Original Article

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# Impact of Seasonal Variation on Health-Related Quality of Life and Lung Function among Patients with Bronchial Asthma

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## ABSTRACT

**Background:** Seasonal variations may affect asthma symptoms, lung function, and patients' health-related quality of life (HRQoL). **Objectives:** This study aimed to examine the association between seasonal variation, HRQoL, and lung function among patients with bronchial asthma. **Methods:** A descriptive cross-sectional study was conducted among 497 patients attending inpatient and outpatient clinics at the Chest Department of Assiut University Hospital, Egypt. Data were collected through structured interviews, the Mini Asthma Quality of Life Questionnaire (Mini AQLQ), the Lung Function Questionnaire, and spirometry measurements, including forced expiratory volume in one second ($FEV_1$) and forced vital capacity (FVC). Seasonal variation data were categorized, and both descriptive statistics and bivariate analyses were used to assess the relationships between seasons, respiratory symptoms, lung function, and HRQoL. **Results:** Respiratory symptoms, including wheezing, cough, and nocturnal breathlessness, were more prevalent during colder seasons. HRQoL scores were lower in winter, while lung function demonstrated modest seasonal variation, with relatively better values observed during warmer months. **Conclusion:** Seasonal variation is associated with changes in asthma symptoms, lung function, and HRQoL. These findings highlight the importance of considering seasonal environmental factors in the management of bronchial asthma. This study provides novel evidence on the seasonal impact on both physiological and quality-of-life outcomes among asthma patients in Upper Egypt.

***Keywords: Seasonal Variation; Bronchial Asthma; Lung Function; Pulmonary Function, Quality of Life***

## INTRODUCTION

Asthma is a heterogeneous condition for which healthcare providers rely on a combination of subjective symptom-based assessments and objective measurements to guide diagnosis and management (Global Initiative for Asthma, 2024). "Seasonal variation" refers to short-term cyclical changes in environmental conditions within a year, including humidity and dust exposure. It is distinct from climate change, which reflects long-term alterations in global climate patterns (Hu *et al*., 2020). These seasonal changes may influence asthma symptoms, lung function, and patients' quality of life.

Epidemiological evidence suggests that both cold and heat exposure are associated with an increased risk of asthma exacerbations (Hu *et al*., 2020). Quality of life (QOL) encompasses aspects of an individual's life and environment that influence well-being and the ability to engage in meaningful activities. Asthma is one of the most common noncommunicable diseases, affecting an estimated 339 million people worldwide in 2016 (Global Asthma Network, 2018). Despite extensive research on asthma, limited studies have simultaneously examined the combined impact of seasonal variation on both lung function and health-related quality of life among bronchial asthma patients in Upper Egypt. This region is characterized by extreme environmental conditions and remains underrepresented in the literature (Baljet *et al*., 2023). This study is among the few to integrate both lung function and quality-of-life measures within a seasonal framework in a resource-limited and environmentally extreme setting (Ali *et al*., 2021).

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### Significance of the Study

Asthma is a major global health concern, affecting an estimated 262 million people and causing approximately 455,000 deaths annually (WHO, 2024). In northern Egypt, extreme seasonal variation and frequent dust exposure significantly impact respiratory health. This study provides context-specific evidence to support the development of tailored asthma management strategies in Egypt (D'Amato *et al*. 2023).

## METHODOLOGY

### Study Design

A descriptive cross-sectional study was conducted from June 21, 2024, to June 20, 2025, to examine the association between seasonal variations and their association with health-related quality of life and lung function. Due to the cross-sectional design, the findings describe associations and do not imply causality.

### Study Setting

The study was carried out in the inpatient and outpatient clinics of the Chest Department at Assiut University Hospital, Egypt.

### Sampling

A convenience sample of 497 adult patients (≥18 years) diagnosed with bronchial asthma and able to provide informed consent was recruited. A subsample of 49 participants underwent spirometry testing for pulmonary function assessment.

### Inclusion Criteria

Adults ≥18 years diagnosed with bronchial asthma, including the ability to communicate and provide informed consent.

### Exclusion Criteria

Presence of other chronic respiratory diseases (e.g., COPD) with critically ill patients and incomplete data.

### Study Instruments

Five data collection tools were utilized following a comprehensive review of the literature, including the following:

*Tool I: Structured questionnaire interview*

An Arabic structured questionnaire was developed based on recent literature (Abdallah *et al*., 2022). It was used to collect demographic characteristics (age, sex, occupation, education, and marital status) and clinical data, including symptoms, asthma severity, triggers, comorbidities, family history, smoking status, and treatment history.

*Tool II: Lung Function Questionnaire (LFQ)*)

The Lung Function Questionnaire (LFQ) was used to assess respiratory symptoms, smoking history, and age. It consists of five items rated on a Likert scale, with total scores ranging from 0 to 20. Scores ≤ 18 indicate an increased risk (Assaf *et al*., 2021).

*Tool III: Pulmonary Tests (PFTs) Function*

Pulmonary function was assessed using spirometry in accordance with ATS/ERS guidelines. Measurements included Forced Expiratory Volume in 1 second ($FEV_1$), Forced Vital Capacity (FVC), and the Forced Expiratory Volume in 1 second / Forced Vital Capacity ratio ($FEV_1$/FVC ratio). Normal values were defined according to established reference standards (Graham *et al*., 2019; Stanojevic *et al*., 2023).

*Tool IV: Mini Asthma Quality of Life Questionnaire (mini AQLQ)*

The Mini AQLQ was used to assess health-related quality of life. It consists of 15 items covering four domains (symptoms, activity limitation, emotional function, and environmental stimuli), rated on a 7-point Likert scale. The tool demonstrated high internal consistency in this study (Cronbach's $\alpha = 0.904$) (Benslimane *et al*., 2022).

*Tool V: Seasonal Variation Measurement*

This tool was used to assess seasonal variation in temperature based on the guidelines of the World Meteorological Organization (2019). Guide for Meteorological Instruments and Methods of Observation. Seasonal classification was determined according to temperature distribution patterns, which reflect the natural variability across the four seasons rather than long-term climate change trends. Temperature thresholds vary by region and were applied consistently to both observed and modeled data. Winter was defined using the 25th percentile of temperature values (typically from December 21 to March 20), while spring was identified as the transitional period characterized by gradually increasing temperatures (March 21 to June 20), as described by Christidis *et al*. (2020).

## Data collection

Data were collected through individual interviews at the Chest Department, Assiut University Hospital, Egypt, from July 2024 to June 2025. Seasonal classification was based on calendar periods supported by general temperature patterns, not direct temperature measurements. So, data collection followed recognized standards, including those outlined by the World Meteorological Organization (2019), to ensure the accuracy and quality of the observations.

*Summer:* 21 June – 20 September

*Winter:* 21 December – 20 March

*Spring:* 21 March – 20 June

*Autumn:* 21 September – 20 December

## Statistical Analysis

Data was analyzed using SPSS version 23. Descriptive statistics were used to summarize the data, while inferential tests (chi-square and one-way ANOVA) were applied to examine associations. A *p*-value < 0.05 was considered statistically significant.

## Ethical Considerations

Ethical approval was obtained from the Faculty of Nursing Ethics Committee, Assiut University, Egypt, with the reference number 1120240791 on 25th March 2024. Official permission was secured prior to data collection, and written informed consent was obtained from all participants.

## RESULTS

Table 1 revealed statistically significant seasonal differences in participants' sociodemographic characteristics. Age varied significantly across seasons (ANOVA, $F = 25.627$, $df = 3{,}493$, $p < 0.001$), with the highest mean observed in summer (48.92 ± 12.29; 95% CI: 46.46–51.38) and the lowest in winter (39.09 ± 8.37; 95% CI: 37.81–40.37). Sex distribution also differed significantly across seasons ($\chi^2 = 13.954$, $df = 3$, $p < 0.001$), with a higher proportion of males in winter. Marital status showed significant variation ($\chi^2 = 11.030$, $df = 6$, $p < 0.001$), with the majority of participants being married across all seasons. Occupation and educational level demonstrated significant seasonal variation ($\chi^2 = 124.135$, $df = 12$, $p < 0.001$ and $\chi^2 = 30.121$, $df = 9$, $p < 0.001$, respectively), indicating differences in socioeconomic distribution among seasonal groups.

*Table 1: Distribution of Demographic Data among Participant (n=497)*

| Variables | Full (n=126) | Spring (n=113) | Winter (n=164) | Summer (n=94) | Test | *df* | *p*-value |
|---|---|---|---|---|---|---|---|
| **Age (Mean ± SD)** | 44.54±8.78 | 41.36±7.23 | 39.09±8.37 | 48.92±12.29 | *F*=25.627 | **3**<br>**493** | <0.001 |
| **95% CI** | 43.00–46.08 | 40.03–42.69 | 37.81–40.37 | 46.46–51.38 | — | — | — |
| **Sex** | | | | | $\chi^2$=13.954 | 3 | <0.001 |
| Male | 64 | 70 | 87 | 34 | | | |
| Female | 62 | 43 | 77 | 60 | | | |
| **Marital Status** | | | | | $\chi^2$=11.030 | 6 | <0.001 |
| Single | 8 | 9 | 20 | 14 | | | |
| Married | 113 | 100 | 141 | 73 | | | |
| Widows | 5 | 4 | 3 | 7 | | | |
| **Occupation** | | | | | $\chi^2$=124.135 | 12 | <0.001 |
| Housewife | 42 | 23 | 46 | 44 | | | |
| Employee | 72 | 22 | 30 | 9 | | | |
| Unemployed | 0 | 0 | 0 | 1 | | | |
| Farmer | 10 | 38 | 49 | 23 | | | |
| Worker | 2 | 30 | 39 | 17 | | | |
| **Education** | | | | | $\chi^2$=30.121 | 9 | <0.001 |
| Illiterate | 13 | 2 | 15 | 18 | | | |
| Read and write | 3 | 0 | 0 | 0 | | | |
| Basic education | 86 | 86 | 114 | 66 | | | |
| High education | 24 | 25 | 35 | 10 | | | |

*Degrees of freedom (df)- 3 (for between-group df)& 493 (for within-group df); 95% confidence intervals were calculated only for continuous variables; Chi-square tests were used for categorical variables; One-way ANOVA was used for comparison of means; Significance level set at p < 0.05 and all the p-values are statistically significant*

Table 2 shows the seasonal variation observed in physiological parameters. Although systolic and diastolic blood pressure and pulse rate showed slight differences across seasons, these variations were relatively modest. Systolic blood pressure ranged from 120.54 ± 10.75 mmHg in winter (95% CI: 118.91–122.17) to 122.35 ± 13.48 mmHg in summer (95% CI: 119.61–125.09). Diastolic blood pressure was lowest in winter (69.93 ± 9.03 mmHg; 95% CI: 68.56–71.30) and highest in summer (76.17 ± 10.88 mmHg; 95% CI: 73.96–78.38). Pulse rate showed a similar trend, with higher values in summer (83.01 ± 6.47 bpm; 95% CI: 81.69–84.33) compared to other seasons. These findings suggest mild seasonal physiological variants.

*Table 2: Distribution of Medical Data among Participant (n=497)*

| Variable | Season | Mean ± SD | 95% CI | Test | *df* | *p*-value |
|---|---|---|---|---|---|---|
| **Systolic BP** | Autumn | 122.78±13.24 | 120.46–125.10 | *F* | 3 | 0.007 |
| | Spring | 120.54±11.55 | 118.40–122.68 | | | |
| | Winter | 120.54±10.75 | 118.91–122.17 | | 493 | |
| | Summer | 122.35±13.48 | 119.61–125.09 | | | |
| **Diastolic BP** | Autumn | 74.00±11.09 | 72.05–75.95 | *F* | 3 | 0.001 |
| | Spring | 71.15±9.61 | 69.36–72.94 | | | |
| | Winter | 69.93±9.03 | 68.56–71.30 | | 493 | |
| | Summer | 76.17±10.88 | 73.96–78.38 | | | |
| **Pulse** | Autumn | 81.60±8.34 | 80.14–83.06 | *F* | 3 | 0.009 |
| | Spring | 79.75±9.56 | 77.97–81.53 | | | |
| | Winter | 79.93±10.15 | 78.39–81.47 | | 493 | |
| | Summer | 83.01±6.47 | 81.69¯84.33 | | | |

*Data are presented as mean ± standard deviation (SD). Comparisons among seasons were performed using one-way analysis of variance (ANOVA). Degrees of freedom (df), F-statistics, 95% confidence intervals (CI), and p-values are reported. Statistical significance was considered at p < 0.05; p-values are not statistically significant*

Table 3 presents respiratory symptoms varied significantly across seasons. Night-time wheezing and cough were more prevalent during winter ($\chi^2 = 61.278$, $df = 6$, $p < 0.001$; $\chi^2 = 71.536$, $df = 9$, $p < 0.001$).

Exercise-induced symptoms also showed significant seasonal variation ($\chi^2 = 24.455$, $df = 9$, $p < 0.001$), with higher occurrence during winter. Similarly, morning symptoms ($\chi^2 = 24.167$, $df = 6$, $p < 0.001$) and daytime symptoms ($\chi^2 = 108.255$, $df = 6$, $p < 0.001$) were significantly more frequent in colder seasons. Overall, symptom burden was consistently higher during winter compared to other seasons.

***Table 3: Comparison of Distribution Regarding Respiratory Symptoms (Lung Function) Questionnaire among Participant (n=497)***

| **Variables** | **Categories** | **Full n (%)** | **Spring n (%)** | **Winter n (%)** | **Summer n (%)** | $\chi^2$ | *df* | ***p*-value** |
|---|---|---|---|---|---|---|---|---|
| **Night wheezing** | Little wheezing | 52 (10.5) | 10 (2.0) | 47 (9.5) | 23 (4.6) | 61.278 | 6 | <0.001 |
| | Once at night | 74 (14.9) | 75 (15.1) | 91 (18.3) | 65 (13.1) | | | |
| | Most of night | 0 (0.0) | 28 (5.6) | 26 (5.2) | 6 (1.2) | | | |
| **Night cough** | None | 0 (0.0) | 0 (0.0) | 0 (0.0) | 2 (0.4) | 71.536 | 9 | <0.001 |
| | Little wheezing | 49 (9.9) | 11 (2.2) | 47 (9.5) | 18 (3.6) | | | |
| | Once at night | 76 (15.3) | 75 (15.1) | 90 (18.1) | 71 (14.3) | | | |
| | Most of night | 1 (0.2) | 27 (5.4) | 27 (5.4) | 3 (0.6) | | | |
| **Exercise, cough, tightness** | No occur during strong exercise | 2 (0.4) | 0 (0.0) | 0 (0.0) | 1 (0.2) | 24.455 | 9 | <0.001 |
| | Only occurs during strong exercise | 56 (11.3) | 53 (10.7) | 47 (9.5) | 48 (9.7) | | | |
| | Occurs during climbing stairs | 68 (13.7) | 60 (12.1) | 115 (23.1) | 45 (9.1) | | | |
| | Occurs during ordinary activity | 0 (0.0) | 0 (0.0) | 2 (0.4) | 0 (0.0) | | | |
| **Morning cough, exercise and tightness** | Occurs with exertion | 55 (11.1) | 59 (11.9) | 69 (13.9) | 42 (8.5) | 24.167 | 6 | <0.001 |
| | Mild symptoms without exertion | 70 (14.1) | 54 (10.9) | 95 (19.1) | 46 (9.3) | | | |
| | Waking in the morning due to symptoms | 1 (0.2) | 0 (0.0) | 0 (0.0) | 6 (1.2) | | | |
| **Daytime cough, exercise and tightness** | Once a day | 55 (11.1) | 32 (6.4) | 97 (19.5) | 12 (2.4) | 108.255 | 6 | <0.001 |
| | Two or more times a day | 71 (14.3) | 65 (13.1) | 67 (13.5) | 81 (16.3) | | | |
| | Affecting daytime activity | 0 (0.0) | 16 (3.2) | 0 (0.0) | 1 (0.2) | | | |

*Degrees of freedom (df) were reported for all statistical tests.٩٥٪ confidence intervals were calculated only for continuous variables. One-way ANOVA was used for comparison of means. Significance level set at p < 0.05 and all the p-values are statistically significant*

Table 4 shows significant seasonal differences were observed in several variables of the lung function questionnaire. Smoking status varied across seasons ($\chi^2 = 6.187$, $df = 3$, $p<0.001$), with higher prevalence during winter. Similarly, history of lung disease ($\chi^2 = 6.709$, $df = 3$, $p<0.001$), recent respiratory infections ($\chi^2 = 22.413$, $df = 3$, $p<0.001$), and dyspnea on exertion ($\chi^2 = 8.887$, $df = 3$, $p < 0.001$) were all significantly associated with seasonal variation. These findings indicate that respiratory risk factors and symptoms tend to worsen during colder seasons.

***Table 4: Comparison of Distribution Regarding Lung Function Questionnaire among Participant (n=497)***

| **Variables** | **Categories** | **Full n (%)** | **Spring n (%)** | **Winter n (%)** | **Summer n (%)** | $\chi^2$ | *df* | ***p*-value** |
|---|---|---|---|---|---|---|---|---|
| Smoking | No | 67 (13.5) | 35 (7.0) | 65 (13.1) | 59 (11.9) | 6.187 | 3 | <0.001 |
| | Yes | 59 (11.9) | 78 (15.7) | 99 (19.9) | 35 (7.0) | | | |
| Asthma or another lung disease (current/past) | No | 4 (0.8) | 0 (0.0) | 3 (0.6) | 5 (1.0) | 6.709 | 3 | <0.001 |
| | Yes | 122 (24.5) | 113 (22.7) | 161 (32.4) | 89 (17.9) | | | |
| Breathing medicine in last 6 hours | No | 125 (25.2) | 113 (22.7) | 162 (32.6) | 92 (18.5) | 2.468 | 3 | <0.001 |
| | Yes | 1 (0.2) | 0 (0.0) | 2 (0.4) | 2 (0.4) | | | |
| Medicine for heart problem | No | 125 (25.2) | 104 (20.9) | 164 (33.0) | 92 (18.5) | 0.269 | 3 | <0.001 |
| | Yes | 1 (0.2) | 9 (1.8) | 0 (0.0) | 2 (0.4) | | | |
| Head cold or sinus infection (last week) | No | 21 (4.2) | 7 (1.4) | 17 (3.4) | 26 (5.2) | 22.413 | 3 | <0.001 |
| | Yes | 105 (21.1) | 106 (21.3) | 147 (29.6) | 68 (13.7) | | | |
| Dizzy or short of breath walking up incline | No | 3 (0.6) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 8.887 | 3 | <0.001 |
| | Yes | 123 (24.7) | 113 (22.7) | 164 (33.0) | 94 (18.9) | | | |
| Pulmonary function test done | No | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 5.993 | 3 | <0.001 |
| | Yes | 126 (25.4) | 113 (22.7) | 164 (33.0) | 94 (18.9) | | | |
| If yes: result abnormal/normal | No | 0 (0.0) | 0 (0.0) | 1 (0.2) | 0 (0.0) | 2.035 | 3 | <0.001 |
| | Yes | 126 (25.4) | 113 (22.7) | 163 (32.8) | 94 (18.9) | | | |

*Degrees of freedom (df) were reported for all statistical tests. 95% confidence intervals were calculated only for continuous variables. Chi-square tests were used for categorical variables. Significance level set at p < 0.05 and all the p-values are statistically significant*

Table 5 shows pulmonary function parameters showed statistically significant seasonal variation in $FEV_1$ and $FEV_1/FVC$ ratio ($p < 0.05$), with relatively higher values observed during summer. However, no statistically significant differences were found in FVC, MVV, FEF25, and FEF75 across seasons ($p>0.05$).

***Table 5: Pulmonary Function Parameters by Season (Mean ± SD) among Participant (n=49)***

| Parameter | Spring | Winter | Summer | *p*-value |
|---|---|---|---|---|
| $FEV_1$ (L) | 2.94 ± 0.40 | 2.98 ± 0.39 | 3.15 ± 0.52 | **0.007*** |
| FVC (L) | 3.44 ± 0.51 | 3.53 ± 0.48 | 3.83 ± 0.67 | 0.276 |
| $FEV_1$/FVC (%) | 82.95 ± 3.41 | 81.42 ± 9.01 | 78.30 ± 6.55 | **0.009*** |
| MVV | 5.99 ± 1.86 | 5.31 ± 1.57 | 6.38 ± 2.15 | 0.224 |

*Note: One-way ANOVA used. *Significant at $p<0.05$; $FEV_1$ (Forced Expiratory Volume); FVC (Forced Vital Capacity); MVV (Maximum Voluntary Ventilation); p-values for $FEV_1$ are significant ($p < 0.05$) and the p-values for FVC and MVV are not significant ($p > 0.05$)*

Table 6 shows health-related quality of life varied significantly across seasons. Symptom-related variables, including cough, breathlessness, and night awakening, showed strong seasonal associations ($\chi^2 = 159.946$, $df = 15$, $p < 0.001$; $\chi^2 = 494.883$, $df = 15$, $p<0.001$; $\chi^2 = 46.082$, $df = 15$, $p<0.001$, respectively). Chest tightness ($\chi^2 = 29.886$, $df = 12$, $p<0.001$) and wheezing ($\chi^2 = 181.299$, $df = 15$, $p<0.001$) were also significantly more frequent during winter. Emotional responses, including worry and frustration, differed significantly across seasons ($\chi^2 = 71.764$, $df = 6$, $p<0.001$), while environmental triggers such as dust and cigarette smoke showed strong seasonal effects ($\chi^2 = 57.087$, $df = 6$, $p<0.001$). Activity limitation was also significantly associated with seasonal variation ($\chi^2 = 6.578$, $df = 3$, $p<0.001$), with greater impairment reported during winter.

***Table 6: Summary of Mini Asthma Quality of Life Questionnaire Domains by Season among Participant (n=497)***

| Domain | Main Finding (Highest Season) | $\chi^2$ | *df* | *p*-value |
|---|---|---|---|---|
| Symptoms (Cough, Breathlessness, Night Awakening) | Highest in **winter** | 159.946 | 15 | <0.001 |
| Breathlessness | Highest in **winter** | 494.883 | 15 | <0.001 |
| Night Symptoms | Highest in **winter** | 46.082 | 15 | <0.001 |
| Chest Tightness | Highest in **winter** | 29.886 | 12 | <0.001 |
| Wheezing | Highest in **winter** | 181.299 | 15 | <0.001 |
| Emotional Domain (Worry, Frustration) | Higher in **winter** | 71.764 | 6 | <0.001 |
| Environmental Triggers | Higher in **winter** | 57.087 | 6 | <0.001 |
| Activity Limitation | Greater in **winter** | 6.578 | 3 | <0.001 |

*Degrees of freedom (df) were reported for all statistical tests. 95% confidence intervals were calculated only for continuous variables. Chi-square tests were used for categorical variables. One-way ANOVA was used for comparison of means. Significance level set at $p < 0.05$ and all the p-values are statistically significant*

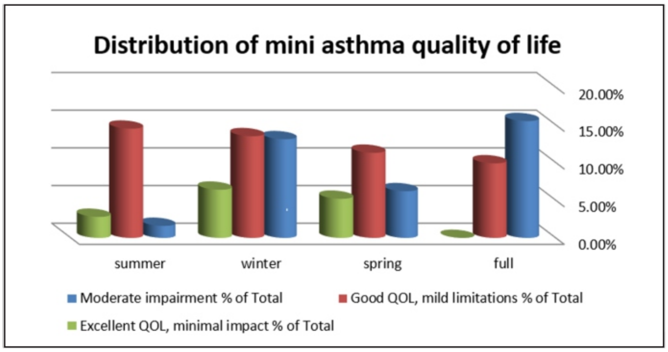

***Figure 1: Relation between Mini Asthma Quality of Life and seasonal variation among participants (n=497)***

Figure 1 presents good QOL with mild limitations was most frequent acrosst the seasons (12%–15%), while moderate impairment was more evident during winter, indicating a seasonal decline in HRQoL.

## DISCUSSION

The findings of this study highlight the clinical importance of seasonal variation as a contributing factor to asthma symptom severity and quality of life, particularly in regions with extreme environmental conditions such as Upper Egypt. The present study revealed significant seasonal variations in the demographic characteristics of patients with bronchial asthma, including age, sex, occupation, and educational level, whereas marital status showed no significant association. Patients presenting in winter were the youngest (mean = 39.09 ± 8.37), while those in autumn were the oldest (mean = 48.92±12.29), suggesting that younger patients may be more susceptible to asthma exacerbations during colder months (Hu *et al*., 2020). These findings are consistent with Montealegre *et al*. (2020), who reported higher rates of asthma exacerbations among younger populations during colder seasons in the United States**.** Educational level varied significantly across seasons, with patients having lower education being more frequently affected (Vicedo-Cabrera *et al* 2021). This suggests limited awareness of asthma triggers and preventive measures, highlighting the need for tailored educational interventions on self-management, particularly in communities with low health literacy. Chronic respiratory diseases continue to represent a significant global health burden, with comorbid conditions contributing to asthma exacerbations (Viegi *et al.,* 2020).

A statistically significant association was observed between seasonal variation and chronic comorbidities ($p = 0.002$). Patients in spring exhibited the highest prevalence of chronic conditions, whereas those in summer and autumn reported the lowest (Areal *et al*., 2022). Diabetes mellitus was most common in winter, suggesting that winter and reduced physical activity may exacerbate metabolic dysregulation and increase asthma severity (Narendra *et al*., 2024; Pham *et al*., 2025 ). Hypertension and heart disease were reported exclusively in autumn and spring ($p < 0.001$), indicating that transitional weather may stress the cardiovascular system, worsening concurrent asthma symptoms. Kidney disease prevalence was highest in spring, coinciding with a peak in positive family history of asthma, highlighting the interplay between hereditary and environmental factors (Listyoko *et al*., 2024). These findings align with Emami-Ardestani and Sajadi (2021), who reported that asthma exacerbations frequently co-occur with chronic conditions that worsen under environmental stress.

Lung function assessment indicated that nearly all participants had impaired function, consistent with Zhang *et al*. (2022), who reported that many asthma patients in real-world settings exhibit impaired lung function despite available treatments. Seasonal analysis showed that most patients had mild or well-controlled asthma, particularly during winter and spring, while moderate asthma was infrequent. The seasonal effect on asthma severity was statistically significant ($p = 0.001$). These findings support Trusculescu *et al*. (2025), who observed slight increases in winter exacerbations, whereas Moore *et al*. (2025) reported no significant seasonal effect among populations with consistent medical therapy, suggesting that treatment adherence may mitigate environmental influences. Poor asthma control has been reported in several populations, highlighting the need for improved management strategies (Vinnikov *et al.,* 2023). Recent evidence also supports the role of advanced pharmacological therapies in improving asthma outcomes (Agache *et al.,* 2025).

Spirometry results showed that $FEV_1$ peaked in summer (3.15 L), reflecting improved airway patency due to warmer weather, increased physical activity, and reduced exposure to infections or indoor allergens (Soriano *et al*., 2020). However, the $FEV_1/FVC$ ratio was lowest in summer, indicating persistent airway obstruction, potentially due to small airway involvement not detected by standard spirometry. These findings suggest that even when lung volumes improve, chronic airway narrowing may persist (Gauderman *et al*., 2015)**.**

QOL assessment showed that nearly half of the participants reported satisfactory QOL with mild limitations, while moderate impairment was most frequent during colder months ($p = 0.000$). These findings are consistent with Makrufardi *et al*. (2025)**,** who reported that colder seasons exacerbate respiratory infections and restrict outdoor activity, increasing symptom burden and psychological stress. Overall, higher asthma severity was associated with lower QOL, highlighting the need for integrated care approaches that combine medical management with behavioral and psychological support to address both physical and emotional aspects of asthma (Makrufardi *et al*., 2023). These findings emphasize the importance of seasonal awareness in asthma management strategies, particularly in regions with harsh environmental conditions (National Asthma Council Australia, 2025).

### Limitations

The cross-sectional, single-center design of this study limits causal inference and generalizability. The use of convenience sampling may introduce selection bias. Additionally, environmental factors such as air pollution, humidity, and pollen exposure were not assessed. The study did not include direct environmental measurements such as humidity or air pollution levels. The study relied on seasonal categorization rather than direct environmental measurements such as air pollution levels.

### Future Scope

Further studies are also recommended to explore the effectiveness of season-specific intervention programs, including preventive strategies and personalized treatment plans. Expanding research to include different geographical regions would enhance the generalizability of findings. Moreover, integrating advanced predictive models and digital health monitoring tools could help in early identification of high-risk periods for asthma exacerbations. This would support proactive management and reduce the burden of asthma on both patients and healthcare systems.

## CONCLUSION

The findings of this study demonstrate that seasonal variation plays a significant role in influencing asthma-related outcomes, including respiratory symptoms, lung function, and HRQoL among patients with bronchial asthma. A clear seasonal pattern was observed, with symptoms such as wheezing, cough, and nocturnal breathlessness being more prevalent during the winter season. Lung function parameters, particularly $FEV_1$ and $FEV_1/FVC$ ratio, showed statistically significant seasonal variation, with relatively improved values during the summer months. However, other parameters such as FVC and Maximum Voluntary Ventilation (MVV) did not show significant differences across seasons. Additionally, HRQoL was notably reduced during winter, where patients experienced higher levels of physical symptoms, emotional distress, environmental triggers, and activity limitations. These findings highlight the combined physiological and psychosocial burden of seasonal changes on asthma patients.

Overall, this study contributes valuable evidence from Northern Egypt, a region characterized by extreme environmental conditions, emphasizing the importance of incorporating seasonal considerations into asthma management strategies. Tailored interventions, including patient education, environmental control, and seasonal treatment adjustments, are essential to improve patient outcomes and quality of life. Nurses should provide season-specific education, particularly before winter, emphasizing medication adherence, trigger avoidance, early symptom recognition, and patient self-management support to enhance quality of life. Future research should focus on longitudinal study designs to better establish causal relationships between seasonal variation and asthma outcomes. Incorporating direct environmental measurements such as temperature, humidity, and air pollution levels would provide more precise insights into environmental triggers.

### Recommendations

Healthcare providers should promote patient enablement, ensure access to insurance coverage, strengthen asthma control, and provide education on self-management, medication adherence, and seasonal risk mitigation to optimize patient well-being and quality of life.

### CRediT Authorship Contribution Statement

S. A. H.: Conceptualization, methodology, data curation, formal analysis, writing – original draft, writing – review and editing. Z. A. M: Supervision, validation, review and editing. M. A. M.: Supervision, validation, review and editing. A. A. H.: Investigation, Clinical supervision, validation, review and editing. W. R. A: Methodology, supervision, writing – review & editing.

### AI Assistance Declaration

The authors declare that generative AI tools (such as ChatGPT) were used only for language enhancement and grammar correction during the preparation of this manuscript. The authors carefully reviewed and revised the content and will take full responsibility for the final version of the manuscript.

### Conflict of Interest

The authors declare no competing interests.

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## REFERENCES

Abdallah, Z. A., & Wagdy Farag, A. A. (2022). Impact of awareness program regarding health consequences of seasonal variation on knowledge, perception and daily life practices among nursing students. *Egyptian Journal of Nursing and Health Sciences, 3*(1), 367–390. https://doi.org/10.21608/ejnhs.2022.227958

Agache, I., Adcock, I. M., Akdis, C. A., Akdis, M., Bentabol-Ramos, G., van den Berge, M., Boccabella, C., Canonica, W. G., Caruso, C., Couto, M., Davila, I., Drummond, D., Fonseca, J., Gherasim, A., Del Giacco, S., Jackson, D. J., Jutel, M., Licari, A., Loukides, S., Moreira, A., … Eguiluz-Gracia, I. (2025). The Bronchodilator and Anti-Inflammatory Effect of Long-Acting Muscarinic Antagonists in Asthma: An EAACI Position Paper. *Allergy, 80*(2), 380–394. https://doi.org/10.1111/all.16436

Ali, N. A., Nafees, A. A., Fatmi, Z., & Azam, S. I. (2021). Dose-response of cotton dust exposure with lung function among textile workers: MultiTex study in Karachi, Pakistan. *International Journal of Occupational and Environmental Medicine, 9*(3), 120–128. https://doi.org/10.15171/ijoem.2018.1191

Areal, A. T., Zhao, Q., Wigmann, C., Schneider, A., & Schikowski, T. (2022).The effect of air pollution when modified by temperature on respiratory health outcomes: A systematic review and meta-analysis. *Science of the Total Environment, 811*(9), 152336. https://doi.org/10.1016/j.scitotenv.2021.152336

Assaf, S. M., Tarasevych, S. P., Diamant, Z., & Hanania, N. A. (2021). Asthma and severe acute respiratory syndrome coronavirus 2019: Current evidence and knowledge gaps. *Current Opinion in Pulmonary Medicine, 27*(1), 45–53. https://doi.org/10.1097/MCP.0000000000000744

Baljet, E., Luijks, H., van den Bemt, L., & Schermer, T. R. (2023). Chronic comorbid conditions and asthma exacerbation occurrence in a general population sample. *NPJ Primary Care Respiratory Medicine, 33*(1), 29. https://doi.org/10.1038/s41533-023-00350-x

Benslimane, A., Garcia-Larsen, V., El Kinany, K., Alaoui Chrifi, A., Hatime, Z., Benjelloun, M. C., El Biaze, M., Nejjar, C., & El Rhazi, K. (2022). Association between obesity and chronic obstructive pulmonary disease in Moroccan adults: Evidence from the BOLD study. *SAGE Open Medicine, 9*, 20503121211031428. https://doi.org/10.1177/20503121211031428

Christidis, N., McCarthy, M., & Stott, P. A. (2020). The increasing likelihood of temperatures above 30 to 40°C in the United Kingdom. *Nature Communications, 11*, 3093. https://doi.org/10.1038/s41467-020-16834-0

D'Amato, G., Annesi-Maesano, I., Biagioni, B., Lancia, A., Cecchi, L., D'Ovidio, M. C., & D'Amato, M. (2023). New Developments in Climate Change, Air Pollution, Pollen Allergy, and Interaction with SARS-CoV-2. *Atmosphere, 14*(5), 848. https://doi.org/10.3390/atmos14050848

Emami-Ardestani, M., & Sajadi, G. (2021). Relationship between metabolic syndrome components and severity of asthma in outpatients referring to Alzahra Hospital Clinic. *Tanaffos (Respiration), 20*(4), 327–331. https://www.tanaffosjournal.ir/article_254205.html

Gauderman, W. J., Urman, R., Avol, E., Berhane, K., McConnell, R., Rappaport, E., Chang, R., Lurmann, F., & Gilliland, F. (2015). Association of improved air quality with lung development in children. *New England*

*Journal of Medicine, 372*(10), 905–913. https://www.nejm.org/doi/full/10.1056/NEJMoa1414123

Global Asthma Network. (2018). The global asthma report 2018. Global Asthma Network. *The Global Asthma Report 2018*. Auckland, New Zealand: Global Asthma Network; 2018. https://globalasthmareport.org/2018/resources/Global_Asthma_Report_2018.pdf

Global Initiative for Asthma (GINA). (2024). *Global strategy for asthma management and prevention*. World Health Organization. https://www.knowledge-action-portal.com/en/content/global-strategy-asthma-management-and-prevention-0

Graham, B. L., Steenbruggen, I., Miller, M. R., Barjaktarevic, I., Cooper, B. G., Hall, G. L., Hallstrand, T. S., Kaminsky, D. A., McCarthy, K., McCormack, M. C., & Thompson, B. R. (2019). Standardization of spirometry 2019 update. An official American Thoracic Society and European Respiratory Society technical statement. *American Journal of Respiratory and Critical Care Medicine, 200*(8), e70–e88. https://doi.org/10.1164/rccm.201908-1590ST

Hu, Y., Cheng, J., Jiang, F., Liu, S., Li, S., Tan, J., Yin, Y., & Tong, S. (2020). Season-stratified effects of meteorological factors on childhood asthma in Shanghai, China. *Environmental Research, 191*, 110115. https://doi.org/10.1016/j.envres.2020.110115

Listyoko, A. S., Okazaki, R., Harada, T., Inui, G., & Yamasaki, A. (2024). Exploring the association between asthma and chronic comorbidities: Impact on clinical outcomes. *Frontiers in Medicine, 11*, 1305638. https://doi.org/10.3389/fmed.2024.1305638

Makrufardi, F., Manullang, A., & Rusmawatiningtyas, D. (2023).Extreme weather and asthma: A systematic review and meta-analysis. *European Respiratory Review, 32*(168), 230019. https://doi.org/10.1183/16000617.0019-2023

Makrufardi, F., Rusmawatiningtyas, D., Murni, I. K., Arguni, E., Lin, Y.-C., Ho, K.-F., Chung, K. F., Lin, S.-C., & Chuang, H.-C. (2025). Seasonal variation of pediatric asthma exacerbations and its association with asthma phenotypes. *Pediatric Research, 98*, 2178–2185. https://doi.org/10.1038/s41390-025-04073-2

Makrufardi, F., Rusmawatiningtyas, D., Murni, I. K., Arguni, E., Lin, Y. C., Ho, K. F., Chung, K. F., Lin, S. C., & Chuang, H. C. (2025). Seasonal variation of pediatric asthma exacerbations and its association with asthma phenotypes. *Pediatric research, 98*(6), 2178–2185.

Moore, C. M., Thornburg, J., & Elizabeth, M. (2025). Comparative analysis of ambient, in-home, and personal exposures reveals associations between breathing zone pollutant levels and asthma exacerbations in high-risk children. *Respiratory Research, 26*(1), 40. https://doi.org/10.1186/s12931-025-03114-y

Narendra, D. K., & Khurana, S. (2024). Asthma and hyperglycemia: Exploring the interconnected pathways. *Diagnostics, 14*(17), 1869. https://doi.org/10.3390/diagnostics14171869

National Asthma Council Australia. (2025). *Australian Asthma Handbook: The national guidelines for health professionals* (Version 3.0). http://www.asthmahandbook.org.au

Pham, A., Corcoran, R., & Foer, D. (2025). The role of type 2 diabetes in the severity of adult asthma. *Current Opinion in Allergy and Clinical Immunology 25*(1), 34-40. https://doi.org/10.1097/aci.0000000000001045

Soriano, J. B., Kendrick, P. J., Paulson, K. R., Gupta, V., Abrams, E. M., Adedoyin, R. A., ... & Moradi, M. (2020). Prevalence and attributable health burden of chronic respiratory diseases, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet Respiratory Medicine, 8*(6), 585-596. https://www.thelancet.com/journals/lanres/article/piis2213-2600(20)30105-3/fulltext

Stanojević, A. D., Vasov, M. S., Randjelović, D. J., & Bogdanović, V. B. (2023). Summer outdoor thermal comfort in multi-family housing: Combining microclimate indicators with human thermal sensation. *Thermal Science, 27*(3B), 2399-2412. https://doi.org/10.2298/TSCI220531150S

Trusculescu, A. A., Ancusa, V. M., Burducescu, A., Pescaru, C. C., Trăilă, D., Wellmann, N., Fira-Mladinescu, O., & Oancea, C. I. (2025). Age-related variations and seasonal influences: A network analysis of comorbidities in asthma hospitalizations (2013–2023). *Journal of Clinical Medicine, 14*(7), 2350. https://doi.org/10.3390/jcm14072350

Vicedo-Cabrera, A. M., Scovronick, N., Sera, F., Royé, D., Schneider, R., Tobias, A., Astrom, C., Guo, Y., Honda, Y., Hondula, D. M., Abrutzky, R., Tong, S., de Sousa Zanotti Stagliorio Coelho, M., Nascimento Saldiva, P. H., Lavigne, E., Matus Correa, P., Ortega, N. V., Kan, H., Osorio, S., … Gasparrini, A. (2021).The burden of heat-related mortality attributable to recent human-induced climate change. *Nature Climate Change, 11*(6), 492–500. https://doi.org/10.1038/s41558-021-01058-x

Viegi, G., Maio, S., Fasola, S., & Baldacci, S. (2020). Global burden of chronic respiratory diseases. *Journal of Aerosol Medicine and Pulmonary Drug Delivery, 33*(4), 171-177. https://doi.org/10.1089/jamp.2019.1576

Vinnikov, D., Raushanova, A., Mukatova, I., Nurpeissov, T., Kushekbayeva, A., Toxarina, A., Yessimova, B., Bespayeva, F., & Brimkulov, N. (2023). Asthma control in Kazakhstan: Need for urgent action. *BMC Pulmonary Medicine, 23*, 7. https://doi.org/10.1186/s12890-022-02287-2

World Health Organization. (2024, May 6). *Asthma – Key facts*. https://www.who.int/news-room/fact-sheets/detail/asthma

World Meteorological Organization. (2019). *Guide to meteorological instruments and methods of observation*. Secretariat of the World Meteorological Organization. https://wmo.int/guide-instruments-and-methods-of-observation-wmo-no-8-0

Zhang, J., Tang, L., Xu, Y., Yang, Y., & Wang, J. (2022). Novel insights into the association between seasonal variations `, blood pressure, and blood pressure variability in patients with new-onset essential hypertension. *BMC Cardiovascular Disorders, 22*(1), 401. https://doi.org/10.1186/s12872-022-02840-1