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Assessment of Nurses' Knowledge and Self-Reported Beliefs Regarding Inhaler Therapy in Bronchial Asthma and Chronic Obstructive Pulmonary Disease

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ABSTRACT

Bronchial asthma and chronic obstructive pulmonary disease (COPD) are important diseases to treat with inhaled medications, but their effectiveness relies on proper device use. **Objective:** To evaluate nurses' knowledge and self-reported beliefs regarding inhalation therapy devices, metered dose inhalers (MDIs), spacers, and dry powder inhalers (DPIs) in two hospitals in Multan, Pakistan. **Methods:** The descriptive cross-sectional study was done with Consecutive sampling for six months. A total of 115 nurses were enrolled in the sample. Nurses were given a self-developed 20-item yes/no questionnaire with a Cronbach's alpha of 0.78 in the two hospitals: Medicare Hospital and Nishtar Hospital. Patients were excluded if they were nursing students or non-clinical staff, and registered nurses were included who had worked with patients for ≥1 year. **Results:** There was a significant lack of knowledge. As far as general knowledge was concerned, 58.3% of them thought inhalers are addictive, 43.5% believed inhalers to be a "last resort", and more than 67% were misinformed about inhalers leading to weight gain and stunted growth. The critical technique errors were common: 61.7% thought patients should breathe in before pressing the MDI canister, and 16.5% did not know that MDIs should be shaken before use. Only 26.1% had good knowledge. The best predictor of adequate knowledge was prior training (p=0.002). **Conclusions:** The nurses were found to have poor knowledge of inhaler therapy. There is an urgent need for structured, device-specific training, along with supervised competency assessment, to address patient education and improve treatment outcomes.

INTRODUCTION

Respiratory diseases, such as bronchial asthma and chronic obstructive pulmonary disease (COPD), are chronic conditions that require consistent management and regular monitoring by specialist physicians [1]. Inhaled medications are the preferred therapeutic option as they deliver medication directly to the airways, resulting in rapid onset of action and requiring lower doses compared to systemic administration [2]. However, the therapeutic benefit of inhaled medications is entirely dependent on proper device use. Correct inhaler technique involves a coordinated sequence of preparation, inhalation, and breath-holding; failure at any step can significantly reduce

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drug delivery to the lungs [3]. Common errors include failure to exhale before inhalation, inadequate breath-holding, improper device handling, and incorrect spacer use [4]. Additionally, patient misconceptions—such as beliefs that inhalers are addictive, too strong, or less effective than other treatments—can further compromise adherence and disease control [5]. Globally, the prevalence of asthma and COPD continues to rise. According to the Global Initiative for Asthma (GINA), approximately 300 million people worldwide suffer from asthma, with COPD affecting an estimated 10-15% of adults over 40 years in high-income countries [1]. In Pakistan, the prevalence of asthma ranges from 4-8%, while COPD affects approximately 6-10% of the adult population, representing a substantial public health burden [6]. Despite these high rates, evidence suggests that healthcare providers, including nurses, often lack adequate knowledge of inhaler devices and their correct use [7]. Nurses play a pivotal role in patient education and inhaler technique assessment [8]. During hospitalization, nurses administer medications, observe patient technique, correct errors, and provide ongoing education [9]. The quality of nurse-led education significantly influences patients' long-term self-management behaviors [10]. Nurses who are proficient in inhaler techniques can provide accurate instructions and demonstrate proper use, whereas those with knowledge gaps may inadvertently reinforce incorrect practices, leading to suboptimal treatment outcomes and increased healthcare utilization [11, 12].

Despite extensive international evidence on nurses' role in inhaler education and the prevalence of device-handling errors, there is a notable absence of empirical data on Pakistani nurses' knowledge of inhaler therapy. Given Pakistan's distinct educational and clinical training contexts, international findings may not be generalizable, leaving critical misconceptions and technique-specific deficits largely unexplored. This gap is clinically significant, as uninformed nursing practices can perpetuate patient errors and reduce treatment efficacy. Therefore, this study was designed to systematically assess nurses' self-reported knowledge and beliefs regarding inhaler therapy for asthma and COPD, identify specific misconceptions, and generate baseline data to inform targeted educational interventions tailored to the Pakistani nursing workforce.

METHODS

A descriptive cross-sectional study design was used to evaluate the knowledge of nurses about inhaler therapy. The study was carried out from October 2025 to March 2026 for six months in Medicare Hospital and Nishtar Hospital, Multan, Pakistan. The sample included RN's working in medical, surgical, and critical care units and who were registered nurses. Consecutive sampling was used to recruit participants. All eligible nurses who attended the data collection period and gave informed consent were included. The inclusion criteria were the presence of at least one year of clinical experience in patient care and the presence of at least one nurse registered in the participating hospitals (diploma or degree holders). Students were excluded if they were either nursing students, working in non-clinical administrative positions, or nursing students on extended leave, or those who refused to participate, and the sample size was determined using the single population proportion formula for cross-sectional surveys: $n = Z^2 \times p(1-p) / d^2$. The sample size was calculated for an expected proportion of adequate knowledge ($p = 0.5$) with an absolute margin of error ($d = 0.09$) of 9% and a 95% confidence level ($Z = 1.96$), and resulted in a minimum required sample of 118 participants.

Given the exploratory nature of this descriptive study and the practical resource constraints in the hospital setting, a 9% margin of error was deemed acceptable to achieve a feasible sample size while maintaining reasonable precision for generating baseline prevalence estimates. A total of 124 questionnaires were distributed to eligible nurses across the two study hospitals. Of these, 115 were fully completed and returned, yielding a response rate of 92.7%. This final analyzed sample (n=115) fell marginally short of the calculated minimum required sample size of 118, resulting in a slightly wider actual margin of error than the targeted 9%. Despite this minor shortfall, the sample size remains adequate for the descriptive aims of this exploratory study. A structured, self-designed questionnaire was used to evaluate nurses' self-reported knowledge and beliefs about inhaler therapy. The 20-item questionnaire assessed cognitive knowledge and misconceptions (e.g., beliefs about addiction, safety, and technique steps) rather than directly observed clinical practice competence.

The questionnaire contained 20 yes/no questions covering general knowledge and misconceptions, device care and spacer use, metered-dose inhaler (MDI) technique, and dry-powder inhaler (DPI) technique and inhalation sequence. For scoring, each correct response was assigned a score of 1, while each incorrect response received a score of 0, yielding a total knowledge score ranging from 0 to 20 (with higher scores indicating greater knowledge). Based on the total score, participants were categorized into two groups: 'good knowledge' (≥50% score, i.e., ≥10 correct responses out of 20) and 'poor knowledge' (<50% score, i.e., <10 correct responses). The ≥50% cut-off was selected as a pragmatic threshold representing a minimum acceptable level of competency for this exploratory descriptive study, consistent with similar methodological approaches used in previous research assessing healthcare professionals' knowledge of inhaler therapy. This binary classification

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facilitated the analysis of associated demographic and professional factors. The content validity was achieved by five pulmonology experts. The internal consistency of the instruments was determined by the Cronbach's alpha reliability coefficient, which was obtained as 0.78, which means that the instruments have acceptable reliability. Participants were approached, consisting of eligible nurses, during their duty hours, and they were given information regarding the purpose and procedures of the study. All participants gave written informed consent. Participants completed questionnaires in private, with the assurance of confidentiality. Completed questionnaires were retrieved on the spot, and incomplete questionnaires were not analyzed. The study was carried out in compliance with the Declaration of Helsinki. Nurses were informed of their right to withdraw at any time without repercussion, and participation was voluntary. All responses were anonymous and confidential. Data were analyzed using SPSS version 26.0. Categorical variables were expressed as frequencies and percentages. Cronbach's alpha of 0.78 was used to test the internal consistency of the questionnaire. Chi-square tests were used to examine the relationships between participants' characteristics and knowledge scores. Cronbach's alpha was used to determine the internal consistency of the questionnaire. A p-value <0.050 was considered statistically significant.

RESULTS

A total of 115 nurses completed the questionnaire (100% response rate among those approached). The study presents the demographic and professional characteristics of the study participants. The study sample comprised predominantly female nurses (74.8%), with the majority aged 25-34 years (60.9%) and holding diploma qualifications (55.7%). Most participants had 1-5 years of clinical experience (50.4%) and worked in medical-surgical wards (41.7%), while only 29.6% had received prior training in inhaler therapy, highlighting a significant gap in formal education on this topic (Table 1).

Table 1: Demographic and Professional Characteristics of Participants (n=115)

Characteristics	Category	n (%)
Gender	Male	29 (25.2%)
	Female	86 (74.8%)
Age (years)	20-24	18 (15.7%)
	25-34	70 (60.9%)
	35-44	22 (19.1%)
	≥45	5 (4.3%)
Education	Diploma in Nursing	64 (55.7%)
	BSN	41 (35.7%)
	MSN/Postgraduate	10 (8.7%)
Experience (years)	1-5	58 (50.4%)
	6-10	34 (29.6%)
	>10	23 (20.0%)
Work Area	Medical-Surgical Ward	48 (41.7%)
	ICU/CCU	32 (27.8%)
	Emergency	20 (17.4%)
	Respiratory Unit	15 (13.0%)
Prior Inhaler Training	Yes	34 (29.6%)
	No	81 (70.4%)

A substantial proportion of nurses held misconceptions, with 58.3% incorrectly believing inhalers are habit-forming, 67.0% believing they cause weight gain, and 67.8% believing they cause stunted growth in children. Critical technique errors were common, with 61.7% incorrectly believing patients should breathe in before pressing the MDI canister, and 74.8% incorrectly believing inhalers are less effective than nebulizers. The highest correct response rate was for the spacer not being held between teeth (88.7%), while the lowest was for inhaler effectiveness compared to nebulizers (25.2% correct) (Table 2).

Table 2: Knowledge of Inhaler Therapy Across All Domains (n=115)

Sr. No.	Questions	Correct Response	n (%)
General Knowledge and Misconceptions			
1	Have you heard about the term inhaler?	Yes	107 (93.0%)
		No	8 (7.0%)
2	Are inhalers habit forming?	Yes	67 (58.3%)
		No	48 (41.7%)
3	Inhalers are very strong. Are they used as a last resort?	Yes	65 (56.5%)
		No	50 (43.5%)
4	Do inhalers cause weight gain?	Yes	77 (67.0%)
		No	38 (33.0%)
5	Do inhalers cause stunted growth in Children?	Yes	78 (67.8%)
		No	37 (32.2%)
Device Care, Dose Delivery, and Spacer Use			
6	Inhalers and spacers should be cleaned with hot water?	Yes	74 (64.3%)
		No	41 (35.7%)
7	Should we put the canister in water to see whether it floats in water to check whether it contains a drug in it or not?	Yes	56 (48.7%)
		No	59 (51.3%)
8	Do spacers increase the amount of medicine reaching the lung?	Yes	78 (67.8%)
		No	37 (32.2%)
9	Is the amount of medicine in the inhaler quite less as compared to nebulizers?	Yes	64 (55.7%)
		No	51 (44.3%)
10	Do spacers decrease the amount of medicine deposition in the mouth?	Yes	80 (69.6%)
		No	35 (30.4%)
Metered-Dose Inhaler (MDI) Technique			
11	Is inhaler less effective than nebulizers?	Yes	86 (74.8%)
		No	29 (25.2%)
12	Should we shake the inhaler before use?	Yes	96 (83.5%)
		No	19 (16.5%)
13	Should we breathe out fully through the mouth before putting the mouthpiece fully into our mouth?	Yes	89 (77.4%)
		No	26 (22.6%)

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14	Should we hold the breath for 10 seconds after a puff?	Yes	96 (83.5%)
		No	19 (16.5%)
15	Is it better to use a spacer with MDI?	Yes	93 (80.9%)
		No	22 (19.1%)
Inhalation Sequence and Dry-Powder Inhaler (DPI) Technique			
16	Should spacer not be held between the teeth?	Yes	102 (88.7%)
		No	13 (11.3%)
17	Should we wait for 5 seconds before taking the next puff?	Yes	85 (73.9%)
		No	30 (26.1%)
18	Is it good to inhale too early before pressing the canister?	Yes	71 (61.7%)
		No	44 (38.3%)
19	Can we breathe out through a DPI because the moisture of a can breathe gum up the mechanism and decrease the effectiveness?	Yes	56 (48.7%)
		No	59 (51.3%)
20	Is it necessary to shake the DPI before use?	Yes	83 (72.2%)
		No	32 (27.8%)

The overall mean knowledge score was 56.2 ± 14.8. Domain-specific analysis revealed that nurses achieved the highest scores in metered-dose inhaler technique (70.1 ± 18.1) and the lowest scores in general knowledge and misconceptions (51.3 ± 19.7). Intermediate scores were observed for dry-powder inhaler technique and inhalation sequence (64.9 ± 17.4) and device care, dose delivery, and spacer use (59.5 ± 15.3) (Table 3).

Table 3: Domain-Specific Mean Knowledge Scores of Nurses

Domain	Mean ± SD
Metered-Dose Inhaler Technique	70.1 ± 18.1
General Knowledge and Misconceptions	51.3 ± 19.7
Dry-Powder Inhaler Technique and Inhalation Sequence	64.9 ± 17.4
Device Care, Dose Delivery, and Spacer Use	59.5 ± 15.3
Overall Mean Knowledge Score	56.2 ± 14.8

Prior training was the strongest predictor of adequate knowledge (p=0.002), with trained nurses achieving nearly double the pass rate compared to untrained nurses (61.8% vs. 32.1%). Knowledge improved significantly with advancing clinical experience, rising progressively from 29.3% in nurses with 1-5 years' experience to 65.2% in those with >10 years' experience (p=0.014). Higher educational attainment was also associated with better knowledge scores, improving stepwise from 29.7% (diploma) to 60.0% (MSN/postgraduate) (p=0.021) (Table 4).

Table 4: Factors Associated with Overall Knowledge Scores (n=115)

Characteristics	Category	Knowledge Score ≥50% n (%)	χ^2 Value	df	p-value*
Education	Diploma	19 (29.7%)	7.74	2	0.021
	BSN	22 (53.7%)			
	MSN/Postgraduate	6 (60.0%)			
Experience	1-5 Years	17 (29.3%)	8.52	2	0.014
	6-10 Years	15 (44.1%)			
	>10 Years	15 (65.2%)			
Prior Training	Yes	21 (61.8%)	9.74	1	0.002
	No	26 (32.1%)			

Overall, only 47 (40.9%) of nurses demonstrated good knowledge (≥50% score), while 68 (59.1%) had poor knowledge. Among trained nurses, 21 (61.8%) had good knowledge, compared to only 26 (32.1%) of untrained nurses. This indicates that prior training more than doubles the likelihood of having good knowledge, emphasizing the critical importance of structured educational programs for improving nurses' competency in inhaler therapy (Table 5).

Table 5: Comparison of Knowledge Levels by Prior Training

Knowledge Level	Trained Nurses (n=34), n (%)	Untrained Nurses (n=81), n (%)	Total (n=115), n (%)
Good Knowledge (≥50%)	21 (61.8%)	26 (32.1%)	47 (40.9%)
Poor Knowledge (<50%)	13 (38.2%)	55 (67.9%)	68 (59.1%)
Total	34 (100%)	81 (100%)	115 (100%)

DISCUSSION

This study revealed that there is a significant lack of knowledge and/or reporting of inhaler therapy among nurses, and it was a clinically relevant gap in knowledge [11]. This was not an issue related to a single device or a single step. There were identified areas of knowledge gaps, particularly in basic concepts, common beliefs, cleaning of the devices, spacer use, metered dose inhaler technique, and instructions on dry-powder inhaler use [12, 13]. From the perspective of other health care workers, such as nurses, a similar pattern has been observed in previous studies: many individuals are unable to explain or demonstrate all the necessary steps correctly [14]. The current results are in agreement with previous studies, supporting our results that contact with respiratory patients does not necessarily guarantee competence. When the participant does not structure the observation, correction, and re-evaluation of staff's bad habits, it can take years to disappear [15]. Nurses should be aware of the indication for an inhaled medicine. Researchers also must learn the difference between local and systemic therapeutic delivery and how a small mistake can have a huge impact on how much drug actually reaches the lungs [16]. Patients' beliefs about inhalers being addictive, too strong, associated with weight gain, unsafe for children, and only used when a disease is serious enough to affect their decision to use them. Similar beliefs have come up in previous studies of both patients and healthcare staff [17]. This study is particularly troubling because it is problematic that we should be expecting nurses to be the professionals who fix this misunderstanding. If a nurse hesitates or gives the incorrect response, this can reaffirm a patient's sense of fear. It may make them use their inhaler less regularly or even end their controller treatment as soon as they start to feel better. It might also strengthen the idea that a nebulizer is always better, even when a

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properly used handheld inhaler would work just fine. Results were similar to previous research in which the most frequent errors were with metered-dose inhalers in terms of coordination and sequencing [18]. The current results confirm earlier evidence that naming an inhaler doesn't necessarily mean that they will be able to use it or pass it on in a correct manner. The issue of poor coordination is huge as it can make a good medicine appear ineffective. When the inhaler is used too soon, too late, or during a fast inhalation, a significant portion of the aerosol can remain trapped in the mouth or simply dissipate into the air [19]. In the real world, this can mean unnecessarily raising the dose, prescribing additional medications, or repeat emergency room visits or hospitalizations. However, before it's deemed a failure, at least one person should observe the patient operating his/her real gadget, rather than simply asking them how [20]. If a nurse is familiar with what a spacer is but cannot demonstrate its proper use, they may unintentionally transmit their mistakes to the patient. For children, older adults, patients with poor coordination, and those who are acutely short of breath, this is an important consideration as these are the patients who tend to benefit the most from using a spacer for practical purposes. Results indicated that there was a lack of understanding when instructions differed from those for a metered-dose inhaler for use of the dry-powder inhalers. Previous research has also identified that sometimes HCPs provide a single explanation of inhaler use for all types of inhalers [21]. With most of the dry-powder variety, the patient is required to prepare the dose, exhale while away from the mouthpiece, inhale rapidly and deeply, and ensure that they do not exhale into the device or wet it. Many of these don't need to be shaken. Routes of instructions for various devices may be confused, causing the release of the dose improperly or delivery may be inadequate. As a minimum, device-specific teaching should be taught to every student as part of the curriculum, and staff should always refer to the manufacturer's instructions when they encounter an unfamiliar inhaler. Another aspect of the work that we share with earlier research is that of theory versus practice [22].

Several limitations must be considered when interpreting the findings of this study. The achieved sample size (n=115) was slightly smaller than the calculated minimum required sample size (n=118), resulting in slightly less precision (actual margin of error >9%) than the desired precision, and the use of a 9% margin of error is relatively wide for a questionnaire-based study, which may have reduced the accuracy of prevalence estimates. It is important to clarify that while convenience sampling primarily affects external validity (generalizability) by introducing selection bias, it does not inherently compromise the internal validity of our findings or the reliability of our measurement instrument, which was established through pilot testing (Cronbach's α = 0.78). Future research should employ larger, multi-center samples with consecutive or probability sampling methods using smaller margins of error (e.g., 5%), incorporate direct observational assessments using validated device-specific checklists to validate self-reported findings, use longitudinal designs to assess changes over time and retention of knowledge, and test the effectiveness of structured, device-specific training programs using pre-post and retention assessments.

CONCLUSIONS

In the hospitals studied, nurses' knowledge and practices regarding inhaler therapy of asthma and chronic obstructive pulmonary disease (COPD) were inadequate. There were obvious limitations: lack of basic understanding, continued misconceptions, and difficulty with instructions for dry powder inhalers, sequencing of metered dose inhalers and spacers, and instructions for metered dose inhalers. These gaps make a big difference. It is the job of nurses to repeatedly educate patients and correct their technique, so this lack of knowledge may result in less medication being delivered and treatment not being as effective. Thus, hospitals need to offer hands-on, device-related training and supervised return demonstrations. Standardized teaching checklists and regular competency testing would also help nurses provide consistent, accurate, and patient-centered inhaler education.

Authors' Contribution

Conceptualization: MA
Methodology: MA, ZI
Formal analysis: MA
Writing and Drafting: MA, ZI, TA, MP, MK, IT, MS
Review and Editing: MA, ZI, TA, MP, MK, IT, MS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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REFRENCES

[1] Bartziokas K, Papaporfyriou A, Hillas G, Papaioannou AI, Loukides S. Global Initiative for Chronic Obstructive Lung Disease (GOLD) Recommendations: Strengths and Concerns for Future Needs. Postgraduate Medicine. 2023 May; 135(4): 327-33. doi: 10.1080/00325481.2022.2135893.

[2] Morton RW, Elphick HE, Craven V, Shields MD, Kennedy L. Aerosol Therapy in Asthma–Why We Are

DOI: https://doi.org/10.54393/nrs.v6i2.248

Failing Our Patients and How We Can Do Better. Frontiers in Pediatrics. 2020 Jun; 8: 305. doi: 10.3389/fped.2020.00305.

[3] Sayed OA, Laz NI, Abdelrahim ME, Saeed H. Emergency-Use Spacers: A Considerable Option for Asthmatic Patients. Heart and Lung. 2026 May; 77: 102719. doi: 10.1016/j.hrtlng.2025.102719.

[4] Živanović D, Javorac J, Savić D, Mikić A, Jevtić M, Ilić M *et al*. Adherence, Disease Control, And Misconceptions Related to the Use of Inhalation Therapy in Patients with Obstructive Pulmonary Diseases: A Cross-Sectional Study. Medicina. 2024 May; 60(6): 853. doi: 10.3390/medicina60060853.

[5] Benito-Ruiz E, Sánchez-Recio R, Alijarde-Lorente R, Iguacel I, Pérez-Corral M, Martin de Vicente CL *et al.* The Nurse's Role in Educating Pediatric Patients on Correct Inhaler Technique: An Interventional Study. International Journal of Environmental Research and Public Health. 2022 Apr; 19(7): 4405. doi: 10.3390/ijerph19074405.

[6] Marko M, Klimczak M, Sobczak M, Wojakiewicz M, Dębowski T, Emeryk A *et al*. Effective Inhaler Technique Education Is Achievable-Assessment and Comparison of Five Inhaler Devices Errors. Frontiers in Pharmacology. 2025 Apr; 16: 1538283. doi: 10.3389/fphar.2025.1538283.

[7] Liu H, Huang H, Li M, Mao P, Zhang A, Sun Y *et al.* The Effect of "Online-Simulation-Bedside" Three-Step Teaching Method in Team Cardiopulmonary Resuscitation Skills Training of Emergency Department and Critical Care Nursing Interns—An Analysis Based on Kirkpatrick Model. Journal of Nursing Management. 2025; 2025(1): 8624274. doi: 10.1155/jonm/8624274.

[8] Yin CC, Luo YY, Shen KL, Mao GX, Tang FS. Professionals' Perspectives on Factors Influencing Adherence to Inhaler Medication in Patients with COPD and Asthma: A Qualitative Study. Geriatric Nursing. 2026 Mar; 68: 103778. doi: 10.1016/j.gerinurse.2025.103778.

[9] Akhtar A, Shamas S, Uddin S. Impact of Improper Inhaler Use in Asthma and COPD Patients. Pakistan Journal of Medical and Cardiological Review. 2026 May; 5(2): 3643-64.

[10] Nygård T, Wright D, Kjome RL, Nazar H, Aarli B, Raddum A. Barriers and Enablers to Medicine-Taking Behaviours in Chronic Obstructive Pulmonary Disease: A Qualitative Interview Study. International Journal of Clinical Pharmacy. 2025 Jun; 47(3): 775-83. doi: 10.1007/s11096-025-01872-9.

[11] Wu ZY, Jiang B, Han YX, Niu ME, Zhao Q. Inhaled Therapy Guidance Competency among Respiratory Nurses Across Hospital Tiers in Eastern China: A Cross-Sectional Study. Frontiers in Medicine. 2026 Apr; 13: 1817376. doi: 10.3389/fmed.2026.1817376.

[12] Kapatais C, Papaioannou AI, Fouka E, Samitas K, Tryfon S, Porpodis K *et al.* Optimizing Adherence to Inhaled Therapy in Asthma: Behavioral and Digital Strategies with Insights from the Greek Healthcare Context. Respiratory Medicine. 2026 Mar; 253: 108709. doi: 10.1016/j.rmed.2026.108709.

[13] Viswalingam V and Kumar D. Advancements in smart inhaler technology for enhancing chronic obstructive pulmonary disease care. In Advanced Drug Delivery Systems in Management of Chronic Obstructive Pulmonary Disease 2025 (pp. 55-77). CRC Press. doi: 10.1201/9781003498926-5.

[14] Baker JA and Berlinski A. Use of Digital Health in Pediatric Asthma. Respiratory Care. 2025 Jun; 70(6): 686-99. doi: 10.1089/respcare.12574.

[15] Seigler CP, Velasco K, Paxton P. "Choppy Waters": Navigating Political Generational Conflict in Social Movement Organizations. American Sociological Review. 2025 Dec; 90(6): 1092-122. doi: 10.1177/00031224251387319.

[16] Hussain S, Arif A, Shah MR. Targeted Drug Delivery: Designing Nanocarriers for Improved Therapeutic Action. Chemical Communications. 2026 Mar; 62(23): 6232-56. doi: 10.1039/D5CC07306E.

[17] Aigner C. Towards Semantic Interoperability for Behavior Change Driven Serious Games and Gamified Mobile Applications-Platform Engineering for Prevention of NCDs (Doctoral dissertation, Technische Universität Wien). 2025.

[18] Mahdi FF and Hassan HAR. Design and Implementation of Portable Nebulizer. American Journal of Botany and Bioengineering. 2025 Mar; 2(3).

[19] Talaat M, Si XA, Xi J. Effects of Applied Spray Mass on Evaporation Rate and Deposition Distribution of Aerosol Droplets in the Respiratory Tract. Experimental and Computational Multiphase Flow. 2026 Jun; 8(2): 276-94. doi: 10.1007/s42757-025-0262-1.

[20] Kwong J. Crossing the Phantom Pass: A Cancer Journey. University of Toronto Press. 2025 Oct. doi: 10.3138/9781487565923.

[21] Rahman N and Ullah U. Comparison of Inhaler Technique between Dry Powder Inhalers and Metered Dose Inhalers among Adults with Obstructive Airway Disease. Pakistan Journal of Chest Medicine. 2025 Dec; 31(4): 291-8.

[22] Kimeli J, Otieno R. Medical Device Safety-an E-Guide for Nursing Students. 2025.