Influence of Gender on Inhaler Technique

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BACKGROUND: This study was designed to evaluate the influence of gender on the inhaler technique of subjects on inhaler therapy and to determine the factors predicting the correct inhaler technique and a change of inhaler device. METHODS: A total of 568 adult subjects (276 male, 292 female) on inhaler therapy were included in this cross-sectional, observational study. Data on sociodemographic characteristics, inhaler therapy, subject-reported difficulties, and technician-reported errors in inhaler technique were recorded. RESULTS: A change of inhaler device was noted in 71.0% of male subjects and 77.4% of female subjects, and this was based on the physicians' decision in most cases (41.7% and 51.7%, respectively). A higher percentage of female subjects reported difficulties with using inhalers (63.7% vs 40.6%, *P* < .001). Overall, having received training on the inhaler technique was associated with a higher likelihood of correct inhaler technique (odds ratio 12.56, 95% CI 4.44–35.50, *P* < .001) and a lower risk of device change (odds ratio 0.46, 95% CI 0.27–0.77, *P* = .004). CONCLUSIONS: Errors in the inhaler technique, including inhalation maneuvers and device handling, were common in subjects on inhaler therapy. Subject-reported difficulties with using inhalers were more prevalent among female subjects, whereas errors in the inhaler technique identified by direct observation were similarly high in both genders. Overall, a lack of training on the inhaler technique predicted a higher likelihood of errors in the inhaler technique and a change of inhaler device. *Key words: inhaler therapy; inhaler technique; gender; metered dose inhalers; dry powder inhalers.* [Respir Care 2020;65(10):1470–1477. © 2020 Daedalus Enterprises]

Introduction

Despite advances in inhaler device technology, an incorrect inhaler technique with both pressurized metered-dose inhalers (pMDIs) and dry powder inhalers (DPIs) remains a common problem in the management of COPD and asthma, with a risk of critical errors that jeopardizes the drug delivery and disease control.[1-5]

Recent global position documents from the Global Initiative for Asthma (GINA) and Global Initiative for Chronic Obstructive Lung Disease (GOLD) highlight the critical importance of assessing the inhaler technique to guide appropriate inhaler prescription, as well as correcting poor inhalation techniques before escalating drug therapy.[6,7] However, while errors in inhaler technique have been addressed in terms of types of inhaler devices and the sociodemographic characteristics and preferences of patients, findings still remain inconclusive, and studies with a particular emphasis on gender are relatively scarce.[8-10]

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This study was designed to evaluate the gender influence on subject-reported and observer-reported inhaler techniques among subjects on inhaler therapy and to determine the factors predicting correct inhaler technique and a change of inhaler device.

QUICK LOOK

Current knowledge

Errors in inhaler technique have been addressed in terms of types of inhaler devices and the sociodemographic characteristics and preferences of patients. However, the findings remain inconclusive, and studies with a particular emphasis on gender are relatively scarce.

What this paper contributes to our knowledge

Along with illiteracy and a low educational status, subject-reported difficulties with using inhalers were more prevalent among female subjects than male subjects, whereas technician-reported errors in inhaler technique were similarly high in both genders. Overall, older age and female gender were predictive of a higher likelihood of errors in inhaler technique, whereas a lack of training on inhaler technique predicted a higher likelihood of errors in inhaler technique and change of inhaler device.

Methods

Study Population

A total of 568 adult subjects (276 male, 292 female) who were on inhaler therapy for at least one month were included in this cross-sectional, observational study conducted at a tertiary pneumology out-patient clinic between June 2017 and February 2018. pMDIs and several DPIs including Aerolizer (Novartis, Surrey, UK), Handihaler (Boehringer Ingelheim, Ingelheim, Germany), Turbuhaler (Astra, Lund, Sweden) and Diskhaler (GlaxoSmithKline, Ware, UK) were assessed in this study as the most commonly used devices of those available in Turkey. Subjects $>$ 18 y old who were diagnosed with asthma according to the Asthma, COPD, and asthma-COPD overlap syndrome, GINA, and GOLD criteria were included in this study.[11] The use of inhaler therapy for less than one month, lack of attendance to regular control visits, confirmed or suspected pregnancy, breastfeeding, allergy, sensitivity or intolerance to asthma or COPD therapy, and being on nebulizer therapy were the exclusion criteria applied to this study.

Written informed consent was obtained from each subject following a detailed explanation of the study objectives and protocol. This study was conducted in accordance with the ethical principles stated in the Declaration of Helsinki and approved by the University of Health Sciences, Sureyyapasa Chest Diseases and Thoracic Surgery Training and Research Hospital Ethics Committee.

Data Collection

The recorded data included subject age, gender, diagnosis, duration of disease, characteristics of inhaler therapy (ie, type and duration of inhaler therapy, previous change of inhaler device and reasons for change), subject-reported difficulties with using an inhaler device, and the top 10 errors in inhaler technique via direct observation of the patient's performance. The inhaler technique for each device was evaluated using checklists developed in-house, which were specific to each inhaler device and based on the manufacturer instructions and recommendations for the correct implementation of inhalers provided by the Turkish Thoracic Society Patient Information Handbook on Asthma and the Turkish Thoracic Society National Asthma Diagnosis and Management Guidelines.[12,13] The interviewer registered whether each step was performed properly and in an appropriate order, and errors in inhaler technique were compared with regard to gender groups. Factors determining the correct inhaler technique and a change of inhaler device were also analyzed in gender groups via logistic regression analyses.

Statistical Analysis

The statistical analysis was conducted using IBM SPSS Statistics for Windows 21.0 (IBM, Armonk, New York). Data were expressed as the mean ± SD, percent (%), and range where appropriate. The chi-square test and the Fisher exact test were used to analyze categorical data, and the Student t test and the Mann-Whitney U test were used for the analysis of numerical data. P values $< .05$ were considered statistically significant. A logistic regression analysis was performed to evaluate the factors determining an increased risk of errors in inhaler technique and change of inhaler device.

Results

Demographic and Clinical Characteristics and Types of Inhaler Therapy

Asthma diagnoses (47.0% vs 14.9%, $P < .001$) were more common in female subjects than in male subjects (Table 1). Overall, 102 (18.5%) subjects were on a single inhaler device, and 448 (81.5%) were on multiple inhalers, including ≥ 3 inhalers in 203 (35.7%) subjects, 2 DPIs in 23 (5.1%) subjects, and DPI + pMDI in 194 (43.3%) subjects. pMDIs were the most common type of inhaler,

Table 1. Demographic and Clinical Characteristics

	Male	Female	*P*
Age, y	60.8 ± 12.0	61.0 ± 13.7	.84
Diagnosis			< .001
COPD	214 (77.5)	114 (39.0)	
Asthma	41 (14.9)	140 (47.0)	
Duration of disease, y	8.8 ± 7.6	9.4 ± 9.1	.84
Type of inhaler used			
pMDI	226 (81.9)	224 (76.7)	.07
Dry powder inhaler			
Aerolizer	197 (71.4)	149 (51.0)	< .001
Diskhaler	74 (26.8)	96 (32.9)	.069
Turbuhaler	42 (15.2)	45 (15.4)	.52
Handihaler	2 (0.7)	15 (5.1)	.001
Nebulizer	67 (24.3)	87 (29.8)	.08
Duration of inhaler therapy	5.0 (0.2–26.0)	5.0 (0.0–4.0)	.29
pMDI	6.0 (0.5–26.0)	5.0 (0.0–4.0)	.64
Dry powder inhaler			
Aerolizer	6.0 (0.5–26.0)	5.0 (0.1–35.0)	.59
Diskhaler	5.0 (1.0–2.0)	5.0 (0.0–37.0)	.39
Turbuhaler	4.5 (1.0–26.0)	6.0 (1.0–37.0)	.48
Handihaler	2.0 (1.0–12.0)	7.0 (1.0–15.0)	ND
Nebulizer	9.5 (1.0–26.0)	9.0 (1.0–3.0)	.56
Reason for change of inhaler device	196 (71.0)	226 (77.4)	.050
Physician's decision	115 (41.7)	151 (51.7)	.01
Difficulty in use	50 (18.1)	60 (2.5)	.26
Failure to sense the drug	22 (8.0)	24 (8.2)	.51
Subject trained on inhaler technique	191 (69.2)	182 (62.3)	.051
By a physician	86 (45.0)	89 (48.9)	
By a nurse	74 (38.7)	55 (3.2)	
Other	31 (16.2)	38 (20.9)	
Repeated check of inhaler technique	93 (33.7)	95 (32.5)	.41

Data are presented as mean ± SD, *n* (%), or median (range). *N* = 568 subjects (276 male, 292 female).
pMDI = pressurized metered-dose inhaler
ND = no data

followed by the Aerolizer type of DPI in both male subjects (81.9% and 71.4%, respectively) and female subjects (76.7% and 51.0%, respectively). A change of the inhaler device was noted in 71.0% of male subjects and in 77.4% of female subjects, and in most cases the change was based on a physician's decision (41.7% and 51.7%, respectively). No significant difference was noted between male and female subjects in terms of the characteristics of inhaler therapy (Table 1).

Subject-Reported Difficulties with Using Inhalers

A higher percentage of female subjects reported difficulties with using inhalers overall (63.7% vs 40.6%, $P < .001$) and for each type of inhaler ($P < .001$ for pMDIs; *P* values ranged from .01 to < .001 for DPIs). Among the subjects who reported difficulties with inhaler use, the most commonly identified difficulties were remembering to exhale before inhaling, preventing the loss of aerosolized medicine through the mouth or nostrils, and remembering to prepare the device before inhalation in both male subjects (100%, 49.0%, and 46.0%, respectively) and female subjects (89.0%, 60.0%, and 52.0%, respectively) (Table 2).

Although a significantly higher percentage of subjects on multiple inhaler devices reported having difficulties with inhaler use compared to those on a single inhaler device (55.4% vs 42.2%, $P = .02$), no significant differences were noted in the rates for subject- or technician-reported errors according to the number of inhaler devices.

Technician-Reported Errors in Inhaler Technique

Among the top 10 errors in inhaler technique, failure to exhale before inhaling through the device (80.5%), failure to deeply inhale (53.5%), and failure to shake the pMDI before use (49.1%) were the most commonly identified upon direct observation of the subjects' performance for both genders. Apart from a significantly higher rate of failure to pierce the Aerolizer capsule by female subjects (27.2% vs 17.4%, $P = .004$), no significant gender influence was noted regarding errors in inhaler technique (Table 3).

Logistic Regression Analysis for Factors Predicting Correct Inhaler Technique

In the overall study population, older age (odds ratio [OR] 0.98, 95% CI 0.95–0.10, $P = .03$) was associated with a decreased likelihood of correct inhaler technique, whereas a longer duration of inhaler therapy (OR 1.04, 95% CI 1.00–1.08, $P = .03$) and training on inhaler technique (OR 12.56, 95% CI 4.44–35.50, $P < .001$) were associated with a higher likelihood of correct inhaler technique (Table 4).

Training on inhaler technique was associated with a higher likelihood of correct inhaler technique in both male subjects (OR 12.79, 95% CI 2.97–55.02, $P = .01$) and female subjects (OR 12.51, 95% CI 2.83–55.36, $P = .01$) (Table 4).

Logistic Regression Analysis for Factors Predicting a Change of Inhaler Device

A longer duration of disease (OR 1.08, 95% CI 1.01–1.16, $P = .02$) and failure in preventing the loss of aerosolized medicine through the mouth or nostrils (OR 2.41, 95% CI 1.23–4.71, $P = .01$) were associated with an increased risk of changing the inhaler device in the overall study population, whereas the presence of training on

Table 2. Subject-Reported Difficulties in Using Inhalers

	Yes	Difficulty				
		Understanding Trainer's Explanations	Understanding Device Brochure	Remembering to Prepare the Device Before Inhalation	Remembering to Exhale Before Inhaling	Preventing Loss Through Mouth or Nostrils
Total						
Male	112 (40.6)	10 (9.0)	25 (22.0)	51 (46.0)	112 (10.0)	55 (49.0)
Female	186 (63.7)	32 (17.0)	30 (16.0)	96 (52.0)	166 (89.0)	111 (6.0)
P	< .001	.01	.36	< .001	.01	< .001
Pressurized metered-dose inhaler						
Male (*n* = 226)	94 (41.6)	8 (9.0)	16 (17.0)	46 (49.0)	94 (10.0)	48 (51.0)
Female (*n* = 224)	142 (63.4)	24 (17.0)	23 (16.0)	79 (56.0)	138 (97.0)	96 (68.0)
P	< .001	.003	.24	< .001	< .001	< .001
Aerolizer						
Male (*n* = 197)	81 (41.1)	7 (9.0)	16 (2.0)	32 (4.0)	76 (94.0)	35 (43.0)
Female (*n* = 149)	100 (67.1)	15 (15.0)	12 (12.0)	45 (45.0)	86 (86.0)	54 (54.0)
P	< .001	.02	.79	.003	< .001	< .001
Diskhaler						
Male (*n* = 74)	34 (45.9)	4 (12.0)	6 (18.0)	19 (56.0)	33 (97.0)	14 (41.0)
Female (*n* = 96)	64 (66.7)	16 (25.0)	13 (2.0)	33 (52.0)	58 (91.0)	42 (66.0)
P	.08	.030	.33	.24	.045	.01
Turbuhaler						
Male (*n* = 42)	14 (33.3)	4 (29.0)	4 (29.0)	8 (57.0)	14 (10.0)	8 (57.0)
Female (*n* = 45)	28 (62.2)	10 (36.0)	14 (5.0)	21 (75.0)	26 (93.0)	25 (89.0)
P	.01	.14	.01	.007	.28	.01
Handihaler						
Male (*n* = 2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Female (*n* = 15)	13 (86.7)	1 (8.0)	1 (8.0)	7 (54.0)	9 (69.0)	9 (69.0)
P	ND	ND	ND	ND	ND	ND
Nebulizer						
Male (*n* = 67)	30 (44.8)	1 (3.0)	1 (3.0)	7 (23.0)	22 (73.0)	4 (13.0)
Female (*n* = 87)	63 (72.4)	10 (16.0)	5 (8.0)	30 (48.0)	61 (97.0)	41 (65.0)
P	.01	.02	.23	.01	< .001	< .001

Data are presented as *n* (%).
ND = no data

Table 3. Top 10 Errors in Inhaler Technique on Direct Observation of Performance

	Total	Male	Female	*P*
Failure to exhale before inhaling through device	457 (8.5)	223 (80.8)	234 (8.1)	.91
Failure to deeply inhale	304 (53.5)	139 (50.4)	165 (56.5)	.15
Failure to shake the pressurized metered-dose inhaler before use	279 (49.1)	139 (50.4)	140 (47.9)	.61
Loss through mouth/nostrils	202 (35.6)	91 (33.0)	111 (38.0)	.22
Failure to pierce Aerolizer capsule	129 (22.7)	48 (17.4)	81 (27.7)	.004
Failure to open Diskhaler	60 (10.6)	22 (8.0)	38 (13.0)	.056
Shaking Turbuhaler before use	54 (9.5)	23 (8.3)	31 (10.6)	.39
Failure to open cap of the Turbuhaler	46 (8.1)	18 (6.5)	28 (9.6)	.21
Failure to place Aerolizer capsule into the space	43 (7.6)	16 (5.8)	27 (9.2)	.15

Data are presented as *n* (%). *N* = 568 subjects (276 male, 292 female).

inhaler therapy (OR 0.46, 95% CI 0.27–0.77, $P = .004$) was associated with a lower likelihood of device change (Table 4).

Among male subjects, failure in preparing the device before use (OR 3.59, 95% CI 1.04–12.34, $P = .043$) was associated with an increased risk of changing the inhaler

Table 4. Logistic Regression Analysis for Factors Predicting Correct Inhaler Technique and Change of Inhaler Device

	Correct Inhaler Technique (Yes)											
	Total				Male Subjects				Female Subjects			
	B	SE	*P*	Odds Ratio (95% CI)	B	SE	*P*	Odds Ratio (95% CI)	B	SE	*P*	Odds Ratio (95% CI)
Age	−0.025	0.011	.03	0.98 (0.95–0.10)	−0.025	0.016	.11	0.98 (0.95–1.00)	−0.023	0.017	.16	0.98 (0.95–1.01)
Duration of inhaler therapy (high)	0.040	0.018	.03	1.04 (1.00–1.08)	0.032	0.028	.25	1.03 (0.98–1.09)	0.047	0.025	.056	1.05 (1.00–1.10)
Training on inhaler technique (yes)	2.531	0.530	< .001	12.56 (4.44–35.50)	2.549	0.744	.01	12.79 (2.97–55.02)	2.527	0.759	.01	12.51 (2.83–55.36)
Constant	−0.715	0.674	.28	0.49 (NA)	−0.611	0.991	.58	0.54 (NA)	−0.960	0.941	.30	0.38 (NA)
	Change of Inhaler Device (Yes)											
Age	−0.017	0.009	.067	0.98 (0.97–1.00)	−0.006	0.014	.67	0.99 (0.97–1.02)	−0.030	0.014	.033	0.97 (0.95–1.00)
Gender (female)	0.028	0.238	.91	1.03 (0.65–1.64)	NA	NA	NA	NA	NA	NA	NA	NA
Duration of disease (long)	0.079	0.035	.02	1.08 (1.01–1.16)	0.073	0.052	.17	1.06 (0.97–1.19)	0.083	0.049	.09	1.09 (0.99–1.20)
Duration of inhaler therapy (long)	0.027	0.040	.50	1.03 (0.95–1.11)	0.010	0.058	.86	1.01 (0.90–1.13)	0.052	0.060	.38	1.05 (0.94–1.19)
Training on inhaler technique (yes)	−0.783	0.268	.004	0.46 (0.27–0.77)	−0.965	0.407	.01	0.38 (0.17–0.85)	−0.686	0.384	.07	0.50 (0.24–1.07)
Failure in												
Understanding physicians' explanations	1.103	0.575	.055	3.01 (0.98–9.30)	0.480	1.146	.68	1.62 (0.17–15.28)	1.162	0.681	.09	3.20 (0.84–12.14)
Understanding the device brochure	−0.466	0.445	.30	0.63 (0.26–1.50)	−0.302	0.748	.69	0.74 (0.17–3.21)	−0.771	0.584	.19	0.46 (0.15–1.46)
Remembering to prepare the device	0.004	0.336	> .99	1.00 (0.52–1.94)	1.278	0.630	.043	3.59 (1.04–12.35)	−0.658	0.451	.14	0.52 (0.21–1.25)
Remembering to exhale before inhaling	0.176	0.268	.51	1.19 (0.71–2.02)	−0.123	0.372	.74	0.88 (0.43–1.83)	0.526	0.398	.19	1.69 (0.78–3.69)
Preventing vapor exit through the nostrils	0.879	0.342	.01	2.41 (1.23–4.71)	0.382	0.544	.48	1.45 (0.51–4.26)	1.206	0.461	.01	3.34 (1.35–8.25)
Constant	NA	NA	NA	NA	1.716	1.060	.10	5.57 (NA)	2.583	0.882	.003	13.23 (NA)

B stands for unstandardized regression weight.
SE = standard error
NA = not applicable

device, whereas the presence of training on inhaler therapy (OR 0.38, 95% CI 0.17–0.85, $P = .01$) was associated with a lower risk of device change (Table 4).

Among female subjects, failure in preventing the loss of aerosolized medicine through the mouth or nostrils (OR 3.34, 95% CI 1.35–8.25, $P = .01$) was associated with an increased risk of changing the inhaler device, whereas older age (OR 0.97, 95% CI 0.95–1.00, $P = .033$) was associated with a lower risk of device change (Table 4).

Discussion

Our findings in a cohort of subjects with COPD and asthma revealed a higher prevalence of subject-reported difficulties with using inhalers in female subjects than in male subjects, whereas technician-reported errors in inhaler technique were similarly high in both genders. A longer duration of inhaler therapy predicted a higher likelihood of correct inhaler technique, whereas a lack of training on inhaler technique predicted a higher likelihood of errors in inhaler technique and change of inhaler device. A change of the inhaler device was based on the physician's decision in most cases, followed by difficulties with inhaler use and failure to sense the drug.

pMDIs require good hand–lung coordination and are therefore considered to be inherently more difficult to use and are associated with a larger numbers of errors in inhaler technique compared to DPIs.[7-9,14-17] High rates for pMDI therapy in our cohort seem notable in this regard, given the high rates of poor inhaler performance, regardless of the gender. However, while suboptimal inhaler technique is more likely with the pMDI type of inhaler,[3,5,18-20] such technique is in fact considered to be very common with both pMDIs and DPIs, despite advances in inhaler device technology.[1-5]

Device handling for pMDIs and inhalation maneuvers for DPIs are considered to be the most common errors in inhaler technique.[13] Data from a large systematic review revealed a high frequency of poor and suboptimal inhaler use for all types of devices, with the highest average frequency of errors for pMDIs and high rates of errors in preparation, full expiration, and breath-hold maneuvers for DPIs.[5] Supporting the high frequency of incorrect inhaler use and the nature of the most common errors in inhaler technique reported in previous studies,[5] errors in inhalation maneuvers were common to all types of inhalers in our study, including pMDI and DPIs. This emphasizes the risk of insufficient drug delivery to the lungs and limited effectiveness of the medication.[3,4,21-24]

In our cohort, technician-reported rates of errors were higher than subject-reported rates in terms of inhalation maneuvers. Notably, whereas only 57% of female subjects and 41% of male subjects reported difficulty with remembering to exhale before inhaling and none reported difficulty with deep inhalation, a direct observation of the subjects' performance revealed the failure to exhale before inhaling in 80% of subjects and failure to deeply inhale in 50% of subjects, regardless of gender. This supports the consideration that patients overestimate the correctness of their inhaler technique with high levels of confidence, despite high rates of errors upon direct observation.[9]

Nonetheless, higher rates of self-reported difficulties by female subjects seem to emphasize the likelihood of better recognition of individual inhaler performance among female subjects or a lower self-confidence in their abilities. Low health literacy and low educational attainment are considered potential factors in poor inhaler technique, although not as barriers against responding well to interventions to improve the inhaler technique.[16,17] Hence, the higher rate of self-reported difficulties among the female subjects in our study may be related to the consideration of certain factors that challenge the individual inhaler performance by female subjects who otherwise believe they display a much better performance. For example, a higher rate of illiteracy in female subjects than in male subjects (38.4% vs 7.6%) in our cohort may be one of these factors, as well as the likelihood of limited time for self-care among female subjects, given that they are considered to be the primary individual responsible for child care and all household tasks in the Turkish culture. Our results emphasize a need for inhaler training beyond written materials for improving inhaler techniques among female patients in relation to the association of illiteracy with a limited ability to interpret written materials.[16]

In a past study on inhaler errors, although a self-rating score for inhaler use was reported to be associated with a higher likelihood of correct inhaler technique overall, the authors reported no significant difference in the self-rating scores of subjects with versus those without critical errors in inhaler technique.[10] Accordingly, our results emphasize the crucial role of training by health care professionals in improving inhaler technique, particularly for critical errors, which are likely to significantly impair the delivery of adequate medication to the lungs.[2,4,21,25-27] With a similar duration of inhaler therapy and similar rates of training on inhaler use between female subjects and male subjects, our results indicate that a longer duration of inhaler therapy predicts a higher likelihood of correct inhaler technique, and a lack of training on inhaler technique predicts a higher likelihood of errors in inhaler technique and change of inhaler device. In addition, our results support past studies showing a decline in correct inhaler technique with aging.[4,9,21,28-30]

The basics of effective inhaler training are considered to be simplification, demonstration, and repetition.[8,31] Subjects receiving repeated instructions over a period of time and regular follow-up[23,32-34] were reported to demonstrate improved performance of handling inhaler devices,

while a longer duration of therapy was associated with a proper inhaler technique.[35] However, inhaler technique is considered likely to deteriorate again after education, along with a steep increase in the number of errors among patients using devices for a longer duration.[8,23,36,37] This seems to emphasize a need for regular reassessment and intermittent checkups regarding inhalation techniques to prevent overconfidence of patients in their performance and to reinforce the correct inhalation technique.[8,23,36,37]

Along with a lack of previous training in almost 30% of our subjects, repeated evaluation of inhaler technique at follow-up visits was evident only in 30% of subjects. Accordingly, our findings support the critical importance of structured and detailed patient education on inhaler techniques,[38] as well as physician awareness regarding the close follow-up of patients with repeated evaluations of inhaler techniques and correction of suboptimal techniques with tailored in-depth support.[21,23,32]

The major strength of this study is the comparative assessment of inhaler techniques in a large-scale cohort of female and male subjects through a self-reported rating as well as through direct observation of subject performance across a large array of device types in accordance with real-life clinical practice conditions. However, certain limitations to this study should be considered. First, the cross-sectional design limits the interpretation of the findings and the ability to establish any cause and effect relationships. Second, a potential lack of generalizability due to the single-center design of the study is another important limitation. Third, the inhaler technique was assessed based on frequently used types of inhalers, and several types of infrequently used inhalers were not included in the analysis. Third, a lack of data on subject confounders (eg, cognitive status and vision or hearing capabilities) with a potential impact on inhaler technique is another limitation that would otherwise extend the results of our study. It should also be noted that although there are many pMDIs containing solution-form drug (eg, QVAR, Albesco, Flutiform) that do not require shaking before use; these pMDIs are not available in our country. In addition, loss through mouth/nostrils was noted in almost half of our subjects, which seems to be a very high error rate for a step that may be valid only for aerosolized medicine. Finally, while the data on the error of shaking the inhaler before use was presented only for Turbuhaler users in accordance with inclusion of only the top 10 errors in this analysis, it should be noted that the correctness of this maneuver is also required in other devices that have a "never shake" direction in the manufacturer instructions (eg, Diskus type inhalers).

Conclusions

Our results indicate that errors in inhaler technique, including inhalation maneuvers and device handling, are common in subjects with COPD and asthma, as are high rates of change of the inhaler device and low rates of both previous training on inhaler therapy and repeated evaluations of inhaler techniques. Subject-reported difficulties with using inhalers were more prevalent among female subjects than male subjects, whereas errors in inhaler technique identified via direct observation of the subjects' performance were similarly high in both genders. Overall, a lack of training on inhaler technique predicted a higher likelihood of errors in inhaler technique and of a change of inhaler device. Our results highlight a high rate of inhaler technique errors in both genders and emphasize the role of close patient follow-up with repeated evaluations and reinforcement of the correct inhalation technique, as well as tailored in-depth support for better treatment outcomes.

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