



## Chronic Obstructive Pulmonary Diseases, its Prevalence, Risk Factors, Causes and Management in Saudi Arabia: Systematic Review

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### ABSTRACT

Chronic obstructive pulmonary illnesses is among the most frequent noncommunicable illnesses, and it is currently the third biggest cause of mortality globally. Our study sought to determine the prevalence of COPD, its associated risk factors, causes, and management in Saudi Arabia. The PubMed database and EBSCO Information Services were utilised to pick articles. In our review, we used all related papers to our issue as well as additional publications. Other papers that were unrelated to this field were not considered. The data was extracted in a specified format, which the group members examined. In Saudi Arabia, the prevalence estimated of COPD is relatively high, moreover, it increases over time. The high prevalence of smoking and increased age were reported to be the most common effective risk factors of COPD in the Saudi population. COPD is generally recognised as a preventable and potentially treated condition if discovered early. Avoiding exposure to hazardous particles, particularly smoking, can help to keep the condition from progressing to a clinically relevant level.

**Keywords:** Chronic obstructive pulmonary disease, Mortality rates, Acute respiratory failure, Risk factor, Saudi Arabia, Smoking

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### INTRODUCTION

Chronic obstructive pulmonary disorder is a widespread noncommunicable not-transmittable illness with a high mortality rate. Currently, COPD is the third leading cause of death worldwide, and It is anticipated that it will top the list within the upcoming ten years (Khan *et al.*, 2014). The Global Initiative for Chronic Obstructive Lung Disease (GOLD) claims that COPD is a widespread, progressive lung condition, controllable, and curable illness. There were 455 million COPD cases and 3.9 million deaths worldwide in 2019 (Singh *et al.*, 2019). COPD is a major public health issue with a negative cost impact. COPD cost the world \$2.1 trillion in 2010, and it is estimated to cost \$4.8 trillion by 2030 (CeE *et al.*, 2011). COPD is still underdiagnosed and underestimated throughout the Middle East, notably in the Gulf Cooperation Council countries. According to World meter statistics, With a population of 35.6 million inhabitants as of 2022, Saudi Arabia is the most populated country in the Middle East. According to the BREATH research conducted in MENA countries (Alqahtani, 2022). Because COPD remains underdiagnosed, this is a conservative estimate. Moreover, the vast comorbidities list associated with COPD, as heart disease, lung cancer, and mental wellness, would create an additional load regarding the medical system

(Dehcheshmeh *et al.*, 2020; Faller *et al.*, 2020; Makhoahle *et al.*, 2022). COPD is characterised by increasing airflow restriction and a heightened chronic inflammatory response to irritating particles or gases in the airways and lungs. Asymptomatic to respiratory failure are possible symptoms (Al Ghobain *et al.*, 2015).

Prolonged exposure to hazardous chemicals or particles results in COPD. There are many risk factors for COPD including genetic factors, family history, type of work, smoking, sex, and age. Cigarette smoking is the leading cause of COPD globally. Other variables might include secondhand smoking exposure, the environment, occupational dangers, and a deficiency of alpha-1 antitrypsin (AATD) (Salama *et al.*, 2020). The symptoms of COPD often appear in maturity, frequently in the winter. Patients typically complain of chronic and deteriorating dyspnea, coughing, and sputum production. Additionally, wheezing and chest tightness are possible in patients. Although smoking history is present in the majority of cases, many people lack it. They need to be questioned about their family history, occupational and environmental exposures, and exposure to secondhand smoke. People with COPD should be questioned about previous exacerbations, overnight awakenings, inhaler use, and how the illness impacts their level of activity. For illnesses such as asthma, allergies, and childhood respiratory infections, patients should be asked about their past medical history (Wali *et al.*, 2014). Several studies done in Saudi Arabia over the last three decades show

that smoking is on the rise, particularly among young men and women. Successful symptom management for chronic diseases is dependent on a variety of factors, including patient adherence to the suggested treatment plan. However, studies indicate that many patients with chronic diseases do not take their medications as directed. PFT (pulmonary function testing) is critical in the diagnosis, staging, and management of COPD (Alaithan *et al.*, 2012; Davani *et al.*, 2022). Spirometry is conducted both before and after an inhaled bronchodilator is administered. Inhaled bronchodilators can be either short-acting beta2-agonists (SABA) or anticholinergics (SAC). Treatment of COPD depends mainly on controlling the symptoms, however, some cases may need IC admission.

#### Objectives

This study's goal was to identify the prevalence of COPD in Saudi Arabia as well as its risk factors, causation, and treatments.

### MATERIALS AND METHODS

This systematic review was carried out in accordance with the established principles (PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses).

#### Study design

This was a comprehensive review.

#### Study duration

From 1<sup>st</sup> June to 31<sup>st</sup> August 2022.

#### Study condition

This review looks at previous studies on the prevalence of COPD, its risk factors, aetiology, and treatment in Saudi Arabia.

#### Search strategy

A thorough literature search of five major databases, including PubMed, Web of Science, Science Direct, EBSCO, and the Cochrane library, was conducted to include the suitable material. Our search was limited to English and was adjusted to each database as needed. To find relevant articles, the following keywords were transformed into Mesh terms in PubMed: "the prevalence of COPD, its associated risk factors, causation, and management in Saudi Arabia." The terms in question were joined with the "OR" and "AND" Boolean operators. Full-text publications in English, publicly available articles, and human trials were among the search results.

#### Selection criteria

The following criteria were used in our study:

- Retrospective cohort studies and cohort cohorts, as well as research designs, offered qualitative or quantitative data on COPD prevalence, risk factors, and management in Saudi Arabia.

The following were among the exclusion criteria:

- Studies that are not done in English
- Studies that do not have open access

#### Data extraction

Rayyan (QCRI) (Al Ghobain *et al.*, 2011) was utilised to discover duplicate features the outcomes of the search approach. By comparing the combined search results to a list of inclusion/exclusion criteria, the researchers evaluated the appropriateness of the titles and abstracts. The reviewers assessed the whole texts of the papers that satisfied the requirements for inclusion. The writers had a discussion to settle any differences. The eligible study was developed into a data extraction form. Research titles, authors, study year, study design, study population, participant count, goals, problems mentioned, and key findings were all gathered by the writers.

#### Evaluation of the bias risk

The ROBINS-I approach for non-randomized studies (Al Ghobain *et al.*, 2011) was used for qualitative data synthesis to assess the quality of the included research. The reviewers discovered and addressed any flaws in the quality assessment.

#### Data synthesis strategy

To provide a qualitative overview of the included research components and outcome data, summary tables with the obtained material from the relevant studies were created. Following the completion of the data collection in this systematic review, judgements were taken on how to best utilise the published information from the listed study publications. Papers that met the full-text inclusion criteria but did not provide data on degree of awareness were excluded.

### RESULTS AND DISCUSSION

#### Search results

The systematic search yielded 87 study papers, after which 44 duplicates were deleted. Twenty papers were eliminated after having their titles and abstracts screened. A total of 122 reports were requested for retrieval, with just 30 items not being found. Finally, 92 articles were screened for full-text evaluation; 20 were excluded due to incorrect research outcomes, 38 were excluded due to insufficient data on the present issue, and 43 were excluded because of the improper sort of population. This study's systematic review included seven eligible articles for research.

#### Characteristics of the studies included

This review covered a total of seven papers. The primary focus of the majority of these studies was ranging from the prevalence of COPD, its associated risk factors, causes, and management in Saudi Arabia. Sex studies had a cross-sectional design (Døssing *et al.*, 1994; Al Ghobain *et al.*, 2011; Wali *et al.*, 2014; Al Ghobain *et al.*, 2015; Salama *et al.*, 2020; Alqahtani, 2022), while only one had a retrospective cohort design (Alaithan *et al.*, 2012; Maiti *et al.*, 2022). The sample size of the studies varied from 119 to 784 individuals. Different age groups were studied including the elderly, adults, and adolescents. All of the included studies were done in Saudi Arabia.

In **Table 1** we included the summary of the included previous studies with their main objectives, key findings, and the year of publication.

**Table 1.** Objectives, key findings, and the year of publication of the included studies

Study	Study design	Location	Sample	Prevalence of COPD	Study Objective	Key findings
Al Ghobain et al. (2015)	Cross-sectional study	Riyadh	784	Total: 4.2% men: 5.7% Women: 2.5%	Using standardised post-bronchodilator spirometry in accordance with the Burden of Obstructive Lung Disease (BOLD) methodology, determine the prevalence of chronic obstructive pulmonary disease (COPD) and associated risk factors in Saudis aged 40. Using standardised post-bronchodilator spirometry in accordance with the Burden of Obstructive Lung Disease (BOLD) methodology, determine the prevalence and risk factors of chronic obstructive pulmonary disease (COPD) in Saudi people aged 40 years.	In Saudi Arabia, the total prevalence of COPD is 4.2%. The primary risk factors for COPD were being male, becoming older, and smoking.
Al Ghobain et al. (2015)	Cross-sectional study	Saudi Arabian		2019: 434,560.64 1990: 101,104.05	Using the Global Burden of Disease (GBD) 2019 dataset, this study analyses and examines Saudi Arabia's COPD prevalence trends from 1990 to 2019.	The prevalence and incidence of COPD has rose in Saudi Arabia between 1990 and 2019. Despite a decline in COPD morbidity and death rates, older adults and men continue to have higher rates than others. The frequency and incidence of COPD have risen gradually in Saudi Arabia between 1990 and 2019. Even though COPD mortality and morbidity rates have been declining, males and older people continue to have higher rates than women.
Salama et al. (2020)	case-control study	Arar City, Northern Border Province, Saudi Arabia	314	50%	to discover risk factors for Chronic Obstructive Pulmonary Disease in people.	The findings of this study revealed that the amount and duration of smoking, rather than merely smoking, were key risk factors for COPD.
Wali et al. (2014)	cross-sectional,	Saudi Arabian		2.4%	This study set out to find out how common chronic obstructive pulmonary disease (COPD), as defined by epidemiology, was in Saudi Arabia. To estimate the incidence of chronic obstructive pulmonary disease (COPD), as defined by epidemiology, in Saudi Arabia	The prevalence of epidemiologically characterised COPD in Saudi Arabia's general population is 2.4%, which is lower than the prevalence recorded in developed nations.
Alaithan et al. (2012)	retrospective cohort	Saudi Arabia	119	100%	to assess the in-hospital and intensive care unit (ICU) outcomes of patients hospitalised with COPD exacerbation, and to identify prognostic markers.	Patients with COPD who are admitted to the ICU with an exacerbation had low chances of early ICU and hospital mortality. The development of acute renal failure, intubation, prolonged use of mechanical ventilation, and low Glasgow Coma Scale scores upon admission were found to be risk factors for greater hospital mortality. Patients with COPD who have been admitted to the ICU with an exacerbation have a low rate of early ICU and hospital death. The development of acute renal failure, intubation, extended use of mechanical ventilation, and low Glasgow Coma Scale scores upon admission were found to be risk factors linked to higher hospital mortality.

Al Ghobain et al. (2011)	cross-sectional	Saudi Arabia	501	29 (22%)	to assess the prevalence of COPD among smokers over the age of 40 attending primary healthcare clinics.	Underdiagnosis of COPD at primary healthcare clinics in Saudi Arabia is widespread, however the amount is comparable to evidence available in the literature for other countries. Spirometry as a standard test for all patients over the age of 40 with a smoking history can aid in the early detection and appropriate diagnosis of COPD, allowing for the implementation of preventative treatments.
Døssing et al. (1994)	case-control	Saudi Arabia	121	41.3%	to reveal possible risk factors for COPD.	There was no difference in incense burner use between cases and controls. However, two-thirds of the COPD-women and just one-twentieth of the control women had been exposed to indoor open fire for more than 20 years (P005).

Based on the previously estimated data regarding chronic obstructive pulmonary disease (COPD) its prevalence, risk factors, and management in Saudi Arabia, limited data are available. However, it is thought that instances of COPD go undiagnosed until they reach an advanced state (Chapman et al., 2006). The few studies that have looked at the prevalence of COPD in Saudi Arabia have found it to be comparable to other wealthy countries (Khattab et al., 2012; Tageldin et al., 2012; Adeloye et al., 2015). The stated prevalence in the general Saudi adult population ranges between 2.4% and 4.2% (Tageldin et al., 2012), and it is predicted to rise further due to the relatively high number of smokers in Saudi Arabia (27.9% of the Saudi population aged >40 years) (Khattab et al., 2012). Mohammed Al Ghobain et al. (2015) The total prevalence of GOLD COPD was predicted to be 4.2% (male 5.7%) and (2.5% women). Using the LLN, the total prevalence of stage 1 or higher COPD was lower (3.2%) than using the GOLD criteria. Overall, 3.7% of people had GOLD stage 2 or higher COPD. Wali et al. (2014) According to the epidemiological definition of COPD employed, the estimated prevalence was only 2.4%, which is lower than the prevalence reported by local and international research (Al Ghobain et al., 2011; Tageldin et al., 2013). In another study by Alqahtani (2022), Using the GBD database to investigate the COPD burden in Saudi Arabia, they projected the country's Incidence of COPD in 2019 to be 1,918.06-2,194.29 instances per 100,000, or 2,053.04 a 49% rise since 1990. The growing incidence of COPD in Saudi Arabia can be attributed to a rise in adult smoking rates, the use of water pipes, exposure to biomass fuel, outdoor air pollution, and the ageing of the population (Al Ghobain, 2011). There has been a rise in smoking in Saudi Arabia over the past three decades, according to many studies done there, particularly among young men and women. According to a representative 2013 poll, the overall prevalence of smoking was 12.2%, with men smoking at a higher rate than women (21.5% vs. 1.1%). Many other previous studies estimated that age, sex, and smoking are the most common risk factors for COPD (Laniado-Laborin, 2009). Mohammed Al Ghobain et al. (2015) reported male sex, increasing age, and smoking as risk factors for COPD, as these items were significantly associated with COPD diagnosis. This was similar to the results reported by Salama et al. (2020), in their case-control study, found a significant difference with regard to age, duration of smoking,

and the amount of smoking between the study group and controls. This was consistent with most of the studies in Asia and Saudi Arabia (Tuder & Petrache, 2012; Wang et al., 2018; Zha et al., 2019). Basem M M Salama et al. (2020) found a significant difference related to age in our study group compared to the control group, with male dominance, as the male and female ratio was (57% and 43% respectively). This is consistent with many studies worldwide (Aryal et al., 2013; Fragoso, 2016). Al Ghobain et al. (2011) recently revealed that 14.2% of smokers >40 years of age attending a basic healthcare clinic in Saudi Arabia had COPD. Similar results were obtained by Døssing et al. (1994) Genetic factors and family history were also reported as risk factors for COPD previously (Terzikhan et al., 2016). In addition, a lot of Saudis have a history of COPD risk factors such TB, recurrent asthma, and respiratory tract infections dating back to childhood. As the frequency of COPD rises in Saudi Arabia, non-smoking factors such biomass fuel, dust, gases, and outdoor air pollution are frequently to blame. This supports the findings of Salama et al. (2020). As the population ages, so do the incidence, morbidity, and death rates, emphasising the necessity of early COPD screening and diagnosis (Quaderi & Hurst, 2018). Those with COPD who are admitted to the ICU with an exacerbation have early ICU and hospital mortality has been observed to be low. Low Glasgow Coma Scale scores at entry, intubation, The development of acute renal failure and prolonged use of mechanical ventilation were found to be risk factors for greater hospital mortality. Alaitan et al. (2012) ICU mortality was 6%, and hospital mortality was 11%; nevertheless, total hospital mortality was lower than death rates reported in earlier studies (Raurich et al., 2004; Ai-Ping et al., 2005). This could be because the continuous observation of the patient and The use of noninvasive mechanical ventilation as soon as possible was associated with a high success rate (84%). Alqahtani (2022) found a mild reduction in the mortality rates COPD-related deaths were decreased to 1.65% in 2019 in comparison to 1990 (1.74%), however, Saudi males had greater rates than Saudi females. Morbidity and mortality rates in the Saudi Arabian COPD population are increasing as the population ages. Saudi Arabia is ranked 26th out of 190 nations in terms of healthcare system quality, according to the WHO (Almalki et al., 2011). However, the overall number of patients who attended public hospital emergency departments and chest

illness clinics, as well as the number of persons who died from respiratory disorders, has climbed considerably during the last four years. This, however, may be explained by the growing number of patients suffering from respiratory disorders (Al-Ahmadi & Roland, 2005; Idrees et al., 2012). More efforts should be done to modification of IC units, hospitalization levels, and health care providers in order to decrease mortality rates.

### CONCLUSION

In Saudi Arabia, the prevalence estimated of COPD is relatively high, moreover, it increases over time. The high prevalence of smoking and increased age were reported to be the most common effective risk factors of COPD in the Saudi population. COPD is generally recognised as a preventable and potentially treated condition if discovered early. Avoiding exposure to hazardous particles, particularly smoking, can help to keep the condition from progressing to a clinically relevant level.

### Limitations

The inclusion of a descriptive and cross-sectional study into one meta-analysis may introduce heterogeneity in the results; this weakness was covered by using a random effect. Also, the lack of access to some of the published or unpublished articles could be considered the limitations of the study.

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### REFERENCES

- Adeloye, D., Chua, S., Lee, C., Basquill, C., Papana, A., Theodoratou, E., Nair, H., Gasevic, D., Sridhar, D., Campbell, H., et al. (2015). Global and regional estimates of COPD prevalence: Systematic review and meta-analysis. *Journal of Global Health*, 5(2), 020415.
- Ai-Ping, C., Lee, K. H., & Lim, T. K. (2005). In-hospital and 5-year mortality of patients treated in the ICU for acute exacerbation of COPD: A retrospective study. *Chest*, 128(2), 518-524.
- Al Ghobain M. (2011). The prevalence of chronic obstructive pulmonary disease in Saudi Arabia: Where do we stand? *Annals of Thoracic Medicine*, 6(4), 185-186.
- Al Ghobain, M., Al-Hajjaj, M. S., & Wali, S. O. (2011). Prevalence of chronic obstructive pulmonary disease among smokers attending primary healthcare clinics in Saudi Arabia. *Annals of Saudi Medicine*, 31(2), 129-133.
- Al Ghobain, M., Alhamad, E. H., Alorainy, H. S., Al Kassimi, F., Lababidi, H., & Al-Hajjaj, M. S. (2015). The prevalence of chronic obstructive pulmonary disease in Riyadh, Saudi Arabia: A BOLD study. *The international journal of tuberculosis and lung disease: The official journal of the International Union against Tuberculosis and Lung Disease*, 19(10), 1252-1257. doi:10.5588/ijtld.14.0939
- Al-Ahmadi, H., & Roland, M. (2005). Quality of primary health care in Saudi Arabia: A comprehensive review. *International Journal for Quality In Health Care: Journal of the International Society for Quality in Health Care*, 17(4), 331-346.
- Alaithan, A. M., Memon, J. I., Rehmani, R. S., Qureshi, A. A., & Salam, A. (2012). Chronic obstructive pulmonary disease: Hospital and intensive care unit outcomes in the Kingdom of Saudi Arabia. *International Journal of Chronic Obstructive Pulmonary Disease*, 7, 819-823.
- Almalki, M., Fitzgerald, G., & Clark, M. (2011). Health care system in Saudi Arabia: An overview. *Eastern Mediterranean health journal = La revue de sante de la Mediterranee orientale = al-Majallah al-sihhiyah li-sharq al-mutawassit*, 17(10), 784-793.
- Alqahtani J. S. (2022). Prevalence, incidence, morbidity and mortality rates of COPD in Saudi Arabia: Trends in burden of COPD from 1990 to 2019. *PloS One*, 17(5), e0268772. doi:10.1371/journal.pone.0268772
- Aryal, S., Diaz-Guzman, E., & Mannino, D. M. (2013). COPD and gender differences: An update. *Translational Research: The Journal of Laboratory and Clinical Medicine*, 162(4), 208-218.
- Bloom, D. E., Cafiero, E., Jané-Llopis, E., Abrahams-Gessel, S., Bloom, L. R., Fathima, S., Feigl, A. B., Gaziano, T., Hamandi, A., Mowafi, M., et al. (2011). The global economic burden of non-communicable diseases. In *Geneva: World Economic Forum and the Harvard School of Public Health*. Available from: www.weforum.org/EconomicsOfNCD
- Chapman, K. R., Mannino, D. M., Soriano, J. B., Vermeire, P. A., Buist, A. S., Thun, M. J., Connell, C., Jemal, A., Lee, T. A., Miravittles, M., et al. (2006). Epidemiology and costs of chronic obstructive pulmonary disease. *The European Respiratory Journal*, 27(1), 188-207.
- Davani, S. A., Rahimi, C., & Imani, M. (2022). Emotional expression styles among depressed and OCD patients. *Journal of Advanced Pharmacy Education and Research*, 12(4), 102-106.
- Dehcheshmeh, N. F., Dashti, R., Moradi-Joo, E., & Khiavi, F. F. (2020). Association between social capital and quality of health services from the perspective of hospital managers. *Entomology and Applied Science Letters*, 7(1), 14-19.
- Døssing, M., Khan, J., & Al-Rabiah, F. (1994). Risk factors for chronic obstructive lung disease in Saudi Arabia. *Respiratory Medicine*, 88(7), 519-522.
- Faller, E. M., Hernandez, M. T., Hernandez, A. M., & Gabriel, J. R. S. (2020). Emerging roles of pharmacist in global health: An exploratory study on their knowledge, perception and competency. *Archives of Pharmacy Practice*, 11(1), 40-46.
- Fragoso C. A. (2016). Epidemiology of Chronic obstructive pulmonary disease (COPD) in aging populations. *COPD*, 13(2), 125-129.
- Idrees, M., Koniski, M. L., Taright, S., Shahrour, N., Polatli, M., Ben Kheder, A., Alzaabi, A., Iraqi, G., Khattab, A., Javed, A., et al. (2012). Management of chronic obstructive pulmonary disease in the Middle East and North Africa: Results of the BREATHE study. *Respiratory Medicine*, 106 Suppl 2, S33-S44.

- Khan, J. H., Lababidi, H. M., Al-Moamary, M. S., Zeitouni, M. O., Al-Jahdali, H. H., Al-Amoudi, O. S., Wali, S. O., Idrees, M. M., Al-Shimemri, A. A., Al Ghobain, M. O., et al. (2014). The Saudi guidelines for the diagnosis and management of COPD. *Annals of Thoracic Medicine*, 9(2), 55-76.
- Khattab, A., Javaid, A., Iraqi, G., Alzaabi, A., Ben Kheder, A., Koniski, M. L., Shahrour, N., Taright, S., Idrees, M., Polatli, M., et al. (2012). Smoking habits in the Middle East and North Africa: Results of the BREATHE study. *Respiratory Medicine*, 106 Suppl 2, S16-S24.
- Laniado-Laborín, R. (2009). Smoking and chronic obstructive pulmonary disease (COPD). Parallel epidemics of the 21st century. *International Journal of Environmental Research and Public Health*, 6(1), 209-224.
- Maiti, S., Rai, N., Appanna, P., & Jessy, P. (2022). Digital telescopic denture- A viable treatment modality of preventive prosthodontics: Clinical report. *Annals of Dental Specialty*, 10(4), 1-4.
- Makhoahle, P., & Gaseitsiwe, T. (2022). Efficacy of disinfectants on common laboratory surface microorganisms at R.S mangaliso hospital, NHLS laboratory, South Africa. *Bulletin of Pioneering Researches of Medical and Clinical Science*, 1(1), 1-12.
- Quaderi, S. A., & Hurst, J. R. (2018). The unmet global burden of COPD. *Global Health, Epidemiology And Genomics*, 3, e4.
- Raurich, J. M., Pérez, J., Ibáñez, J., Roig, S., & Batle, S. (2004). In-hospital and 2-year survival of patients treated with mechanical ventilation for acute exacerbation of COPD. *Archivos de Bronconeumología*, 40(7), 295-300.
- Salama, B. M., Abukanna, A. M., & Hegazy, A. M. (2020). Risk factors associated with chronic obstructive pulmonary disease in Arar, Saudi Arabia: A case-control study. *Medical Science*, 24(104), 2487-2493.
- Singh, D., Agusti, A., Anzueto, A., Barnes, P. J., Bourbeau, J., Celli, B. R., Criner, G. J., Frith, P., Halpin, D. M. G., Han, M., et al. (2019). Global strategy for the diagnosis, management, and prevention of chronic obstructive lung disease: The GOLD science committee report 2019. *The European Respiratory Journal*, 53(5), 1900164.
- Tageldin, M. A., Nafti, S., Khan, J. A., Nejjari, C., Beji, M., Mahboub, B., Obeidat, N. M., Uzaslan, E., Sayiner, A., Wali, S., et al. (2012). Distribution of COPD-related symptoms in the Middle East and North Africa: Results of the BREATHE study. *Respiratory Medicine*, 106 Suppl 2, S25-S32.
- Terzikhan, N., Verhamme, K. M., Hofman, A., Stricker, B. H., Brusselle, G. G., & Lahousse, L. (2016). Prevalence and incidence of COPD in smokers and non-smokers: The rotterdam study. *European Journal of Epidemiology*, 31(8), 785-792.
- Tuder, R. M., & Petrache, I. (2012). Pathogenesis of chronic obstructive pulmonary disease. *The Journal of Clinical Investigation*, 122(8), 2749-2755.
- Wali, S. O., Idrees, M. M., Alamoudi, O. S., Aboulfarag, A. M., Salem, A. D., Aljohaney, A. A., Soliman, M. H., & Abdelaziz, M. M. (2014). Prevalence of chronic obstructive pulmonary disease in Saudi Arabia. *Saudi Medical Journal*, 35(7), 684-690.
- Wang, C., Xu, J., Yang, L., Xu, Y., Zhang, X., Bai, C., Kang, J., Ran, P., Shen, H., Wen, F., et al. (2018). Prevalence and risk factors of chronic obstructive pulmonary disease in China (the China Pulmonary Health [CPH] study): A national cross-sectional study. *Lancet (London, England)*, 391(10131), 1706-1717.
- Zha, Z., Leng, R., Xu, W., Bao, H., Chen, Y., Fang, L., Liu, Z., & Ye, D. (2019). Prevalence and risk factors of chronic obstructive pulmonary disease in Anhui Province, China: A population-based survey. *BMC Pulmonary Medicine*, 19(1), 102.