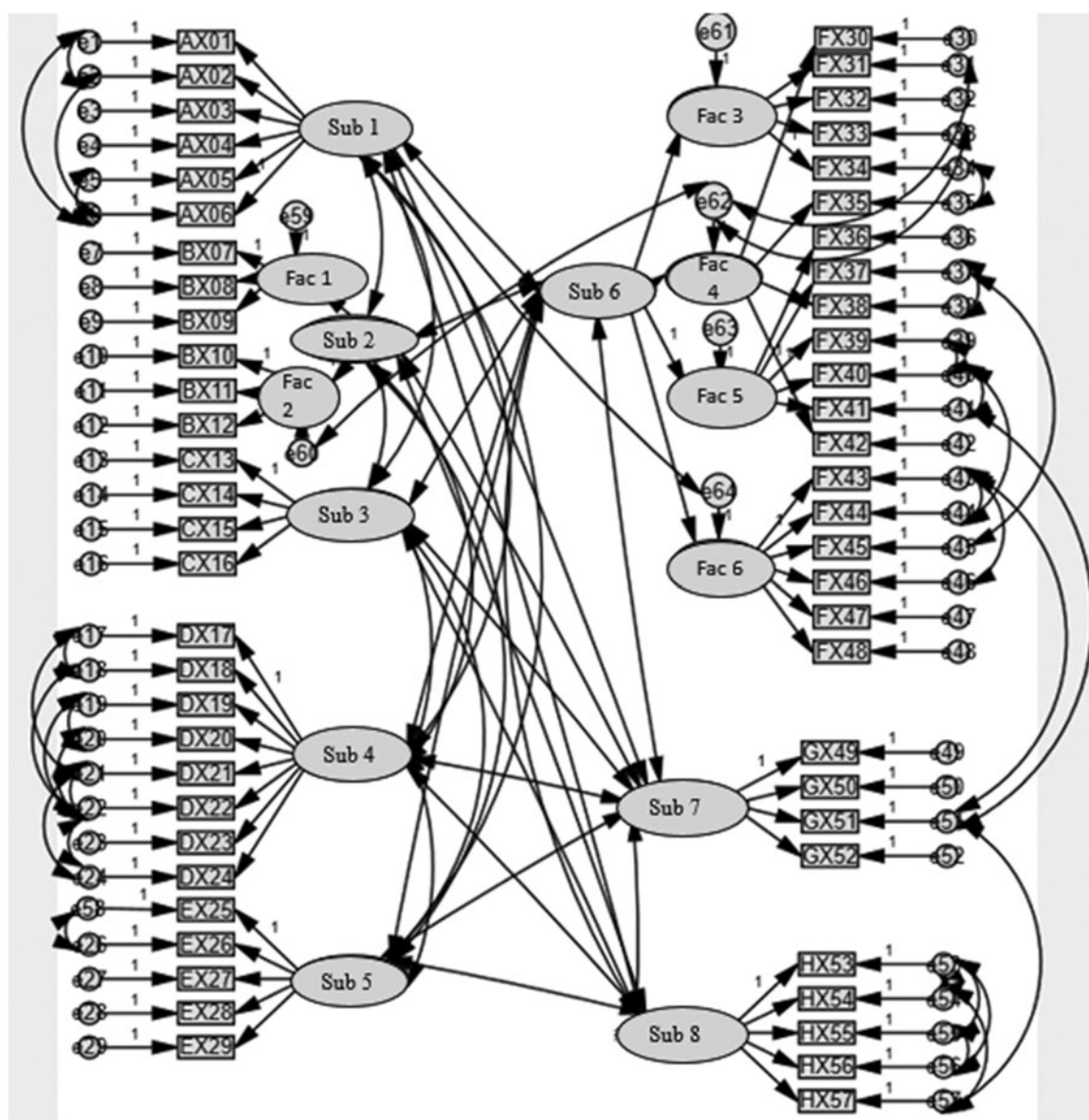
Discussion

The primary purpose of this study was to develop and validate a meaningful instrument to quantify the family management level for caregivers of children with asthma in Chinese population. First of all, this study involved a large number of 929 children with asthma, including 69% boys and 31% girls. This male/female ratio (2.1:1) was consistent with but slightly higher than that found in the third nationwide survey of childhood asthma in urban areas of China (1.5:1)[3].

Table 4. Intercorrelations among FMSCA subscales (Pearson correlation coefficient).

Subscale	Children Identity	View of Condition	Management Mindset	Parental Mutuality	Parenting Philosophy	Management Approach	Family Focus	Future Expectation	Total scale
Children Identity	1								
View of Condition	0.293**	1							
Management Mindset	0.313**	0.398**	1						
Parental Mutuality	0.328**	0.382**	0.249**	1					
Parenting Philosophy	0.330**	0.395**	0.274**	0.445**	1				
Management Approach	0.439**	0.555**	0.195**	0.532**	0.604**	1			
Family Focus	0.228**	0.260**	0.344**	0.265**	0.274**	0.264**	1		
Future Expectation	0.395**	0.328**	0.270**	0.407**	0.551**	0.514**	0.399**	1	
Total Scale	0.520	0.677**	0.408**	0.716**	0.700**	0.876**	0.475**	0.632**	1

FMSCA, the Family Management Scale for Children with Asthma.

** $p < 0.01$.**Figure 3.** Revised confirmatory factor analysis model. Sub, subscale; Fac, factor. Subscales 1 ~ 8 represent “Children Identity, View of Condition, Management Mindset, Parental Mutuality, Parenting Philosophy, Management Approach, Family Focus and Future Expectation” subscales, respectively. Subscales 1, 3, 4, 5, 7, 8 have one factor, respectively; subscale 2 has 2 factors; subscale 6 has 4 factors.

To our surprise, girls were less in this study. Actually, it's likely that convenience sampling collection has some limitations in our study. The study participants were recruited from five hospitals from three cities in northern China, they may not be representative of all children with asthma throughout the country, so some inconsistencies in asthma prevalence by sex may exist compared with the national level on account of uneven medical resources and visiting rates. In addition, a possible selection bias due to convenience sampling may explain these inconsistencies.

As expected, our results confirm that the resulting 57-item scale has excellent internal consistency, quite good split-half and test-retest reliability, and satisfactory content and construct validity. Those results are consistent with the studies of McQuaid et al. [17], Celano et al. [22], and da Silva et al. [23], who all demonstrated that FAMSS had good internal consistency (α ranges from 0.84–0.87) and convergent validity. In conclusion, our study provided evidence that the FMSCA is a theory-based valuable and reliable tool to assess family asthma management in China context. For the calculation of the scale, questions are scored on a 5-point Likert-type scale, with responses ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The total score is obtained by adding together the scores for all items, among which items 13, 14, 15, 16, 49, 50, and 52 are reverse scored. And the total higher scores indicting higher family asthma management levels.

Of the 8 subscales, View of Condition subscale explained the most variance, which remains the underpinning for family management, namely “parental beliefs about the causes, seriousness, predictability, and course of the condition” [14]. Given that parents are increasingly playing an important role in family asthma management, parents' poor knowledge, and incorrect beliefs about asthma associated with unnecessary and frequent visits to the emergency department can demonstrate negative outcomes [35]. Conversely, more accurate disease beliefs may able to alter biological profiles in children with asthma [10]. In particular, as reported in a previous study, mothers and children shared similar beliefs concerning asthma and its treatment, regardless of ethnicity and age, they were uncertain about the causes, consequences of asthma, which may lead to concerns and discomforts. In addition, a lack of knowledge about asthma may indicate an explanation for nonadherent behavior [36], which was associated with increased risk of severe asthma exacerbations and poor asthma control [37].

Through exploratory factor analysis, we explored the potential structure of variables. Notably, if the scale structure has been established according to related theory and expert evaluation, the EFA can be carried out in the form of subscale, that is, we can implement EFA from each subscale, instead of incorporating all items of scale into EFA. That strategy is a difference between the FMSCA and other scales. In accordance with principles above, we removed 4 items and extracted 2 factors from the “View of Condition” subscale after the third EFA, in which factor 1 was named as basic knowledge cognition, factor 2 named as disease characteristics cognition. Additionally, in “Management Approach” subscale, 3 items were deleted and 4 factors emerged after the second EFA, in which factor 1 was named as daily life management, factor 2 named as treatment compliance management, factor 3 named as symptom recognition and processing ability and factor 4 named as ability of family environment control. Beyond that, the variance explained by common factors at each subscale exceeded 50% (51.586%~74.063%), demonstrating that the factors at each subscale basically represents its structure, and the construct validity of this scale is good.

Moreover, CFA was performed based on the FMSCF conceptual framework. It's of note that there is still no single model fitting index that can be used as a completely independent standard to test the model, multiple indicators may be required to perform multi-faced model identification. In the process of CFA, the model needs to be modified according to the MI. Nonetheless, we should be aware that the results of AMOS software were only based on data, specific amendments should take theory and items' contents into consideration. Considered comprehensively, the modified model established the covariant relationship among variables, and provided a good fit to the data. So in general, the revised model is acceptable and can basically explain the construct validity of the FMSCA.

Additionally, the Pearson correlation coefficients of item-to-subscale, intersubscale, and subscale-to-total indicate reasonable structure of the scale. The correlation between the subscales illustrates the interaction between three major components of FMSCF, which in line with what Ying Zhang et al. [15] have reported. Generally, how the family as a unit responds to child's asthma determines behaviors the family takes to manage children and perceptions of consequences for child's condition. When family members take a positive view of the children's asthma and make positive responses, better perceived consequences are expected.

Whereas a negative view towards asthma, parents tend to feel helpless to manage asthma, leading to lower perceived consequences and worries about the family's future life.

Limitations

There were several limitations in this study warranting consideration. First, since there is no gold standard for measuring the level of family asthma management, the criterion validity of the scale was not tested. Second, this study was only conducted in three cities in the north China, which may resulted in the fact that FMSCA couldn't be generalizable to a range of different populations outside China. Therefore, further research may come to explore the family asthma management in populations with wider variations. Third, most of the participants in this study come from cities and towns, family asthma management for children living in rural areas needs further investigation. Finally, there are plenty of entries in the scale, in light of the response burden, FMSCA should be comprehensive but as brief as possible. Thus a shortened scale may be needed for further work.

Conclusions

In summary, we used standardized scale development methods to develop the FMSCA. The scale was deemed as a meaningful, reliable, and credible measurement for the family management level, with excellent internal reliability and good validity. The scale may be of value for nurses and other health care providers to improve asthma management in daily clinical practice, as well as providing a basis for family-centered care to promote family disease management in children with asthma. Continuous revision of this instrument is necessary for ongoing effectiveness of evaluating children with asthma.

Disclosure statement

The authors declare no conflicts of interests. The authors alone are responsible for the content and writing of the paper.

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Appendices

The scale in English version:

The Family Management Scale for Children with Asthma (FMSCA)

Please read each statement carefully, and choose just one answer on each line in accordance with your attitude to family asthma management.

	Strongly disagree 1	Disagree 2	Unsure 3	Agree 4	Strongly agree 5
1. Despite asthma, our child can still accomplish some activities as same as other healthy even-aged children (such as attending school, taking part in sports or exercise, and group activities, etc.).					
2. I think my child looks like as same as other healthy even-aged children.					
3. Despite asthma, our child can still keep enough sleep.					
4. Despite asthma, our child is able to maintain their daily intake of nutrients (meat, vegetables and fruits).					
5. Despite asthma, our child still gets along well with partners.					
6. Despite asthma, our child can still maintain a relaxed and happy mood.					
7. I know that asthma is a chronic inflammatory disease of the airway.					
8. I know that asthma requires regularly long-term medication and treatment.					
9. I know that regular use of inhaled corticosteroids (ICS) in compliance with doctor's advice has no effect on children's growth and development.					
10. I know the cause of asthma.					
11. I exactly know the symptoms of asthma.					
12. I know the general triggers of asthma.					
13. I often feel exhausted for taking care of child's asthma.					
14. It's very difficult to take care of child's asthma.					
15. Asthma management in my child consumes a lot of organizational work.					
16. It's hard to find someone to take care of my child.					
17. My partner and I share similar views on the severity of asthma in our children.					
18. My partner and I consult each other on the decision-making of asthma treatment and care for our child.					5
19. My partner and I share similar views on the choice of medication for asthma in our child.					
20. My partner and I share similar views on treatment compliance for asthma in our child.					
21. We are intimate family that my partner and I manage our child's asthma together.					
22. I feel very satisfied to take care of child's asthma with my					

	Strongly disagree 1	Disagree 2	Unsure 3	Agree 4	Strongly agree 5
partner.					
23. My partner and I share similar opinions on the choice of Chinese medicine or western medicine for asthma in our child.					
24. My partner and I support each other in caring for child's asthma.					
25. The comforting words of doctors make me confident in the treatment of asthma.					
26. Asthma management can help my child learn, work and live as same as normal people in future.					
27. Cooperating and participating in disease management can minimize the adverse effects of asthma on child's physical and mental development.					
28. The good effect of asthma treatment give me confidence to manage child's asthma continually.					
29. The improvement and enrichment of medical technology and resources make me confident to cure child's asthma					
30. I can identify the triggers for asthma attacks in children.					
31. I wash child's bedding regularly (every 2-4 weeks).					
32. I avoid child exposed to a smoking environment.					
33. I try to maintain environmental hygiene at home and keep room ventilated and dry.					
34. I prevent child from places with more dust and pollen.					
35. Childhood asthma is characterized by seasonal exacerbation, and I know how to deal with it.					
36. I can regularly visit doctors to cooperate them entirely.					
37. I actively communicate disease-related information with medical staff.					
38. I know the effect and function of asthma medicines.					
39. I can adjust (increase or decrease) the dosage of medicines according to doctor's instruction.					
40. I supervise my child to use medications which prevent asthma in a long term (such as flixotide, pulmicort, symbicort, seretide, and montelukast, etc.).					
41. I instruct my child to use a variety of inhaled medications with correct techniques identified by asthma specialist or nurse (such as flixotide, pulmicort, symbicort, seretide, etc.).					
42. I know how to deal with child's asthma attack.					
43. Often have a pleasant communication with my child.					
44. Avoid making child feel that he/she is different from other healthy children.					
45. Regular family entertainment activities were recommended to enhance parent-child relationship.					
46. Try to create a harmonious and happy family atmosphere for my child.					
47. Avoid scolding and adopt a persuasive parenting style.					
48. Advocate to cultivate children's interests in life and study					

	Strongly disagree 1	Disagree 2	Unsure 3	Agree 4	Strongly agree 5
as much as possible.					
49. Child's illness hinders our family relationship.					
50. Sometimes it's hard for me to decide how to balance child care with family life.					
51. It is no problem to integrate child's asthma caring into our daily life.					
52. Taking care of child's illness makes family life very difficult.					
53. I have confidence in child's asthma control and recovery.					
54. I think child's asthma can be cured.					
55. I think child will be able to take care of themselves later.					
56. I don't think child will be affected by asthma in the future.					
57. I think our family life will return to normal in the future.					