Pediatric Asthma Management in Japan: A Large-scale, Cross-sectional Survey

Shigemi Yoshihara[1], Toshiko Itazawa[2], Taiji Nakano[3], Daisuke Hayashi[4], Takumi Takizawa[5], Arshan Perera[6], and Yoshiyuki Yamada[7]

[1]Dokkyo Ika Daigaku Byoin Tochigi Kodomo Iryo Center
[2]Saitama Medical Center
[3]Chiba Daigaku Daigakuin Igaku Kenkyuin Igakubu Shoni Byotaigaku
[4]Tsukuba Medical Center Byoin
[5]Gunma Daigaku Igakubu Fuzoku Byoin
[6]PARI Gmbh
[7]Tokai Daigaku

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Abstract

Background: Pediatric asthma remains a critical public health problem, particularly in Japan, where adherence to new treatment guidelines and effective medication use are inconsistent. Therefore, we aimed to evaluate the current management practices for pediatric asthma to identify areas for improvement and enhance future treatment approaches. Methods: We conducted a web-based cross-sectional survey involving caregivers of children and adolescents aged 0–19 years diagnosed with asthma at various medical institutions in Japan. The survey focused primarily on evaluating the control status of asthma in these patients and examining factors such as treatment adherence, environmental exposure, and the presence of allergic diseases. Results: The data showed that 65.9% of the patients received some form of asthma treatment; however, a significant proportion (26.2%) still experienced poor symptom control (n=2000). The most affected group were children aged 0–3 years. The analysis showed that environmental factors and coexisting allergic diseases notably influenced poor asthma control, although direct correlations with treatment adherence were not statistically significant. Conclusion: These findings highlight the substantial gap in the effective management of pediatric asthma, particularly in very young children. Notably, pharmacotherapy is essential; however, there is an urgent need to develop comprehensive treatment plans that address environmental and lifestyle factors. Future strategies should focus on personalized care tailored to each child's specific need, incorporating medical and non-medical interventions to optimize asthma control and improve overall health outcomes.

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1 Dokkyo Medical University, Department of Pediatrics, Tochigi, Japan; 2 Saitama Medical University, Department of Pediatrics, Saitama, Japan ; 3 Department of Pediatrics, Graduate School of Medicine, Chiba University, Chiba, Japan; 4 Tsukuba Medical Center Hospital, Ibaraki, Japan; 5 Gunma University, Department of Pediatrics, Gunma, Japan; 6 PARI Medical Holding GmbH; 7 Tokai University School of Medicine, Department of Pediatrics, Kanagawa, Japan

the name, address and e-mail address of the author responsible for correspondence about the manuscript;

Shigemi Yoshihara, M.D.

Department of Pediatrics, Dokkyo University School of Medicine

880 Kita-Kobayashi, Mibu-machi, Shimotsuga-gun, Tochigi Prefecture 321-0293, Japan

Phone: 0282-86-1111 (Main)

E-mail: shigemi@dokkyomed.ac.jp

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Summary

Background: Pediatric asthma remains a critical public health problem, particularly in Japan, where adherence to new treatment guidelines and effective medication use are inconsistent. Therefore, we aimed to evaluate the current management practices for pediatric asthma to identify areas for improvement and enhance future treatment approaches.

Methods: We conducted a web-based cross-sectional survey involving caregivers of children and adolescents aged 0–19 years diagnosed with asthma at various medical institutions in Japan. The survey focused primarily on evaluating the control status of asthma in these patients and examining factors such as treatment adherence, environmental exposure, and the presence of allergic diseases.

Results: The data showed that 65.9% of the patients received some form of asthma treatment; however, a significant proportion (26.2%) still experienced poor symptom control (n=2000). The most affected group were children aged 0–3 years. The analysis showed that environmental factors and coexisting allergic diseases notably influenced poor asthma control, although direct correlations with treatment adherence were not statistically significant.

Conclusion: These findings highlight the substantial gap in the effective management of pediatric asthma, particularly in very young children. Notably, pharmacotherapy is essential; however, there is an urgent need to develop comprehensive treatment plans that address environmental and lifestyle factors. Future strategies should focus on personalized care tailored to each child's specific need, incorporating medical and non-medical interventions to optimize asthma control and improve overall health outcomes.

Key words: pediatric asthma, children, adolescent, poor control, treatment adherence, web survey

Introduction

Asthma is one of the most common chronic diseases in children globally, posing a significant public health challenge and burden on affected families and healthcare systems. Effective pediatric asthma management requires appropriate pharmacological interventions and a comprehensive understanding of the environmental and familial factors that influence disease control[1)]. The variability in asthma symptoms and the impact of different treatment modalities by age emphasize the need for tailored therapeutic approaches to ensure optimal disease management across various pediatric age groups[2)].

Recent advances in asthma management have emphasized the importance of precise control and regular monitoring to prevent exacerbations and improve overall quality of life[1)]. However, despite these advances, achieving optimal asthma control in children remains challenging for clinicians. This is largely due to factors such as poor medication adherence, environmental triggers, and the presence of comorbid allergic diseases[3)]. Furthermore, the role of family history and socioeconomic status in influencing asthma outcomes remains unclear, necessitating further research to elucidate their impact.

Notably, various asthma cases no longer require hospitalization, and overall management has improved. However, inappropriate asthma management in childhood can lead to a long-term decline in respiratory function, adversely impacting quality of life in adulthood and older age[4)]. Moreover, cases that appear to remit during adolescence may become more severe, highlighting the critical importance of robust management in childhood, including the appropriate use of biological agents.

Therefore, we aimed to explore the current management practices for pediatric asthma by analyzing data from a large-scale, cross-sectional survey of caregivers of pediatric patients diagnosed with bronchial asthma in Japan. By examining factors such as asthma control status, medication adherence, and the influence of family and environmental factors, this study seeks to provide new insights into the complexities of managing pediatric asthma. The findings are intended to inform better clinical practices and improve asthma treatment guidelines, particularly for younger children, who represent a vulnerable subgroup within the asthma population.

Methods

Participants and survey method

This cross-sectional survey was conducted among caregivers of pediatric patients with asthma aged 0–19 years diagnosed with bronchial asthma and treated at medical institutions across Japan. First, a preliminary survey was conducted to identify patients who had discontinued treatment owing to clinical cure or remission based on the disappearance of symptoms, and these patients were excluded from the main survey. This preliminary survey assessed (1) the current status of asthma treatment, (2) reasons for not seeking treatment (if any), and (3) the duration without symptoms.

The main survey was conducted online between November 14 and November 17, 2023 using a panel from Macromill Inc., which has the highest quality control policy standards in the online survey industry. The selection criteria were caregivers who voluntarily agreed to participate in the study, had access to information about the survey on the website, and were caregivers of children and adolescents aged 0–19 years diagnosed with bronchial asthma. No exclusion criteria were established. This main survey targeted caregivers of children and adolescents who were currently continuing treatment at medical institutions and those who were not (for reasons other than the disappearance of symptoms). The primary assessment items in the main survey were the control status of pediatric asthma and the status of the tests performed, including respiratory function and fractional exhaled nitric oxide (FeNO) levels. Secondary evaluation items included medications used and adherence\sout.

Questionnaires appropriate for each age group were used to assess control status. The Best Asthma Control Test for Preschoolers (Best ACT-P)[5)] was used for children aged <4 years old, the Childhood Asthma Control Test (C-ACT)[6)] was used for children aged 4–11 years, and the Asthma Control Test (ACT)[7)] was used for patients aged [?]12 years.

The survey covered patient backgrounds, including age, smoking environment, pet ownership, family history of asthma, presence of allergic diseases, and household income. For treatment assessment, questions were asked regarding the medical facility providing attention, symptoms at treatment initiation, whether clinical tests were conducted, medications administered, asthma control status, and medication adherence. Adherence is considered good at a medication-taking rate of 80%[8)]. However, for this survey, questions were set for respondents as 100%, easy recall.

Analysis methods

For patient background, chi-square and Fisher's exact tests were used for binary variables, Student's t-test for continuous variables, and logistic regression analysis for ordinal categorical variables. Z-tests were used to analyze testing, control, and adherence levels at medical facilities.

Results

Preliminary survey

Figure 1 shows the flowchart of the preliminary and main surveys. In the preliminary survey (n=2549), 1232 respondents (48.3%) reported that they were not currently receiving treatment, whereas 1317 (51.7%) were receiving treatment. The reasons for not receiving treatment were: "mild asthma symptoms" (48.1%), "no asthma symptoms" (44.6%), "going to the clinic is difficult" (3.9%), "it does not get better even with treatment" (2.8%), "the treatment is troublesome" (1.7%), and "others" (1.9%). Among the 549 patients who reported "no asthma symptoms," the period without symptoms was <1 year in 15.3%, 1 year in 5.3%, 2 years in 6.7%, 3 years in 8.9%, 4 years in 4.9%, and > 5 years in 58.8%.

Main survey

The main survey targeted 2000 caregivers of children who are currently continuing treatment at medical institutions and those who are not (for reasons other than the disappearance of symptoms).

Patient background

The age distribution was 23.1% for children aged <4 years old, 63.4% for 4–11 years old, and 13.5% for [?] 12 years. Regarding the smoking environment, 31.6% had a smoking environment and 68.4% did not. Regarding pet ownership, 30.5% of patients had pets, among which 14.8% had dogs, 9.2% had cats, and 12.5% had other pets. Regarding the family history of asthma, in 20.6% of respondents only the father had asthma, in 17.7% only the mother, in 2.9% both parents, and 59.0% had no family history of asthma. The allergic diseases were reported as follows: hay fever (33.1%), allergic rhinitis (31.7%), atopic dermatitis (17.3%), food allergies (14.1%), other allergic diseases (2.5%), and no allergic diseases (37.7%). Household income was million yen for 65.3%, and unknown or unanswered for 20.6% (Table 1).

The proportion of asthma symptoms at diagnosis was as follows: 63.8% experienced occasional coughing or mild wheezing or whistling sounds few times a year, depending on the season, sometimes making breathing difficult; 20.4% experienced coughing or mild wheezing less than once a week and more than once a month, sometimes making breathing difficult, but for a short duration without disrupting daily life; 7.7% had coughing or mild wheezing more than once a week but not every day, with occasional attacks becoming severe and disrupting daily life and sleep; 3.7% had coughing or wheezing every day, with attacks becoming severe once or twice a week and disrupting daily life and sleep; and 4.4% did not fit into any of these categories.

Status of asthma control

Symptoms at diagnosis and the current status of asthma control based on age group are shown in Figure 2. The current control status showed that 26.2% of all patients were poorly controlled, whereas 73.8% were well controlled. However, since different questionnaires were used across age groups for all cases, the items for this variable included "poor control" for those aged <4 years and "uncontrolled" for those aged 4–11 years and [?]12 years. The variable of good control included "good control and relatively good control" for those aged <4 years, "controlled" for those aged 4–11 years, and "total control and well control" for those aged [?]12 years.

Specifically, 56.8% of patients aged <4 years (n=241) had poorly controlled asthma, 11.6% were moderately controlled, and 31.5% were well controlled. For patients aged 4–11 years (n=1053), 21.7% were uncontrolled, and 78.3% were controlled. Finally, 22.7% of patients aged [?]12 years (n=706) were uncontrolled, 46.5% were well-controlled, and 30.9% were completely controlled. Therefore, based on age group, those aged 0–4 years had the most insufficient control.

When cross-tabulating and examining the relationship between patient background and control status (poor or good) based on age group, the items with an odds ratio (OR) >1 were as follows: Household income, relative risk (RR)=1.11, OR=1.16, p=0.30; family history of asthma, RR=1.49, OR=1.73, p<0.01; food allergies, RR=1.14, OR=1.20, p=0.19; hay fever and allergic rhinitis, RR=1.17, OR=1.24, p=0.03; atopic dermatitis, RR=1.37, OR=1.56, p<0.01; pet ownership, RR=1.41, OR=1.41, p<0.01; and inhaled corticosteroid (ICS) use, RR=1.07, OR=1.11, p=0.38. The results according to age group are presented in Table 2.

Table 3 lists the rates of poor asthma control according to ICS use by age group. In the group of children aged <4 years (n=168), there were 106 (63.1%) cases of poor control. Among them, 43 (38.1%) were in the ICS group, whereas 63 (61.9 %) were in the non-ICS group. In the 4–11 years age group (n=725), 198 (27.3%) patients had poor control. Among them, 98 (49.5%) were in the ICS group, whereas 100 (50.5 %) were in the non-ICS group. In the group aged [?]12 years (n=424), 137 patients (32.3%) had poor control. Among them, 71 (51.8%) were in the ICS group, whereas 66 (48.2 %) were in the non-ICS group.

Clinical testing

The proportion of tests conducted at the time of diagnosis and during treatment was as follows: allergen testing, 46.3%; respiratory function testing, 35.4%; FeNO testing, 15.3%; prick test/skin testing, 7.5%; other tests, 0.7%; and no testing, 33.9%. Respiratory function tests and FeNO tests were conducted for subjects aged 6 years and older, with a total of n=1467(Supplementary Material 1).

Medication

Notably, 65.8% of the 2000 patients surveyed were currently receiving some form of treatment, whereas the remaining 34.2% discontinued treatment. Among the patients included in the main survey, 40.2% used inhaled medications, 37.8% used oral medications, 20.3% used patch medications, 3.0% used other medications, and 30.1% did not use any medication. The breakdown of inhaled medications was as follows: ICS, 30.8%; ICS monotherapy, 17.5%; ICS/long-acting beta$_2$-agonist (LABA), 12.5%; ICS/LABA/long-acting muscarinic antagonist, 1.3%; LABA, 0.7%; short-acting beta$_2$-agonist, 9.0%; and disodium cromoglycate, 3.0%. For oral medications, 9.3% of respondents used β2 agonists, 8.3% used oral corticosteroids, 5.3% used xanthine derivatives, and 22.8% used leukotriene receptor antagonists. The patch medication consisted of LABA (20.3 %) and biologics included omalizumab (0.1%), dupilumab (0.1%), and benralizumab (0.1%).

The usage of ICS by age group (per ICS class) showed that 26.1% of those aged <4 years, 30.1% of those aged 4–11 years, and 30.9% of those aged >11 years used ICS, indicating a trend toward increased ICS usage with age.

Additionally, the forms of inhaled medications used were dry powder inhaler in 30.9% and pressurized metered-dose inhaler (pMDI) in 20.5%. The frequency of spacer use with pMDI was 52.6% (Supplementary Material 2).

Medication adherence

Overall, 41.0% of the patients took their medication >50% of the time, whereas 59.0% took it <50% of the time. By age group, 55.1% of those aged <4 years took their medication time. In the group aged 4–11 years, 41.8% took their medication time. Among those aged [?]12 years, 35.2% took their medication time (Figure 3).

According to the type of institution where participants were receiving care, there was a statistically significant difference for "take medication every day," with 35.6% of patients receiving care in university hospitals and allergy clinics compared to 26.0% of patients receiving care in general hospitals and clinics ($p<0.01$). For "taking instead only when symptoms are present," 30.8% of respondents receiving care in university hospitals and allergy specialty hospitals, compared to 43.7% receiving care in general hospitals and clinics, showed a statistically significant difference ($p<0.01$) (Supplementary Material 3).

Furthermore, budesonide suspension, which is commonly used in nebulizers for infants, was used daily by 27.5% of the patients, whereas 52.9% used it only when symptoms occurred. When cross-tabulating and examining the relationship between patient attributes and medication adherence (>50% or <50%), the results were as follows: Household income <4 million yen and >4 million yen, RR=0.93, OR=0.92, p=0.72; presence or absence of a family history of asthma, RR=1.20, and OR=1.43, p=0.03; food allergies RR=1.16, OR=1.20, p=0.38; hay fever and allergic rhinitis, RR=1.00, OR=0.99, p=0.96; atopic dermatitis, RR=0.91, OR=0.89, p=0.55; smoking or non-smoking environments, RR=1.10, OR=1.15, p=0.41; pet ownership, RR=1.12, OR=1.18, p=0.34; and presence or absence of treatment with medications (including

ICS), RR=1.03, OR=1.49, p=0.17. A statistically significant difference was found between the presence and absence of a family history of asthma.

However, there was no statistically significant difference (RR=1.16, OR=1.23, p=0.22) between asthma control (poor or good) and medication adherence (50%> or <50%).

Discussion

In this study, we clarified that medication adherence was significantly influenced by the patient's and caregiver's understanding of the treatment regimen. We also highlighted the complex interplay between family history and comorbid allergic diseases, providing new insights into their combined impact on asthma outcomes. A certain proportion of patients remained uncontrolled, and significant differences were identified across the different age groups. These findings underscore the need for personalized approaches to asthma management to achieve better control and improve the quality of life of children with asthma. The 2012 survey reported a use rate of 20.9% for inhaled steroids[9)]; however, this survey, which included untreated patients, showed a use rate of 30% (n=2000), indicating an increasing trend in the frequency of ICS prescriptions. However, the 2012 survey reported that 14.6% of children aged 6–11 years were uncontrolled, whereas this survey reported 26.2%, suggesting poor control has not decreased. This indicates that factors other than medication may affect control. However, it became clear that ICS was not always used, even in cases of poor control (Table 3). ICS is not necessarily recommended for all cases; however, current treatments should be regularly evaluated, and the use of ICS should be considered in cases of poor control. Notably, in pediatric asthma cases, where atopic types are more common, ICS should be actively used in mild persistent or severe asthma cases or when symptoms are present. Additionally, for patients using ICS, poor control might necessitate reconsideration of dosage or inhalation technique factors.

However, the notably high proportion of poor control in children aged Exploratory evaluation items (n=1317) questioned the usage rate of chambers among pMDI users, which remained at 52.6%. Nebulizers were rarely used, with 52.9% of patients prescribed budesonide inhalation suspension using it only as needed, indicating challenges in adherence. Therefore, in children aged <4 years, improving control through the proper use of nebulizers or chambers with simple inhalation techniques may be possible[10)11)]. Moreover, using ICS improves control and may enhance patients' and caregivers' quality of life[12)].

Factors associated with asthma control include age, which significantly affects asthma control[13)]. This study also revealed that home environmental factors, such as smoking environment and pet ownership, could affect asthma control[14)15)]. The presence of allergic diseases also significantly impacts asthma control, with patients with comorbidities such as hay fever, allergic rhinitis, or atopic dermatitis experiencing worsening symptoms and requiring appropriate management of these conditions[16)]. These factors interact to determine the status of a patient's asthma control, making it essential to develop treatment plans tailored to each patient's background. Treatment plans should include a comprehensive approach not limited to pharmacotherapy but also environmental management, lifestyle improvements, and educational programs. The relatively high rate of allergen testing reflects the importance of allergen identification in managing allergic asthma. The widespread use of lung function testing underlines the importance of objective assessment in asthma management[17)]. However, the FeNO testing had a relatively low implementation rate, possibly due to its cost or access issues. Therefore, improving the testing is crucial for enhancing the accuracy of asthma diagnosis and enabling more personalized treatment approaches[18)]. Future research should delve deeper into how these various factors impact treatment adherence and evaluate whether interventions using digital health technologies can help improve this adherence.

In this study, we found no significant relationship between adherence and the controls. This may be due to the unknown severity of asthma in the survey, where mild cases could have good control despite poor adherence and, conversely, moderate-to-severe cases could have insufficient control despite good adherence. Furthermore, with only 41.0% of respondents reporting adherence >50%, and considering that good adherence is generally regarded as an 80% cut-off, it is expected that actual adherence rates may be even lower. Additionally, almost half of the respondents took medication only when symptoms appeared; therefore, im-

proving adherence could contribute to better control of pediatric asthma. Asthma control is challenging in the absence of prescribed medication. This is consistent with findings from previous studies that also identified low adherence as a major factor in poor asthma control[19]. However, this study also highlighted potential new factors that could influence adherence, such as the presence or absence of a family history of asthma or a patient's allergic condition.

University and specialty allergy hospitals generally possess more resources and expertise. These facilities often provide access to the latest treatments and comprehensive care from various specialists (allergists, pulmonologists, and pediatricians), which may facilitate achieving a higher level of asthma control for patients treated there. In contrast, community-based general hospitals and clinics offer the advantage of being more accessible to patients and making it easier to continue treatment. Geographic proximity is crucial for regular follow-ups and responses to sudden attacks[10]. However, these facilities may have limited access to specialized care and the latest treatments.

This study revealed a discrepancy between clinical practice and the treatments recommended by guidelines[1]. Our results suggest that improving educational programs and follow-up systems for pediatric patients with asthma can improve medication adherence and asthma control. In addition, medication selection and treatment planning should consider the patient's circumstances, such as family history and allergic conditions. University and specialty hospitals often have comprehensive educational programs and patient support services; however, general hospitals and clinics may have limited offerings. This highlights the importance of disseminating educational programs to general practitioners to standardize treatment[10].

Future research should examine how the different factors identified in this study impact asthma medication adherence. For example, to clarify the specific mechanisms, it is necessary to investigate whether a family history of asthma positively influences medication adherence or how an allergic condition alters treatment engagement. In addition, studies evaluating whether interventions using digital health technologies, such as smartphone apps and wearable devices, help improve adherence would also be beneficial[20][21].

This study has certain limitations. First, its cross-sectional nature does not establish causality, but its results suggest correlations. Second, adherence was assessed using specific self-report questionnaires, which may not accurately reflect actual medication adherence[22]. Third, the survey was conducted online, limiting participants to registered website panel members who may not fully represent the national pediatric asthma patient population[23]. Finally, we did not analyze the diversity of treatment options and strategies; therefore, understanding how these factors influence treatment adherence and asthma control is crucial for developing comprehensive treatment plans. Despite these limitations, this study highlights the current state and challenges of pediatric asthma treatment and management, providing a foundation for improvements in future research and clinical practice. Future studies should aim to overcome these limitations by including broader patient populations.

In conclusion, this study sheds light on the differences in the use of asthma medications and treatment approaches by age, which may help further improve pediatric asthma treatment guidelines. Therefore, optimizing age-appropriate approaches and tailoring patient and caregiver education programs is crucial to improve the quality of asthma management, especially for children aged <4 years.

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Key Message

Recent advances in asthma management have emphasized the importance of precise control and regular monitoring to prevent exacerbations and improve overall quality of life. However, despite these advances, achieving optimal asthma control in children remains challenging for clinicians. This is largely due to factors such as poor medication adherence, environmental triggers, and the presence of comorbid allergic

diseases. Furthermore, the role of family history and socioeconomic status in influencing asthma outcomes remains unclear, necessitating further research to elucidate their impact. Therefore, we aimed to explore the current management practices for pediatric asthma by analyzing data from a large-scale, cross-sectional survey of caregivers of pediatric patients diagnosed with bronchial asthma in Japan. We believe that our study makes a significant contribution to the literature because by examining factors such as asthma control status, medication adherence, and the influence of family and environmental factors, this study provides new insights into the complexities of managing pediatric asthma. The findings are intended to inform better clinical practices and improve asthma treatment guidelines, particularly for younger children, who represent a vulnerable subgroup within the asthma population.

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Figure legends

Figure 1: Flowchart of the study from the preliminary survey to the main survey. The flowchart includes the total number of participants at each stage, reasons for treatment discontinuation, and the criteria for inclusion in the main survey.

Figure 2: The control status of asthma based on age group. BEST ACT-P: Best Asthma Control Test for Preschoolers, C-ACT: Childhood Asthma Control Test, ACT: Asthma Control Test

Figure 3: Adherence* by age group. *When taking multiple medications, if adherence differs by medication, better adherence should be considered the representative value of the percentage of patients in each age group who reported medication adherence of >50% and <50%.

Supplementary Material 1: Clinical tests for asthma. *Respiratory function and FeNO tests were conducted for children aged [?]6 years, with a total of n=1467 participants.

Supplementary Material 2: pMDI: pressurized metered-dose inhaler, DPI: dry powder inhaler.

Supplementary Material 3: Differences in medication habits according to facility type. University and specialty allergy hospitals have higher rates of "taking medication daily" (35.6%) compared with general hospitals and clinics (26.0%). Conversely, "taking medication when symptoms appear" is more common at general hospitals and clinics (43.7%) compared with university and specialty allergy hospitals (30.8%). These differences were statistically significant ($p<0.01$).

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