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Original Research

Evaluation of the Association between Inhaler technique and Adherence in Asthma Control: Cross-Sectional Comparative Analysis Study between Amman and Baghdad

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Abstract

Purpose: Asthma is a chronic condition affecting millions of people all around the world. Asthma has no cure, but disease control is essential and highly recommended. However, the available tools for asthma control assessment don't include factors such as inhaler technique and adherence. This study aimed to assess the correlation between inhaler techniques, adherence, and level of asthma control in two different healthcare settings; Jordan and Iraq. **Patients and methods:** A cross-sectional observational study was con-ducted over six months, from January to August 2018, in two public hospitals in Amman (Jordan) and Baghdad (Iraq). Asthmatic patients were interviewed to assess their inhaler technique, adherence, and asthma control. The researcher personally visited both public hospitals, conducting face-to-face interviews with patients at the hospital outpatient clinics. Validated questionnaires were used for patient assessment, including demographics, asthma history and medication use, the patient's inhaler technique, adherence, and asthma control. **Results:** A total of 300 patients entered the study, with a mean age of 45.54 ± 13.71. The asthma control test showed very poor asthma control for patients living in both countries (Amman n=78 (52.0%) vs. Baghdad n=106 (70.0%)). An asthma knowledge assessment showed that most asthmatic patients in both countries didn't follow their asthma medication plan (Amman n=78 (52.0%) vs. Baghdad n=93 (62.0%). **Conclusion:** In both Jordan and Iraq, asthma patients were found to be poorly controlled. Knowledge of patients was inadequate, probably leading to the poorly managed chronic disease. The results of this study highlight the significance of the pharmacist's role in recognizing asthmatic patients requiring assistance. Furthermore, they underscore the pharmacist's pivotal contribution to delivering patient education and counseling, ultimately resulting in enhanced asthma control.

Keywords: asthma; inhaler technique; adherence; control; Middle East

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INTRODUCTION

Asthma is one of the most common chronic, non-transmitted diseases. It affects around 334 million people worldwide.[1] In 2017, the overall asthma prevalence in the United States was 7.9%, with rates higher in children (8.4%) compared to adults (7.7%).[2] There is a wide variation between countries worldwide; the prevalence seems to be higher in developed countries such as Australia (21.0%) and lower in developing countries like China (0.2%).[1] The diagnosis of asthma primarily relies on a comprehensive evaluation of the patient's medical history and a thorough physical examination. The classic and most common asthma symptoms are shortness of breath, cough, and wheezing.[3] These symptoms can be triggered by respiratory viruses, emotional stress, cold weather, allergens, exercise, or even without any trigger.[4,5] The avoidance of triggers is the first step in asthma management. Unfortunately, this is inadequate, and pharmacological therapy is required.[6]

Primary treatment of asthma includes inhaled short-acting beta-agonists (SABA), inhaled or systemic corticosteroids, anticholinergics, long-acting beta-agonists (LABA), and in some cases, oxygen.[3,7] Although the number of people suffering from this chronic disease has increased, the introduction of inhaled corticosteroids (ICSs) in conjunction with the SABA and LABA bronchodilators has led to a notable decrease in death rates among these patients. It has also improved asthma control and reduced the frequency of exacerbations.[8,9] Treatment is initiated based on the severity of symptoms, physical

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examination findings, and, for some patients, the forced expiratory volume in the first second of expiration (FEV_1) or peak expiratory flow rates.[6] Asthma exacerbation is the major cause of disease morbidity; it also increases healthcare costs and may affect the normal function of the lungs.[10] A recent study in Jordan reported poor knowledge and readiness to deal with asthmatic patients.[11]

Pharmacists can have a valuable role in educating patients on correct inhaler technique leading to improved asthma management.[12] Patients can benefit from the role of the pharmacist considering the barriers found in attending primary health-care facilities in the different healthcare systems.[13-15] In this study, we aimed to assess the association between inhaler techniques, adherence to medications, and the level of asthma control by pharmacists in the healthcare settings of Jordan and Iraq.

MATERIALS AND METHODS

Study design and inclusion criteria

This prospective, cross-sectional study was conducted over six months, from February to August 2018, in the two capitals; Amman (the capital of Jordan) and Baghdad (the capital of Iraq), involving asthma patients residing in these cities. Ethics approval was obtained from the Ethics Committee of the Faculty of Pharmacy at the Applied Sciences Private University, the Jordanian Ministry of Health (Amman, Jordan), and the Al Zahra Center for Allergy and Asthma in Iraq and Baghdad.

Asthma patients were identified by the general practitioners (GPs) in hospitals in these two cities. Patients were asked if they would agree to participate in the study after brief explanation of its content. Patients who agreed to participate signed a written informed consent; their participation was entirely voluntary, and they were assured that their involvement would not affect their care at the institute of health in any way. The participants' privacy was protected by providing a code number for each participant in the data collection and analysis phases. Patients' study information groups were only known to the researcher (a clinical pharmacist) and their physicians. Patients diagnosed with asthma, who lived only in the capitals of both countries, and met all of the following inclusion criteria were recruited: age of patients ≥18 years, patients living in the capital of both countries only, patients who have had an asthma diagnosis for at least one year, and patients who have been on the same medication and dosage for at least a month before study inclusion. The exclusion criteria for the study included patients who did not self-administer their inhaled medication(s), those who did not speak or understand Arabic, and those who were involved in another clinical study.

A convenience sample was decidedly recruited from both Amman and Iraq during the predetermined study period. Based on previous findings of similar studies, this study used a sample size of 300 patients, 150 from each country.

Data collection

The method(s) and tools used to collect the data and by whom (pharmacist or patient) are summarized in Table 1. Data were collected, including demographics, asthma history, medication use, and past inhaler technique education, and the inhaler technique scores as assessed by the researcher pharmacist.

Table 1. Data collected during the study

Data collected	By whom	Methods/Tools
Demographics	Pharmacist	Interview
Patients history	pharmacist	Interview
Asthma control test	patients	Asthma control form
Adult asthma adherence	patients	Asthma adherence form
Patient asthma medical use	pharmacist	Interview
Inhaler technique score (for TH, ACC, and pMDI)	pharmacist	Interview
Spirometry test (FEV_1%)	pharmacist	Spirometer

According to the type of inhaler each patient had been using before study entry, the patient's inhaler technique was assessed by the researcher (a clinical pharmacist who is an expert in asthma management and inhaler technique education). The assessments were performed using placebo inhalers provided by AstraZeneca Pharmaceuticals (Wilmington, Delaware; Amman, Jordan) and GlaxoSmithKline (Philadelphia, Pennsylvania; Amman, Jordan), and standardized inhaler technique checklists translated into Arabic.[16,17]

Each checklist consisted of nine steps (potential scores 0–9). A score of 9/9 was classified as a correct technique for the Turbuhaler (TH); four steps were classified as "essential" (without which little or no medication would reach the airway), and for the Accuhaler (ACC, [Diskus]) and the pressurized metered-dose inhaler (pMDI), three steps were classified as essential. These checklists and essential steps follow the literature.[18-20]

Patients received verbal instruction and a physical demonstration using TH, ACC, and MDI placebo inhalers. The researcher then assessed patients' inhaler technique and used a specialized "Show and Tell" technique counseling service to optimize the inhaler technique.[21] The researcher reviewed each step on the device-specific checklist with the patient in Arabic to describe and demonstrate correct use, then recheck the patient's technique. This cycle of assessment and counseling was repeated up to three times, if necessary, until the patient demonstrated correct technique on all steps (score 9/9). The Accuhaler Technique Checklist, TH Technique Checklist, and MDI Technique Checklist are presented in Table 2.

Spirometry was performed using a spirometer (Spirolab; Medical International Research, Italy) with a disposable turbine. The patient's lung function, specifically the forced expiratory volume in one second, was measured and reported as a percentage (FEV1%). Patients were requested to perform three satisfactory blows to ensure that the documented forced expiratory volumes were "the patient's best." Patients used disposable mouthpieces.

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Table 2. Technique Checklist for the study inhaler types, Accuhaler, Turbuhaler, and Metered Dose Inhaler (MDI)

Step	Accuhaler [ACC, Diskus]	Turbuhaler (TH)	Metered dose inhaler (MDI)
1.	Open the inhaler*	Remove the cap from the inhaler*	Remove the mouthpiece cover and shake*
2.	Push the lever back completely*	Keep the inhaler upright*	Hold the inhaler upright
3.	Exhale to residual volume	Rotate grip until a click is heard*	Exhale to residual volume
4.	Exhale away from the mouthpiece	Exhale to residual volume	Keep head upright or slightly tilted
5.	Place the mouthpiece between teeth and lips	Exhale away from mouthpiece	Place mouthpiece between teeth and lips
6.	Inhale forcefully and deeply*	Place mouthpiece between teeth and lips	Inhale slowly and press the canister*
7.	Hold breath for 5 seconds	Inhale forcefully and deeply*	Continue slow and deep inhalation*
8.	Exhale away from mouthpiece	Hold breath for 5 seconds†	Hold breath for 5 seconds
9.	Close inhaler	Exhale away from mouthpiece	Close the inhaler

* Essential step: if not performed correctly, little or no medication will reach the lung.
† Considered essential by van der Palen and colleagues.[20]
‡ This step is not included in the product insert but appears in the Turbuhaler instructions on the Global Initiative for Asthma Web site[22] and the checklist from van der Palen and colleagues.[20]

A specific adherence questionnaire was completed by the patients to assess their adherence to their asthma medications. It consists of 5 questions with 6 choices ranging from "agree completely" (given 1 mark when chosen by the patient) to "disagree completely" (given 6 marks when chosen by the patient).[23] Each question is marked separately. Patients who got 3 or less for questions 1, 3, and 4 indicated that they had a problem with their adherence. Question 2 required a score of 4 or less to indicate a lack of adherence. As for the question, "I follow an asthma management plan," a score of 1 or more indicated a lack of adherence.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Science (SPSS) version 24 (IBM Corporation, Armonk, NY, USA). The primary outcome variables included inhaler technique score, FEV_1%, and adherence. These variables were assessed and tabulated for all patients. Differences with $p<0.05$ were considered statistically significant. The chi-square test was used to compare the two countries regarding categorical data**.** An independent t-test was used to compare the continuous variables between both countries. Categorical data were represented as a number (percentage), and continuous data were expressed as mean ± standard deviation (SD) unless otherwise stated.

RESULTS

Study flow

A total of 300 participants visiting hospitals in Jordan (n= 150) and Iraq (n= 150) were approached and enrolled in this study once they were found to meet the inclusion criteria. The response rate for the study was 100% [(300/300) * 100]. Eligible total patients from the two countries (n = 276) were recruited: 139 patients from Baghdad (2 patients did not answer all adherence questions, and 9 patients could not do a spirometry test), and 137 patients from Amman (13 patients could not do a spirometry test).

Descriptive of the sociodemographic characteristic of the sample

Patients' sociodemographic characteristics from the two cities were compared, and statistically significant differences found between them were reported in Table 3. Consequently, the patients' data from the two cities were analyzed as two populations. The mean ± SD age of the study sample was 45.54 ± 13.71. Asthmatic females were 116 (77.3%), and 92 (61.3%) in Amman and Baghdad, respectively. The percentage of married people was lower in Amman (71.3%) compared to Baghdad (83.3%).

In Amman, more than half of the participants (n=85, 54.7%) reported having completed secondary school, 24 (16.0%)

Table 3**.** Demographic characteristics of the study subjects (N=300)

	Amman, n=150 (50%)	Baghdad, n=150 (50%)	**Total** (N = 300)	P-value
Gender, n (%)				
Male	34 (22.7)	58 (38.7)	92 (30.7)	0.003
Female	116 (77.3)	92 (61.3)	208 (69.3)	
Age, mean ±SD	48.29±13.54	42.80±13.36	45.54±13.71	<0.001
Education level, n (%)				
Elementary	17 (11.3)	48 (32.0)	65 (21.7)	<0.001
Secondary school	82 (54.7)	56 (37.3)	138 (46.0)	
Diploma	24 (16.0)	16 (10.7)	40 (13.3)	
Bachelor	20 (13.3)	27 (18.0)	47 (15.7)	
Post-graduated	7 (4.7)	3 (2.0)	10 (3.3)	

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Do you work? n (%)				
Yes	40 (26.7)	61 (40.7)	101 (33.7)	
No	93 (62.0)	76 (50.7)	169 (56.3)	0.037
Retired	17 (11.3)	13 (8.7)	30 (10.0)	
Income USD, mean ±SD	675.79±593.575	650.84±293.188	662.88±462.531	<0.001
Smoking, n (%)				
Yes	16 (10.7)	12 (8.0)	28 (9.3)	
No	118 (78.7)	124 (82.7)	242 (80.7)	0.653
Former smoker	16 (10.7)	14 (9.3)	30 (10.0)	
Health education? n (%)				
Yes	27 (18.0)	2 (1.3)	29 (9.7)	<0.001
FEV_1				
	Amman, n=137	**Baghdad, n=139**	**Total (N = 276)**	
Normal (≥80%)	62 (45.5%)	39 (28.1%)	101 (36.6%)	
Mildly abnormal (70%-79%)	16 (11.7%)	22 (15.8%)	38 (13.8%)	
Moderately abnormal (60%-69%)	20 (14.6%)	23 (16.5%)	43 (15.6%)	
Moderate to severe abnormal (50%-59%)	19 (13.9%)	19 (13.7%)	38 (13.8%)	**0.030**
Severely abnormal (35%-49%)	15 (10.9%)	21 (15.1%)	36 (13.0%)	
Very severely abnormal (>35%)	5 (3.6%)	15 (10.8%)	20 (7.2%)	
FVC				
Normal (80%-120%)	74 (54.0%)	64 (46.0%)	138 (50.0%)	0.185
Abnormal > 80%	63 (46.0%)	75 (54.0%)	138 (50.0%)	

held diplomas, and 20 (13.3%) possessed bachelor's degrees. In contrast, in Baghdad, less than half of the patients (n=56, 37.3%) had completed secondary school, 16 (10.7%) held diplomas, and 27 (18.0%) possessed bachelor's degrees. These educational differences between the two cities were found to be statistically significant (P-value <0.001). There were no statistically significant differences between the Amman and Baghdad groups regarding smoking status (p-value=0.653). Most of the study participants were not working (Amman n= 93 (62.0%) and Baghdad n =76 (50.7%).

Inhaler techniques and lung function

Most asthmatic patients in Amman used the ACC device; 58/136 (42.6%) and the THdevice; 73/136 (53.7%), while asthmatic patients in Baghdad mostly used the MDI; 113/131 (86.3%). Results showed good inhaler technique in the essential steps, with a mean of 2.91 ± 0.282 out of 3 (Amman) and 2.83± 0.408 out of 3 (Baghdad) in both countries, P value =0.242 (Table 4). The TH device was predominantly utilized in Amman, with patients demonstrating a good inhalation technique for essential steps (mean=3.40 ± 0.736), in contrast to asthmatic patients in Baghdad (mean=3.00 ± 0.338). This difference was found to be statistically significant with a P-value <0.001. (Table 5).

Most inhaler devices used in Baghdad were the MDI and all asthmatic patients had optimal inhalation technique (mean= 3.00 **±** 0.000); in contrast, in Amman, MDI users had good inhalation technique (mean=2.82**±** 0.587) out of 3; P-Value <0.001 (Table 6).

More than one-third of asthmatic patients (36.6%) had normal values of FEV_1 ≥ 80%, while 15.6% of asthmatic patients had a moderately abnormal obstruction in their lungs. Fewer asthmatic patients (7.2%) (P-Value=0.030) had very severe abnormal lung obstruction >35% (Table 3). In Amman, the asthmatic patients with normal lung function (45.3%) were more than in Baghdad (28.1%) p value?. In addition, fewer very severe abnormal lung obstruction cases were >35% of asthmatic patients in Amman than in Baghdad (Table 3).

There was a significant association between asthma control and FEV_1 >0.005 (Table 7). The normal lung function (≥ 80%) of well-controlled asthmatic patients in Amman (75.0%) was higher than that in Baghdad (46.2%). In Baghdad, 25.3% (P-Value=0.476) had very poorly controlled asthma but normal lung function ≥80%; in addition to that, 18.2% (P-Value=0.476) had poorly controlled asthma and moderately decreased lung function (60%–69%) (Table 7).

Regarding the outcomes, 50.0% of asthmatic patients had normal FVC, while 50% had abnormal FVC; In Amman, 68.7% of asthmatic patients had very poorly controlled asthma and abnormal lung function (FVC>80%), while 86.4% of them had well-controlled asthma and normal lung function (FVC 80%–120%); P-Value <0.001. In Baghdad, 36.4% of patients had very poorly controlled asthma with normal lung function (80%–120%), while 63.6% of them had very poorly controlled asthma and abnormal lung function (FVC>80%); P-Value=0.002 (Table 3).

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Table 4. Inhalation technique level and essential steps for Accuhaler (ACC, n = 64)

	Amman (n=58)	**Baghdad (n=**6)	**Total** (N = 64)	**P-Value**
Inhaler technique level				
Good Inhalation	52 (89.7%)	5 (83.3%)	57 (89.1%)	0.637
Poor Inhalation	6 (10.3%)	1 (16.7%)	7 (10.9%)	
mean ± (SD)	1 (± 0.10)	0.17 (0.408)	0.11 (± 0.315)	
Essential steps				
Step 1				
Incorrect	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.520
Correct	58 (100.0%)	6 (100.0%)	64 (100.0%)	
Step 2				
Incorrect	4 (6.9%)	1 (16.7%)	5 (7.8%)	
Correct	54 (93.1%)	5 (83.3%)	59 (92.2%)	
Step 6				
Incorrect	1 (1.7%)	0 (0.0%)	1 (1.6%)	
Correct	57 (98.3%)	6 (100.0%)	63 (98.4%)	
Mean ± (SD)	2.91 ± 0.282	2.83± 0.408	2.91 ± 0.295	0.242
Inhaler technique steps				
1. Open the inhaler				
Yes	58 (100.0)	6 (100.0)	64 (100.0)	-
No	0 (0.0)	0 (0.0)	0 (0.0)	
2. Push lever back completely				
Yes	53 (91.4)	5 (83.3)	58 (90.6)	0.520
No	5 (8.6)	1 (6.7)	6 (9.4)	
3. Exhale to residual volume				
Yes	11 (19.0)	0 (0.0)	11 (17.2)	0.241
No	47 (81.0)	6 (100.0)	53 (82.2)	
4. Exhale away from the mouthpiece				
Yes	12 (8.0)	0 (0.0)	12 (18.8)	0.216
No	46 (79.3)	6 (100.0)	52 (81.3)	
5. Mouthpiece between teeth and lips				
Yes	57 (98.3)	6 (100.0)	63 (98.4)	0.746
No	1 (1.7)	0 (0.0)	1 (1.6)	
6. Inhale forcefully and deeply				
Yes	57 (98.3)	6 (100.0)	63 (98.4)	0.746
No	1 (1.7)	0 (0.0)	1 (1.6)	
7. Hold the breath for 5 seconds				
Yes	56 (96.6)	5 (83.3)	61 (95.3)	0.145
No	2 (1.3)	1 (16.7)	3 (4.7)	
8. Exhale away from the mouthpiece				
Yes	9 (15.5)	0 (0.0)	9 (14.1)	0.298
No	49 (84.5)	6 (100.0)	55 (85.9)	
9. Close the inhaler				
Yes	58 (100.0)	6 (100.0)	64 (100.0)	-
No	0 (0.0)	0 (0.0)	0 (0.0)	
Mean ± SD	6.31±1.314	5.67±0.816	6.25±1.285	0.377

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Table 5. Inhalation technique level and essential steps for Turbuhaler (TH, n = 109)

	Amman (n=73)	Baghdad (n=36)	Total=109	P-Value
Inhaler technique level				
Good Inhalation	38 (52.1%)	2 (5.6%)	40 (36.7%)	<0.001
Poor Inhalation	35 (47.9%)	34 (94.4%)	69 (63.3%)	
mean ± SD	1± 0.48	0.94±0.232	0.63± 0.210	
Essential steps				
Step 1				
Incorrect	0 (0.0%)	0 (0.0%)	0 (0.0%)	<0.001
Correct	7 3 (100.0%)	36 (100.0%)	109 (100.0%)	
Step 2				
Incorrect	31 (42.5%)	34 (94.4%)	65 (59.6%)	
Correct	42 (57.5)	2 (5.6%)	44 (40.0%)	
Step 3				
Incorrect	6 (8.2%)	1 (2.8%)	7 (6.4%)	
Correct	67 (91.8%)	35 (97.2%)	102 (93.6%)	
Step 7				
Incorrect	8 (11.0%)	1 (2.8%)	9 (8.3%)	
Correct	65 (43.3%)	35 (97.2%)	100 (91.7%)	
Mean ± SD	3.40 ± 0.736	3.00 ± 0.338	3.26± 0.654	<0.001
Inhaler technique steps				
1- Remove the cap from the inhaler				
Yes	73 (100.0)	36 (100.0)	109 (100.0)	-
No	0 (0.0)	0 (0.0)	(0.0)	
2- Keep inhaler upright				
Yes	42 (57.5)	2 (5.6)	44 (40.4)	<0.001
No	31 (42.5)	34 (94.4)	65 (59.6)	
3- Rotate grip anti-clockwise then back until a click is heard				
Yes	67 (91.8)	35 (97.2)	102 (93.6)	0.276
No	(8.2)	1 (2.8)	7 (6.4)	
4- Exhale to residual volume				
Yes	16 (21.9)	3 (8.3)	19 (17.4)	0.079
No	57 (78.1)	33 (91.7)	82.6)	
5- Exhale away from the mouthpiece				
Yes	21 (28.8)	3 (8.3)	24 (22.0)	0.015
No	52 (71.2)	33 (91.7)	78.0)	
6- Place mouthpiece between teeth and lips				
Yes	68 (93.2)	35 (97.2)	103 (94.5)	0.381
No	5 (6.8)	1 (2.8)	(5.5)	
7- Inhale forcefully and deeply				
Yes	65 (89.0)	35 (97.2)	100 (91.7)	0.144
No	8 (11.0)	1 (2.8)	9 (8.3)	
8- Hold breath for 5 seconds				
Yes	59 (80.8)	35 (97.2)	94 (86.2)	0.019
No	14 (19.2)	1 (2.8)	15 (13.8)	
9- Exhale away from the mouthpiece				
Yes	16 (21.9)	4 (11.1)	20 (18.3)	
No	57 (78.1)	32 (88.9)	89 (81.7)	0.170

Table 6. Inhalation technique level and essential steps for the Meter dose inhaler (MDI, n = 215)

	Amman (n=73)	Baghdad (n=36)	Total=109	P-Value
Inhaler technique level				
Good Inhalation	94 (90.4%)	113 (100.0%)	207 (95.4%)	0.001
Poor Inhalation	10 (9.6%)	0 (0.0%)	10 (4.6%)	
Mean ± (SD)	1 (± 0.10)	0.00 (0.0)	0.05 (± 0.210)	
Essential steps				
Step 1				
Incorrect	2 (1.9%)	0 (0.0%)	2 (0.9%)	**<0.001**
Correct	102 (98.1%)	113 (75.3%)	215 (99.1%)	
Step 6				
Incorrect	7 (6.7%)	0 (0.0%)	7 (3.2%)	
Correct	97 (93.3%)	113 (75.3%)	210 (96.8%)	
Step 7				
Incorrect	10 (4.6%)	0 (0.0%)	10 (4.6%)	
Correct	94 (91.4%)	113 (75.3%)	207 (95.4%)	
Mean ± SD	2.82± 0.587	3.00 ± 0.000	2.91± 0.416	
Inhaler technique steps				
1. Remove the mouthpiece cover and shake				
Yes	102 (98.1)	113 (100.0)	215 (99.1)	0.139
No	2 (1.9)	0 (0.0)	2 (0.9)	
2. Hold the inhaler upright				
Yes	43 (41.3)	5 (4.4)	48 (22.1)	<0.001
No	61 (58.7)	108 (95.6)	169 (77.9)	
3. Exhale to residual volume				
Yes	18 (17.3)	5 (4.4)	23 (10.6)	0.002
No	86 (82.7)	108 (95.6)	194 (89.4)	
4. Keep head upright or slightly tilted				
Yes	75 (72.1)	112 (99.1)	147 (86.2)	<0.001
No	29 (27.9)	1 (0.9)	30 (13.8)	
5. Place the mouthpiece between teeth and lips				
Yes	102 (98.1)	113 (100.0)	215 (99.1)	0.139
No	2 (1.9)	0 (0.0)	2 (0.9)	
6. Inhale slowly and press the canister				
Yes	97 (93.3)	113 (100.0)	210 (96.8)	0.005
No	7 (6.7)	0 (0.0)	7 (3.2)	
7. Continue slow and deep inhalation				
Yes	94 (90.4)	113 (100.0)	207 (95.4)	0.001
No	10 (9.6)	0 (0.0)	10 (4.6)	
8. Hold breath for 5 seconds				
Yes	86 (82.7)	113 (100.0)	199 (91.7)	<0.001

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No	18 (17.3)	0 (0.0)	18 (8.3)	
9. Close inhaler				
Yes	101 (97.1)	113 (100.0)	214 (98.6)	0.069
No	3 (2.9)	0 (0.0)	3 (1.4)	

Asthma adherence

Table 8 showed that few asthma patients in Amman (30.0%) followed their action plan correctly, which was significantly higher than that found inBaghdad (12.0%) p= . Many barriers were identified that prevented patients from adhering to their medications. Most patients in Baghdad (82.1%) forgot at least one dose of steroids, which was higher than that for asthma patients in Amman (58.7%); P-Value <0.001. Another barrier reported by asthma patients in Baghdad (50.0%) is that many suffer side effects from the treatment. Unfortunately, almost all asthmatic patients in Amman could not afford the cost of their medication (86.6%); the situation in Baghdad was better, as only 52.7% of the patients could not afford the cost of their medication, P-Value <0.001 (Table 8).

Table 7. Associations revealed between asthma control and FEV_1 for study subjects (n=276)

Parameters N(%)	Well-controlled asthma	Not-well controlled asthma	Very poorly-controlled asthma	P-Value
Amman = 137 patients				
Normal (≥80%)	33 (75.0%)	12 (46.2%)	17 (25.4%)	xxx
Mildly abnormal (70%-79%)	3 (6.8%)	2 (7.7%)	11 (16.4%)	
Moderately abnormal (60%-69%)	3 (6.8%)	4 (15.4%)	13 (19.4%)	
Moderate to severely abnormal (50%-59%)	1 (2.3%)	4 (15.4%)	14 (20.9%)	
Severely abnormal (35%-49%)	3 (6.8%)	4 (15.4%)	8 (11.9%)	
Very severely abnormal (>35%)	1 (2.3%)	0 (0.0%)	4 (6.0%)	
Baghdad = 139 patients				
Normal (≥80%)	6 (46.2%)	8 (29.6%)	25 (25.3%)	0.476
Mildly abnormal (70%-79%)	4 (30.8%)	5 (18.5%)	13 (13.1%)	
Moderately abnormal (60%-69%)	1 (7.7%)	4 (14.8%)	18 (18.2%)	
Moderate to severely abnormal (50%-59%)	1 (7.7%)	5 (18.5%)	13 (13.1%)	
Severely abnormal (35%-49%)	1 (7.7%)	2 (7.4%)	18 (18.2%)	
Very severely abnormal (>35%)	0 (0.0%)	3 (11.1%)	12 (12.1%)	

Table 8. Participants' answers to the asthma adherence questions (n=300), comparing results between Amman and Baghdad

Questions	Amman=150	Baghdad=150	Total	P-Value
1. I follow my asthma medication plan				
a. I agree completely	45 (30.0%)	18 (12.0%)	63 (21.0%)	0.001
b. I agree mostly	6 (4.0%)	3 (2.0%)	9 (3.0%)	
c. I agree somewhat	20 (13.3%)	35 (23.3%)	55 (18.3%)	
d. I disagree somewhat	0 (0.0%)	0 (0.0%)	0 (0.0%)	
e. I disagree mostly	1 (0.7%)	1 (0.7%)	2 (0.7%)	
f .I disagree completely	78 (52.0%)	93 (62.0%)	171 (57.0%)	
Score =1	45 (30.0%)	18 (12.0%)	63 (21.0%)	<0.001
Score<1[1]	105 (70.0%)	132 (88.0%)	237 (79.0%)	
Mean ± (SD)	3.93± 2.260	4.61 ± 1.878	4.2 ± 2.102	<0.001
2. I forget to take at least one dose of my inhaled steroid each day				
a. I agree completely	42 (28.0%)	88 (62.9%)	130 (44.8%)	<0.001
b. I agree mostly	10 (6.7%)	11 (7.9%)	21 (7.2%)	
c. I agree somewhat	36 (24.0%)	16 (11.4%)	52 (17.9%)	
d. I disagree somewhat	0 (0.0%)	0 (0.0%)	0 (0.0%)	
e. I disagree mostly	0 (0.0%)	0 (0.0%)	0 (0.0%)	
f. I disagree completely	62 (41.3%)	25 (17.9%)	87 (30.0%)	
Score ≤3[2]	88 (58.7%)	115 (82.1%)	203 (70.0%)	<0.001
Score >3	62 (41.3%)	25 (17.9%)	87 (30.0%)	
Mean ± (SD)	3.61± 2.136	2.20 ± 1.894	2.93 ± 2.139	<0.001
3. My asthma is mild and does not require regular preventative treatment				
a. I agree completely	29 (19.3%)	11 (7.3%)	40 (13.3%)	<0.001
b. I agree mostly	2 (1.3%)	3 (2.0%)	5 (1.7%)	
c. I agree somewhat	5 (3.3%)	37 (24.7%)	42 (14.0%)	
d. I disagree somewhat	1 (0.7%)	4 (2.7%)	5 (1.7%)	
e. I disagree mostly	1 (0.7%)	1 (0.7%)	2 (0.7%)	
f. I disagree completely	112 (74.7%)	94 (62.7%)	206 (68.7%)	
Score≤4[2]	114 (76.0%)	99 (34.0%)	213 (71.0%)	0.051
Score>4	36 (24.0%)	51 (34.0%)	87 (29.0%)	
Mean ± (SD)	4.86± 2.027	4.75 ± 1.718	4.81± 1.876	0.057
4. My inhaled steroid causes side effects				

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a. I agree completely	54 (36.0%)	33 (23.2%)	87 (29.8%)	0.022
b. I agree mostly	5 (3.3%)	10 (7.0%)	15 (5.1%)	
c. I agree somewhat	27 (18.0%)	28 (19.7%)	55 (18.8%)	
d. I disagree somewhat	4 (2.7%)	0 (0.0%)	4 (1.4%)	
e. I disagree mostly	0 (0.0%)	0 (0.0%)	0 (0.0%)	
f. I disagree completely	60 (40.0%)	71 (50.0)	131 (44.9%)	
Score≤3[2]	86 (57.3%)	71 (50%)	157 (53.7%)	0.263
Score>3	64 (42.7%)	71 (50.0%)	135 (46.2%)	
Mean ± (SD)	3.47 ± 2.216	3.96 ± 2.145	3.71± 2.192	0.211
5. I can't afford my inhaled steroid medication				
a. I agree completely	124 (82.7%)	25 (16.7%)	149 (49.7%)	<0.001
b. I agree mostly	1 (0.7%)	7 (4.7%)	8 (2.7%)	
c. I agree somewhat	5 (3.3%)	39 (26.0%)	44 (14.7%)	
d. I disagree somewhat	1 (0.7%)	2 (1.3%)	3 (1.0%)	
e. I disagree mostly	5 (3.3%)	10 (6.7%)	15 (5.0%)	
f. I disagree completely	14 (9.3%)	67 (44.7%)	81 (27.0%)	
Score≤3[2]	130 (86.6%)	79 (52.7%)	201 (67%)	<0.001
Score>3	20 (13.3%)	71 (47.3%)	99 (33.0%)	
Mean ± (SD)	1.69 ± 1.613	4.11 ± 1.953	2.90 ± 2.158	<0.001

1=Suggest possible adherence problem
2=Indicated probable specific barriers

Table 9 shows the association between asthma control and patient compliance with their action plan. Generally, most patients (85.9%) did not follow their action plan and had poor asthma control, while only 41.4% of them followed an action plan and had well-controlled asthma (P-Value <0.001. In Amman, the situation was better, as only 40.0% of patients followed an action plan and had well-controlled asthma, while 78.2% did not follow their action plan and had poorly controlled asthma. Prospectively, in Baghdad, the situation of asthmatics was the worst; only 46.2% of them had well-controlled asthma and followed their action plan, while 91.5% did not follow their action plan and had poorly controlled asthma, P-Value <0.001.

Another barrier that affected adherence to the medications and was associated with asthma control was the side effects of inhaler devices (Table 10). In Amman, 64.1% of asthmatic patients had poorly controlled asthma, and their inhalers caused side effects, while only 51.1% had well-controlled asthma and their inhalers did not cause them side effects; P-Value=0.212. In Baghdad, the situation was also not ideal in that 53.5% of the asthmatic patients had very poor asthma control, and their inhalers caused side effects. In comparison, only 66.7% had well-controlled asthma, with P-Value=0.345 (Table 10).

Table 11 shows the role of the pharmacist in both cities.

Table 9. The associations found between patients' asthma control and their stated follow up to their action plan (n= 300), comparing putcomes for patients living in Amman and Baghdad

Parameters	**Amman**		
	Follow their action plan	**Not following their action plan**	**P-Value**
Well-asthma controlled	18 (40.0%)	27 (60.0%)	0.071
Not-well asthma controlled	10 (37.0%)	17 (63.0%)	
Very-poorly asthma controlled	17 (21.8%)	61 (78.2%)	
Parameters	Baghdad		
	Follow their action plan	Not following their action plan	P-Value
Well-asthma controlled	6 (46.2%)	7 (53.8%)	0.000*
Not-asthma controlled	3 (9.7%)	28 (90.3%)	
Very-poorly asthma controlled	9 (8.5%)	97 (91.5%)	
Parameters	Total		
	Follow their action plan	Not follow their action plan	P-Value
Well-asthma controlled	24 (41.4%)	34 (58.6%)	0.000*
Not-well asthma controlled	13 (22.4%)	45 (77.6%)	
Very-poorly asthma controlled	26 (14.1%)	158 (85.9%)	

Table 10. Assessing the associations between patients' reported asthma control and side effects of their inhaler devices for both Amman and Baghdad

Parameters	**Amman**		
	Inhalers cause side effects	**Not-Inhalers cause side effects**	**P-Value**
Well-asthma controlled	22 (48.9)	23 (51.1%)	0.212*
Not-well asthma controlled	14 (51.9%)	13 (48.1%)	
Very-poorly asthma controlled	50 (64.1%)	28 (35.9%)	
Parameters	Baghdad		
	Inhalers cause side effects	Not- Inhalers causes side effects	P-Value
Well-asthma controlled	4 (33.3%)	8 (66.7%)	0.345*
Not-asthma controlled	13 (44.8%)	16 (55.2%)	
Very-poorly asthma controlled	54 (53.5%)	47 (46.5%)	
Parameters	Total		
	Inhalers causes side effects	Not- Inhalers causes side effects	P-Value

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Well-asthma controlled	26 (45.6%)	31 (54.4%)	0.168*
Not-well asthma controlled	27 (48.2%)	29 (51.8%)	
Very-poorly asthma controlled	104 (58.1%)	75 (41.9%)	

Table 11. Assessing the role of the pharmacist according to the study participants (n=300) with regards to their role in managing their asthma

Questions asked	Amman (N=150)	Baghdad (N=150)	Total	p-Value
1) Have you ever been provided with information or advice about how to use your inhaler by any of the following?				<0.001
Your regular physician	135 (90.0%)	69 (46.0%)	204 (68.0)	
Pharmacist	4 (2.7%)	10 (6.7%)	14 (4.7)	
Medical Center	7 (4.7%)	43 (28.7%)	50 (16.7)	
Specialist	0 (0.0%)	27 (18.0%)	27 (9.0)	
Hospital Clinic	3 (2.0%)	0 (0.0%)	3 (0.7)	
Package leaflet	1 (0.7%)	1 (0.7%)	2 (0.7)	
Others	0 (0.0%)	0 (0.0%)	0 (0.0%)	
2) What was the method of the advice or information?				
Verbal (spoken) information	14 (9.3%)	9 (6.0%)	23 (7.7%)	0.322
Written information	3 (2.0%)	1 (0.7%)	4 (1.3%)	
Physical demonstration	133 (88.7%)	140 (93.3%)	273 (91.0%)	
3) When did you receive this information or advice? N (%)				
When prescribed the inhaler for the first time	141 (94.0%)	138 (92.0%)	279 (93.0%)	0.418
The first time you used the inhaler	6 (4.0%)	11 (7.3%)	17 (5.7%)	
At some other time	0 (0.0%)	1 (0.7%)	3 (1.0%)	
After you requested some information or advice	2 (1.3%)	0 (0.0%)	1 (0.3%)	
Don't remember	1 (0.7%)	0 (0.0%)	0 (0.0%)	
4) Have you received any information or advice about how to use an inhaler in the last 12 months?				
Yes	21 (14.0%)	0 (0.0%)	21 (7.0%)	<0.001
No	129 (86.0%)	150 (100.0%)	279 (93.0%)	
6) Do you think that you use your inhaler correctly?				
Yes	66 (44.0%)	38 (25.3%)	104 (34.7%)	0.002
No	6 (4.0%)	5 (3.3%)	11 (3.7%)	
I don't Know	78 (52.0%)	107 (71.3%)	185 (61.7%)	

DISCUSSION

This is the first study conducted to assess the association between inhaler techniques, adherence to medications, and the level of asthma control in the healthcare settings of Jordan and Iraq. Lack of proper asthma management leads to economic burden of the medical condition. This economic burden can be direct and indirect. Direct costs come from utilizing healthcare resources to diagnose or treat the disease. Indirect costs are associated with the cessation or decline of work productivity due to the illness.[24] It was estimated previously that a patient with asthma costs around $3300 to be well managed each year in the United States.[25] These figures become higher when the management and control of the disease are suboptimal due to increased healthcare utilization.[26] On the other hand, good management and proper adherence to medical therapy have been associated with reduced exacerbation rates in patients with asthma.[27]

Chronic disease management takes place at home, and decisions on whether to start or discontinue the medical treatment are made by patients and their family members, often without consulting healthcare providers.[28] In this study, many patients in Amman and Baghdad showed poor adherence to their medical therapy. This could be due to several reasons; for example, some studies showed that using more than one inhaler is associated with higher rates of non-adherence compared to single inhaler use in asthmatic patients, possibly because of the complexity of using more than one inhaler.[27] In the past, triple therapy containing corticosteroid, beta-agonist, and antimuscarinic was only available via multiple inhalers. Single-inhaler triple therapy is approved as a maintenance treatment for asthma and showed significantly better adherence than multiple inhalers.[29] Yet, with the hard economic status of most asthmatics in Jordan and Iraq, such feasibility in the type of inhalers could not be available to most patients. A high percentage of asthmatic patients in Amman and Baghdad showed poor adherence to their medical therapy and improper inhaler technique. These errors were associated with poor disease control, an increased rate of hospitalization, and increased economic burden on the healthcare system.. Non-adherence can also result from a lack of effective communication between the patient and their healthcare provider, as this usually results in a misunderstanding of how to self-manage properly.[29] New approaches to improving patients' inhaler technique should be developed as the relationship between suboptimal treatment, and worse disease control has been well established in the literature (Hui 2020). Multiple new ideas have been studied recently to increase adherence to pharmacological therapy. A recent Randomized Control Trial (RCT) studied the effect of using a smartphone application as most of the population use it nowadays. The results showed that using an interactive mobile health intervention improved the medication adherence of adolescents with poor baseline adherence rates (Kosse, Bouvy et al. 2019).

Suboptimal inhaler technique skills are another important issue affecting disease control. Patients in Amman and Baghdad showed improper techniques while using their inhalers, regardless of the type of inhaler. In general, patients

with asthma are mainly treated with pulmonary delivery drugs such as inhalers. The advantages of pulmonary delivery include the possibility to using a relatively low dose, a low incidence of systemic side effects, and for some drugs, a rapid onset of action.[30]

The first successful inhaler system to be introduced in the market was the pMDI, Today, there are other widely used systems, such as dry powder inhalers (DPIs) which have many types, with the ACC and the TH being the most common types.[31] It was noticed that many patients make errors while using inhalers, which has been associated with worsened health outcomes, such as poor disease control and an increased risk of hospitalization.[32] Some studies revealed that only 25% of asthmatic patients demonstrated a correct inhaler technique.[33] Unfortunately, this could be attributed to the fact that many practitioners, including pharmacists, do not provide adequate instructions on inhaler techniques.[34] Rates of incorrect inhaler techniques are high and did not seem to improve in the past 40 years.[35] In this study, most patients were found to lack the correct inhaler technique, whether they were living in Amman or Baghdad.

Health care providers need to have the ability to demonstrate correct inhaler technique to their patients so they can deliver the needed counselling. Pharmacists are in a pivotal position to deliver this education, as they are the last health care provider to see the patients before they go home and start using their inhalers. A cross-sectional study done in Australia and Jordan to evaluate the inhaler technique steps showed that asthmatic patients are not the only individuals to lack knowledge about the inhaler technique steps; even pharmacists could not perform these steps correctly.[36] This suggests that healthcare providers must be educated about inhaler techniques before we expect patient education to be effective.[37,38] In this study, we evaluated inhaler techniques based on generally accepted checklists of maneuvers that affect drug delivery and can easily be used by the busy pharmacist to assess patients' inhaler technique. Our study emphasizes the importance of the pharmacist's role and involvement in delivering patient education and counseling and improving asthma control. Patients in Amman and Iraq stated that they were ever provided with information or advice about how to use their inhaler by a pharmacist. This situation should be addressed by the policy makers in the country, by educating both the patient and the pharmacist on the important relationship they should have together for achieving improved asthma management and enhancing inhaler technique demonstration skills.

CONCLUSIONS

The baseline outcome of asthma control was relatively inferior for patients in both countries Jordan and Iraq. Interesting disparities were observed between the two countries; for instance, the ACC and TH were more commonly used in Amman compared to Baghdad, whereas MDI devices were more prevalent in Baghdad than in Amman. However, patients living in Amman showed higher percentages of well-controlled asthma than patients living in Baghdad. In general, all patients suffered from low asthma disease control, with no one patient having a high knowledge score in both countries. This could have been responsible for the low adherence rates revealed in this study in both countries. Asthmatic patients in Amman exhibited relatively better management compared to those in Baghdad, primarily attributed to their more consistent adherence to their action plans. Conversely, a significant portion of asthmatic patients in Baghdad did not adhere to their action plans, resulting in notably poor asthma control. In Amman, patients with poor asthma control experienced side effects from their inhaler devices.

Asthmatic patients in Amman had good inhalation technique for the ACCTH devices when compared to patients living in Baghdad. In contrast, all asthmatic patients in Baghdad had good inhalation technique for the MDI, which was comparatively better that that demonstrated by the patients living in Amman. Asthmatic patients in Amman had well asthma control and normal FEV <80% and normal FVC (80%-120%) more than that for patients living in Baghdad. The role of the pharmacist was perceived to be more efficient by patients living in Baghdad than in Amman. In conclusion, asthmatics in both countries need to improve their knowledge of the disease, adherence to their medications, improve their inhalation technique, and relationship with their pharmacist who can deliver better patient care in this area.

Future studies need to look at ways to improve the pharmaceutical care service delivered by pharmacists to asthmatic patients in Amman and Baghdad. Pharmacists can be educated on the significance of aiding patients in adhering to their action plans, promoting consistent medication adherence, and ensuring correct inhaler usage. Pharmacists can also play an important role in regularly assessing and correcting patients' inhaler techniques, particularly each time a patient acquires a new inhaler or seeks a refill.

SUPPLEMENTARY MATERIALS

Not applicable

AUTHOR CONTRIBUTIONS

Conceptualization, Zainab Al-kilkawi and Iman Basheti; Formal analysis, Ahmad Alsayed; Funding acquisition, Iman Basheti; Investigation, Zainab Al-kilkawi and Iman Basheti; Methodology, Zainab Al-kilkawi, Muhannad Saleh, Salim Hamadi and Iman Basheti; Project administration, Zainab Al-kilkawi and Nathir Obeidat; Resources, Iman Basheti; Supervision, Nathir Obeidat and Iman Basheti; Validation, Ahmad Alsayed; Visualization, Ahmad Alsayed; Writing – original draft, Salim Hamadi, Ahmad Alsayed and Razan Nassar; Writing – review & editing, Reem Fawaz Abutayeh, Ahmad Alsayed and Iman Basheti.

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INSTITUTIONAL REVIEW BOARD STATEMENT

Ethics approval was obtained from the Ethics Committee of the Faculty of Pharmacy at the Applied Sciences Private University, the Jordanian Ministry of Health (Amman, Jordan), and the Al Zahra Center for Allergy and Asthma in Iraq and Baghdad.

INFORMED CONSENT STATEMENT

All participants who agreed to participate signed the informed consent forms.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

References

1. Papi, A, Brightling, C, Pedersen, et al. Asthma. Lancet Publishing Group: 2018;391:783-800.
2. Stern, J, Pier, J Litonjua, et al. Asthma epidemiology and risk factors. Springer.2020;42:5-15. https://doi.org/10.1007/s00281-020-00785-1
3. GINA Global initiative for asthma (GINA):strategy for asthma management and prevention. (1 october).
4. Tarasidis, G. S, Wilson, K. F, et al. Diagnosis of asthma: clinical assessment. Int Forum Allergy Rhinol. 2015;5(1):S23-6. https://doi.org/10.1002/alr.21518
5. Al-Dulaimi, A, Alsayed, A. R. Maqbali, et al. Investigating the human rhinovirus co-infection in patients with asthma exacerbations and COVID-19. Pharm Pract (Granada) .2022;20(2):2665. https://doi.org/10.18549/pharmpract.2022.2.2665
6. Kwah, J. H, Peters A. T. Asthma in adults: Principles of treatment. Allergy Asthma Proc.2019;40(6): 396-402. https://doi.org/10.2500/aap.2019.40.4256
7. Fergeson J. E, Patel S. S, Lockey R. F. Acute asthma, prognosis, and treatment. J Allergy Clin Immunol. 2017;139(2):438-447. https://doi.org/10.1016/j.jaci.2016.06.054
8. Basheti I. A, Obeidat N. M, Reddel H. K. Inhaler technique education and asthma control among patients hospitalized for asthma in Jordan. Saudi Pharm J. 2018;26(8):1127-1136. https://doi.org/10.1016/j.jsps.2018.06.002. Epub 2018 Jul 7
9. Rehman A,Amin F, Sadeeqa S. Prevalence of asthma and its management: A review. J Pak Med Assoc. 2018;68(12):1823-1827.
10. Castillo J. R, Peters S. P, Busse W. W. Asthma Exacerbations: Pathogenesis, Prevention, and Treatment. J Allergy Clin Immunol Pract. 2017;5(4):918-927. https://doi.org/10.1016/j.jaip.2017.05.001
11. Nour A, Alsayed A. R, Basheti I. Prevalence of Asthma amongst Schoolchildren in Jordan and Staff Readiness to Help. Healthcare (Basel). 2023;11(2). https://doi.org/10.3390/healthcare11020183
12. Basheti I. A, Salhi Y. B, Basheti M. M, et al. Role of the pharmacist in improving inhaler technique and asthma management in rural areas in Jordan. Clin Pharmacol. 2019;11:103-116. https://doi.org/10.2147/cpaa.s213271
13. Qunaibi E, Basheti I. A, Hamadi S. A, et al. Effect of Divergence in Patients' Socioeconomic Background on their Perspective of the Role of the Community Pharmacist in Amman, Jordan. Trop J Pharm Res. 2013;12(2):247-253. https://doi.org/10.18549/pharmpract.2022.1.2618
14. Khader H, Alsayed A, Hasoun L. Z, et al. Pharmaceutical care and telemedicine during COVID-19: A cross-sectional study based on pharmacy students, pharmacists, and physicians in Jordan. Pharmacia. 2022;69(3):891-901.
15. Alsayed A. R, Halloush S, Hasoun L, et al. Perspectives of the community in the developing countries toward telemedicine and pharmaceutical care during the COVID-19 pandemic. Pharm Pract (Granada). 2022;20(1):2618. https://doi.org/10.18549/pharmpract.2022.1.2618
16. Basheti I. A, Bosnic-Anticevich S. Z, Armour C. L, et al. Checklists for powder inhaler technique: a review and recommendations. Respir Care. 2014;59 (7):1140-54. https://doi.org/10.4187/respcare.02342
17. Bosnic-Anticevich S. Z, Sinha H, So S, et al. Metered-dose inhaler technique: the effect of two educational interventions delivered in community pharmacy over time. J Asthma. 2010;47(3):251-6. https://doi.org/10.3109/02770900903580843
18. Basheti I. A, Bosnic-Anticevich S. Z, Armour C. L, et al. Checklists for Powder Inhaler Technique: A Review and Recommendations. Respir Care.2014;59(7):1140-1154. https://doi.org/10.4187/respcare.02342
19. Bosnic-Anticevich S. Z, Sinha H, So S, et al. Metered-dose inhaler technique: the effect of two educational interventions delivered in community pharmacy over time. J Asthma. 2010;47(3):251-6. https://doi.org/10.3109/02770900903580843
20. van der Palen J, Klein J. J, Schildkamp A. M. Comparison of a new multidose powder inhaler (Diskus/Accuhaler) and the Turbuhaler regarding preference and ease of use. J Asthma.1998;35(2):147-52. https://doi.org/10.3109/02770909809068202
21. Basheti I. A, Reddel H. K, Armour C. L, et al. Improved asthma outcomes with a simple inhaler technique intervention by community pharmacists. J Allergy Clin Immunol.2007;119(6):1537-8. https://pubmed.ncbi.nlm.nih.gov/17433831/
22. Global Initiative for Asthma (GINA) - Global strategy for asthma management and prevention 2014 [May 2014], Available online at: http://www.ginasthma.org. Accessed September 2014.
23. Schatz M, Zeiger R. S, Yang S. J, et al. Development and preliminary validation of the Adult Asthma Adherence Questionnaire™.

J Allergy Clin Immunol Pract.2013;1(3):280-8. https://doi.org/10.1016/j.jaip.2013.03.001
24. Ehteshami-Afshar S, FitzGerald J. M, Doyle-Waters M. M, et al. The global economic burden of asthma and chronic obstructive pulmonary disease. Int J Tuberc Lung Dis.2016;20(1):11-23. https://doi.org/10.5588/ijtld.15.0472
25. Loftus P. A, Wise S. K. Epidemiology and economic burden of asthma. Int Forum Allergy Rhinol. 2015; 5(1):S7-10. https://doi.org/10.1002/alr.21547
26. Ismaila A. S, Sayani A. P, Marin M, et al. Clinical, economic, and humanistic burden of asthma in Canada: a systematic review. BMC Pulm Med. 2013;13:70. https://doi.org/10.1186/1471-2466-13-70
27. Mäkelä M. J, Backer V, Hedegaard M, et al. Adherence to inhaled therapies, health outcomes and costs in patients with asthma and COPD. Respir Med.2013;107(10):1481-90. https://pubmed.ncbi.nlm.nih.gov/23643487/
28. George, M., Adherence in Asthma and COPD: New Strategies for an Old Problem. Respir Care.2018; 63(6):818-831. https://doi.org/10.4187/respcare.05905
29. Busse W. W, Abbott C. B, Germain G, et al. Adherence and Persistence to Single-Inhaler Versus Multiple-Inhaler Triple Therapy for Asthma Management. J Allergy Clin Immunol Pract. 2022;10(11): 2904-2913.e6. https://doi.org/10.1016/j.jaip.2022.06.010
30. Newman S. P. Drug delivery to the lungs: challenges and opportunities. Ther Deliv.2017;8(8):647-661. https://doi.org/10.4155/tde-2017-0037
31. Borgström L, Asking L, Thorsson L. Idealhalers or realhalers? A comparison of Diskus and Turbuhaler. Int J Clin Pract.2005;59(12):1488-95. https://doi.org/10.1111/j.1368-5031.2005.00747.x
32. Klijn S. L, Hiligsmann M, Evers S, et al. Effectiveness and success factors of educational inhaler technique interventions in asthma & COPD patients: a systematic review. NPJ Prim Care Respir Med. 2017;27(1):24. https://doi.org/10.1038/s41533-017-0022-1
33. Hilton S. An audit of inhaler technique among asthma patients of 34 general practitioners. Br J Gen Pract 1990;40(341):505-6. http://www.ncbi.nlm.nih.gov/pmc/articles/pmc1371448/
34. Jones T. L, Neville D. M, Chauhan A. J. Diagnosis and treatment of severe asthma: a phenotype-based approach. Clin Med (Lond) .2018;18(2): s36-s40. https://doi.org/10.7861/clinmedicine.18-2-s36
35. Sanchis J, Gich I, Pedersen S. Systematic Review of Errors in Inhaler Use: Has Patient Technique Improved Over Time? .Chest .2016;50(2):394-406. https://doi.org/10.1016/j.chest.2016.03.041
36. Basheti I. A, Qunaibi E, Bosnic-Anticevich S. Z, et al. User error with Diskus and Turbuhaler by asthma patients and pharmacists in Jordan and Australia. Respir Care. 2011;56(12):1916-23. https://doi.org/10.4187/respcare.01205
37. Nguyen Y. B. N, Wainwright C, Basheti I. A, et al. Do health professionals on respiratory wards know how to use inhalers?. J Pharm Pract Res. 2010;40(3):211-216.
38. Basheti I. A, Armour C. L, Reddel H. K, et al. Long-term maintenance of pharmacists' inhaler technique demonstration skills. Am J Pharm Educ.2009;73(2):32. https://doi.org/10.5688/aj730232