

# Evaluation of Pediatric Residents' Knowledge Levels on Inhaler Techniques Used in Asthma Treatment and the Effect of Education on the Level of Knowledge

## Pediatric Asistanlarının Astım Tedavisinde Kullanılan İnhaler Tedavi Teknikleri Konusunda Bilgi Düzeylerinin Değerlendirilmesi

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### ABSTRACT

**Objective:** The use of inhaler drugs results in clinical success only when they are applied using the right technique. Faulty inhaler application techniques reduce therapeutic efficacy, impair treatment compliance, and lead to inadequate control of the disease. This study aimed to evaluate the knowledge levels of pediatric residents who play an important role in the follow-up of patients with pediatric asthma in both inpatient and outpatient services in a tertiary children's hospital and to determine the effect of short-term training on the level of knowledge.

**Material and Methods:** All participants were asked to demonstrate the use of inhaler devices using demo devices. This assessment was designated as the "Pre-test." The participants were then given face-to-face inhaler device training in groups of up to 15 people, which included all application steps. At the end of the training, the steps of inhaler device use were reassessed.

**Results:** Pre-training evaluation of inhaler technique on Metered Dose Inhaler and Dry Powder Inhaler devices showed that none of the 148 participants successfully completed the predetermined mandatory steps of the inhaler technique. After the training, it was observed that all participants were able to fully apply the steps of the previously determined checklist.

**Conclusion:** Medical school curricula and specialty education should include the application training of inhaler devices, which are extremely important for asthma treatment. Regular repetition of in-service training involving inhaler technique and application among health professionals can correct application errors and increase awareness regarding the importance of the right inhaler technique in the treatment of asthma.

**Key Words:** Asthma, Children, Inhaler, Treatment techniques

### ÖZ

**Amaç:** İnhaler ilaçların tedavi başarısı ancak doğru bir teknikle uygulanırsa mümkün olmaktadır. Hatalı inhaler teknik; terapötik etkinliği azaltır, tedavi uyumunu bozar ve hastalığın yetersiz kontrolüne yol açar. Çalışmamızda; üçüncü



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basamak çocuk hastanesinde hem yataklı servis hem de poliklinik hizmetlerinde astımlı çocuk hasta takibinde önemli rol üstlenen pediatri asistan hekimlerinin uygun inhaler teknik konusundaki bilgi düzeylerini değerlendirmek ve kısa süreli bir eğitimin bilgi düzeyine katkısını belirlemek amaçlanmıştır.

**Gereç ve Yöntemler:** Tüm katılımcılardan demo cihazlar ve manken kullanarak, inhaler cihaz kullanımını göstermeleri istendi. Bu değerlendirme 'Ön-Test' olarak adlandırıldı. Daha sonra katılımcılara maksimum 15 kişiden oluşan gruplar halinde, tüm uygulama basamaklarını içeren yüz yüze inhaler cihaz kullanım eğitimi verildi. Eğitim sonunda inhaler cihaz kullanımına ait basamaklar tekrar değerlendirildi.

**Bulgular:** Ölçümlü Doz Inhaler ve Kuru Toz Inhaler cihazlara ait inhaler teknik ile ilgili eğitim öncesi değerlendirme sonucunda 148 katılımcıdan hiçbirinin önceden belirlenmiş zorunlu basamakları eksiksiz tamamlayamadığı görüldü. Eğitim sonrasında tüm katılımcıların önceden belirlenen kontrol listesinin adımlarını tam olarak uygulayabildikleri gözlemlendi.

**Sonuç:** Tıp fakültesi müfredatı ve uzmanlık eğitim sürecine astım tedavisi için son derece önemli olan inhaler cihazların uygulama eğitiminin dahil edilmesi gerektiğine dikkat çekmek istiyoruz. Sağlık profesyonelleri arasında, inhaler teknik uygulamalarını içeren hizmet içi eğitimlerin düzenli aralıklarla tekrarlanması uygulamadaki hataları gidermekle birlikte astım tedavisinde doğru inhaler tekniğin önemi konusundaki farkındalığı da arttıracaktır.

**Anahtar Sözcükler:** Astım, Çocuk, Inhaler, Tedavi Teknikleri

## INTRODUCTION

Asthma is the most common chronic disease among children, and its incidence is gradually increasing. Inhaler therapies have been used for several years and are the most effective asthma treatment. The most important advantages of inhaler treatment include the fact that the application is non-invasive, contains lower doses than oral and parenteral treatments, has fewer systemic side effects, provides local and fast efficacy, and is portable in such a way that the patient can carry the inhaler with him or her at any time (1).

The use of inhaler drugs results in clinical success only when they are applied using the right technique. Faulty inhaler application techniques reduce therapeutic efficacy, impair treatment compliance, and lead to inadequate control of the disease (2-4).

A technique considered ideal for one device can be completely faulty when using another device. For this reason, patients and their parents should be provided with detailed training on the recommended inhaler device, usage technique, and application steps. Further, the inhaler technique employed by patients should be assessed at each doctor visit to prevent possible errors (5,6).

Presently, a metered-dose inhaler (MDI) and dry powder inhaler (DPI) devices, which have completely different working principles, are frequently used in the treatment of childhood asthma. Each inhaler device has its unique usage technique, advantages, and disadvantages. This should be taken into account when choosing the appropriate device for the patient (7-9). The fact that health professionals who provide education to patients and their families teach inhaler devices and application steps clearly and accurately plays a key role in the treatment of asthma.

This study aimed to evaluate the knowledge levels of pediatric residents who play an important role in the follow-up of patients with pediatric asthma in both inpatient and outpatient services

in a tertiary children's hospital and to determine the effect of short-term training on the level of knowledge.

## MATERIALS and METHODS

The study was conducted between September and December 2021 at Ankara City Hospital Pediatric Allergy and Immunology Clinic. Ethics committee approval was obtained from the Ankara City Hospital Clinical Research Committee (decision number E2-21-846). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Work experience in pediatric health and diseases, pediatric allergy and immunology clinics, and pediatric emergency departments were recorded in addition to demographic characteristics, such as age and gender. Further, a general evaluation form was distributed to all participants. This form comprised whether the participants had previously been trained in inhaler treatments, whether they provided inhaler training to any patient, and information on inhaler device preferences by age group.

A checklist was prepared to assess the use of MDI and DPI (turbuhaler and diskus) devices, which are often used in the treatment of childhood asthma. It comprised the mandatory steps mentioned in the literature and was modified in accordance with our clinical experience (9-12).

All participants were asked to demonstrate the use of inhaler devices using demo devices. Meanwhile, the steps were scored as true or false by the pediatric allergy and immunology specialist. This assessment was designated as the "Pre-test." The participants were then given face-to-face inhaler device training in groups of up to 15 people, which included all application steps. The training was provided by the same specialist and lasted for approximately 30 min. At the end of the training, the steps of inhaler device use were reassessed. These data were recorded as the "Post-test." The steps involved in the evaluation of the inhaler technique are shown in Table I.

**RESULTS**

A total of 148 resident doctors working in pediatric clinics were included in the present study. The mean age of the participants was  $28.0 \pm 2.1$  years (Inter-quartile range [IQR]; 26–29 years), and 58.8% were female. The participants' average work experience in the pediatric health and diseases clinic was  $1.7 \pm 0.9$  (min-max; 0.2-5 years) years. Fifty-seven (38.5%) participants were actively working in the outpatient clinic during their residency. Twenty-nine (19.6%) participants were observers at the pediatric allergy and immunology outpatient clinic for at least one month. All participants stated that they worked in the inpatient ward and were actively involved in the follow-up of the patients hospitalized due to asthma. It was found that 26 (17.6%) participants had previously received training on inhaler drugs and application techniques at least once. Further, 60.1% reported that they provided inhaler training for the first time to a patient who had not received any treatment before. When participants were asked about the principles of the devices that they were well aware of, 62.2% responded as MDI, 16.9% as DPI, and 20.9% responded as both. Only 15.5% of the participants stated that they had adequate knowledge about inhaler drugs and application techniques. The characteristics of the participants are summarized in Table II.

Participants were also asked about the inhaler devices that they would choose as their first choice according to age

groups in children with asthma. For the 0–5 years age group, 64.2% of the participants stated that their first choice would be nebulizer devices. For the 5–12 years age group, spacer with face mask and spacer with mouthpiece MDI devices were preferred similarly. For children over the age of 12 years, more than half of the participants stated that they would prefer DPI. Inhaler devices preferred by pediatric residents according to age groups are summarized in Table III.

For MDI devices, the steps that were frequently forgotten in the pre-test were “the inhaler device is shaken for 5 sec before application,” “the mask part of the spacer is placed on the face to fully cover the nose and mouth,” and “inhaler device is reshaken before the second dose is applied”.

Among DPI (turbuhaler and diskus) devices, most erroneous applications were observed in turbuhaler devices. When application steps were evaluated, the steps that were incorrectly applied by the participants included “keep turbuhaler upright,” “exhale before application,” and “wait for 1 min before the second inhalation”. For diskus, the incorrectly applied steps were “hold diskus in a horizontal position,” “exhale before application,” and “hold your breath for 5–10 sec after application.”

After the training, it was observed that all participants were able to fully apply the steps of the previously determined checklist. The correct response rates of participants to the required steps in pre-test and post-test applications are shown in Figure 1 (A, B, C).

**Table I: Check-list containing all application steps of proper inhalation technique**

| Metered dose inhaler with spacer   | Dry Powder inhaler (Turbuhaler)   | Dry Powder inhaler (Diskus)   |
|--|---|---|
| <b>Step 1.</b> Remove the protective cap and shake the inhaler for 5 s   | <b>Step 1.</b> Remove the turbuhaler cap and hold it upright  | <b>Step 1.</b> Open the diskus with one hand and push the notch forward with the thumb of the other hand. |
| <b>Step 2.</b> Hold the inhaler in the upright position, put it into the hole of the spacer. Place your fingers to support the inhaler and spacer. | <b>Step 2.</b> Turn the base part first to the right and then to the left to hear the ‘click’ sound | <b>Step 2.</b> Pull the latch to hear the ‘click’ sound   |
| <b>Step 3.</b> Place the mouthpiece between your teeth and lips or cover the nose and mouth with the mask of spacer                                | <b>Step 3.</b> Exhale to residual volume (away from inhaler)  | <b>Step 3.</b> Hold diskus in horizontal position   |
| <b>Step 4.</b> Press down the inhaler once and breathe in deeply and slowly 5-6 times from the spacer (approximately 10 seconds)                   | <b>Step 4.</b> Place mouthpiece between teeth and lips  | <b>Step 4.</b> Exhale to residual volume (away from inhaler)  |
| <b>Step 5.</b> Shake the inhaler again before the second dose  | <b>Step 5.</b> Take a forcefully and deeply breath  | <b>Step 5.</b> Place mouthpiece between teeth and lips  |
| <b>Step 6.</b> Close cap after use   | <b>Step 6.</b> Remove the device from the mouth before breathing out and hold your breath for 10 s  | <b>Step 6.</b> Take a forcefully and deeply breath  |
|  | <b>Step 7.</b> Wait one minute before second inhalation   | <b>Step 7.</b> Remove the device from the mouth before breathing out and hold your breath for 10 s        |
|  | <b>Step 8.</b> Turn the base again and prepare for the second inhalation                            | <b>Step 8.</b> Wait one minute before second inhalation   |
|  | <b>Step 9.</b> Close cap after use  | <b>Step 9.</b> Pull the latch again for the second dose   |
|  |   | <b>Step 10.</b> Close cap after use   |

**Table II: Characteristics of the participants.**

| Characteristics of the participants  | n (%)                     |
|--|---------------------------|
| Age (year)   | 28.0 ± 2.1<br>(IQR;26-29) |
| Gender Male  | 87 (58.8)                 |
| Resident duration (years) Mean   | 1.7 ± 0.9                 |
| 0-12 month   | 23 (15.5)                 |
| 12-24 month  | 41 (27.7)                 |
| 24-36 month  | 51 (34.5)                 |
| 36-48 month  | 33 (22.3)                 |
| Rotated departments  |                           |
| Child health and diseases out-patient clinic   | 57 (38.5)                 |
| Pediatric Allergy and Immunology out-patient clinic  | 29 (19.6)                 |
| Pediatric emergency outpatient clinic  | 94 (63.5)                 |
| Have you received any training on inhaler devices and administration techniques? Yes                                   |                           |
| From whom did you receive the training?  | 26 (17.6)                 |
| Pediatric Allergy and Immunology specialist  | 10 (38.4)                 |
| Child health and diseases specialist   | 6 (23.0)                  |
| Senior doctors   | 10 (38.4)                 |
| Have you ever started inhaler treatment for the first time to a patient who has not received any treatment before? Yes | 89 (60.1)                 |
| How many patients/parents have you trained inhalers so far?  |                           |
| <10  | 82 (55.4)                 |
| 10-50  | 46 (31.1)                 |
| > 50   | 20 (13.5)                 |
| Which of the inhaler devices do you think you know the principles of use correctly?                                    |                           |
| Metered dose inhaler   | 92 (62.2)                 |
| Dry powder inhaler   | 25 (16.9)                 |
| Both of them   | 31 (20.9)                 |
| Do you consider your level of knowledge about inhaler drugs and administration techniques sufficient? Yes              | 23 (15.5)                 |

**Table III: Inhaler device preferences of participants according to age groups in patients.**

| Which would be your first choice? | MDI<br>(Spacer with face mask) | MDI<br>(Spacer with mouthpiece) | DPI       | Nebulizers |
|-----------------------------------|--------------------------------|---------------------------------|-----------|------------|
| 0-5 years                         | 44 (29.7)                      | 8 (5.4)                         | 1 (0.7)   | 95 (64.2)  |
| 6-12 years                        | 50 (33.8)                      | 58 (39.2)                       | 12 (8.1)  | 28 (18.9)  |
| > 13 years                        | 9 (6.1)                        | 38 (25.7)                       | 86 (58.1) | 15 (10.1)  |

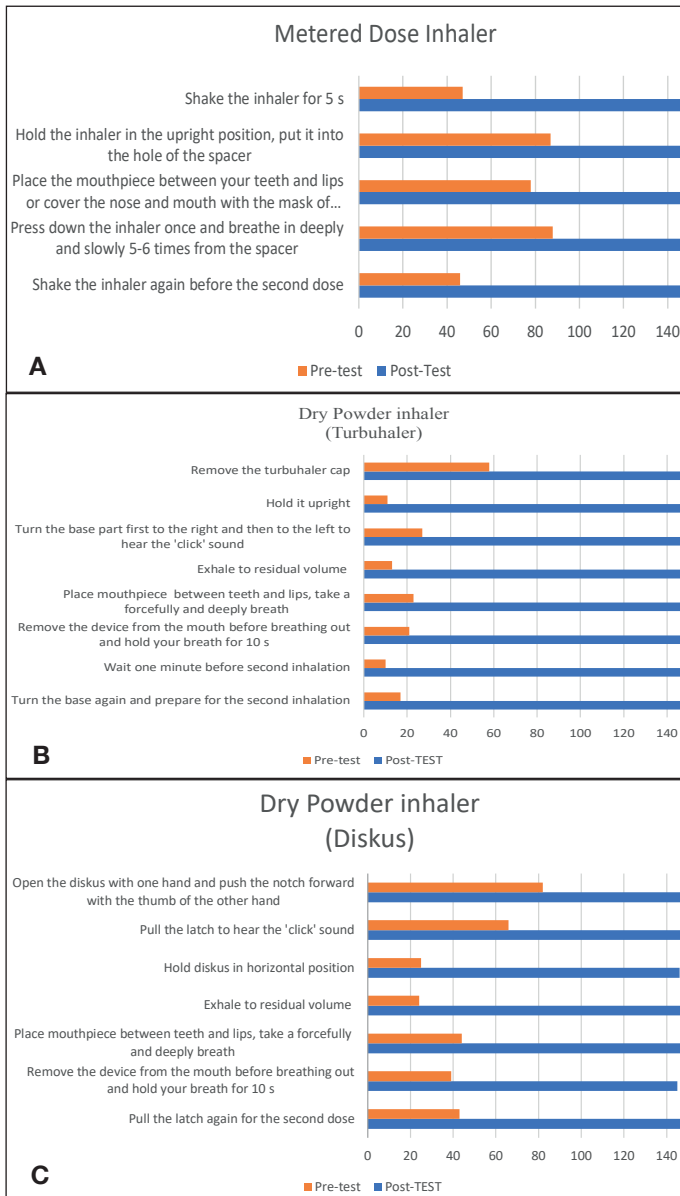
**MDI:** Metered dose inhaler, **DPI:** Dry powder inhaler

## DISCUSSION

The study aimed to evaluate the level of knowledge regarding inhaler technique among pediatric residents, who are frequently involved in the treatment of childhood asthma. Pre-training evaluation of inhaler technique on MDI and DPI devices showed that none of the 148 participants successfully completed the predetermined mandatory steps of the inhaler technique. It was shown that the inhaler technique could be improved post-training.

There are many studies in the literature evaluating inhaler technique and skills in patients with pediatric asthma and their parents. Although there are differences in the age group, asthma control levels, treatment compliance of patients, and definition of correct inhaler technique among these studies,

it can be concluded that there are flaws in the correct application of inhaler devices in the pediatric patient group in general (8,13-16). However, studies that evaluate the level of knowledge of health professionals, especially pediatricians, who provide training to patients, are limited (17). Resnick et al. (18) evaluated the MDI application technique by pediatricians and reported that only 1/4th of the pediatricians were able to complete the steps without errors. Owayed et al. (16) reported that only 15.5% of pediatricians were able to apply MDI devices without any errors. Another study involving nurses and doctors responsible for pediatric patient follow-up found that only <50% of the participants could perform the MDI application steps without any errors. In this study, inhaler technique scores of nurses were higher than that of doctors and no difference was found between residents and senior doctors, which are notable results (19). In the present study, inhaler technique scores of the



**Figure 1: A)** Metered Dose Inhale, **B)** Dry Powder Inhaler (Turbuhaler), **C)** Dry Powder inhaler-Diskus

participants were lower than those reported in previous studies, which may be due to the fact that the study sample comprised residents of different seniority, lack of experience due to the short periods of active work in outpatient clinics, and the fact that the technique was evaluated via face-to-face supervision instead of multiple-choice questions.

In the present study, the most frequently made mistakes during inhaler treatment were consistent with the mistakes identified in previous studies involving patients with asthma and their caregivers (8,9,20,21). This suggests that educators and doctors also need training, and a few steps should be further emphasized during training. Various training methods related to inhaler techniques have been examined in several different clinical settings. Some studies have reported that group training

is the most effective training method among these methods, whereas other studies argue that better results can be achieved with one-to-one training (22,23). The use of visual materials, models, and standard checklists during training can act as reminders for both patients and medical personnel, and the use of these aids has been found to be more effective than oral or written information alone (22).

In the present study, evaluations after group training using demo inhaler devices and models showed that inhaler technique skills can be improved even with short training programs. Kellman et al. applied a short training program to emergency room doctors and nurses and reported that the training increased the success scores from 34% (before the training) to 91% (24). Plaza et al. (25) evaluated the level of knowledge of doctors regarding inhaler technique and determined that the participants mostly obtained their current knowledge via scientific meetings, articles on the subject, personal experiences, and emphasized that the subject was not given the necessary importance in medical school curricula, which should be the primary place of obtaining such knowledge. Timothy et al. (23) outlined their recommendations for improving the skills of health professionals in inhalation therapies as follows: raising awareness, providing training, assessing the impact of training, repeating training, and promoting patient education with reimbursement.

In the present study, pediatric residents were also asked about inhaler device preferences according to pediatric age groups, and it was determined that there were incorrect applications in this regard. It is noteworthy that nebulizer devices are recommended more frequently than MDI devices by health professionals, especially in the 0–5 years age group. Due to the limited side effects, no external power supply, shorter application time, portability, lower cost, and similar efficacy, the use of Spacer and MDI devices is the first choice of recommendation in the current guidelines (26). Nebulizer devices are offered as an alternative method for a small group of patients who cannot use inhaler devices effectively (27).

Although it was determined that training increased success in inhaler application skills in the present study, it was not possible to evaluate how long the effect of a single training lasted due to the fact that the post-test was applied immediately after the training. This can be seen as a limitation of the study. However, the fact that 17.6% of the participants reported that they had previously been trained in inhaler application techniques but continued to make errors during application highlights the issue of regular repetition of the same training. In a systematic review of studies evaluating inhaler technique in children with asthma, it was recommended to treat each outpatient visit as an opportunity and to check the inhaler technique applied by the patients, to identify the wrong steps, and to repeat the training (28). From this point of view, regular repetition of training can also be recommended for health professionals.

The strengths of the present study include a very high number of health professionals evaluated in a single center and the use of pre-test and post-test evaluations before and after face-to-face inhaler technique training. In contrast to the literature, the inhaler technique was also evaluated on DPI devices, the use of which has increased recently in line with the recommendation of the current guidelines. Studies evaluating inhaler techniques on DPI devices in the pediatric population are quite limited in the literature. A systematic review of studies evaluating inhaler techniques among health professionals found that the application errors in DPI devices were more frequent compared with MDI devices (29). Similarly, it was found in the present study that more errors were reported during the application steps of both turbuhaler and diskus devices compared with MDI devices. This may be related to the fact that DPI devices are prescribed less frequently than MDI devices in the pediatric age group and that different forms of DPI devices (turbuhaler/diskus) require different technical knowledge.

In countries such as Turkey, where the number of pediatric allergy and immunology specialists is limited, the treatment follow-up of pediatric patients diagnosed with asthma is mostly conducted by pediatricians. For this reason, medical school curricula and specialty education should include the application training of inhaler devices, which are extremely important for asthma treatment. Regular repetition of in-service training involving inhaler technique and application among health professionals can correct application errors and increase awareness regarding the importance of the right inhaler technique in the treatment of asthma.

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