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Sex based differences in depression, anxiety, and quality of life and predictors of quality of life among South Asian individuals with chronic obstructive pulmonary disease: A Bayesian analysis

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ABSTRACT

Background: COPD can affect both men and women leading to deteriorating impact on general well-being, personal, and family life and decreased quality of life. Anxiety, depression, and self-care behaviours can affect the quality of life of individuals with COPD. There is a dearth of sex-based comparative analyses of anxiety, depression, quality of life, and predictors of quality of life among South Asian individuals with COPD.
Purpose: To identify the sex-based differences in depression, anxiety, and quality of life and the predictors of quality of life among South Asian individuals with COPD.
Methods: A cross-sectional survey of 294 men and 114 women with COPD was conducted in Khyber Pakhtunkhwa, Pakistan. Hospital Anxiety and Depression scale, World Health Organization Quality of Life-brief version, Self-Care of Chronic Obstructive Pulmonary Disease Inventory, the Self-Care Self-Efficacy in COPD Scale were used for data collection. Bayesian independent sample *t*-test was used to compare mean differences in depression, anxiety, and quality of life among men and women. Two regression models were examined to determine if age, years of living with COPD, anxiety, depression, self-care self-efficacy, self-care monitoring, management, and maintenance were predictors of quality of life among men and women.
Findings: Bayesian analysis showed anecdotal evidence that women had higher levels of depression, but lower levels of anxiety compared to men. Anecdotal evidence indicated that the physical quality of life of men was better than women, but strong evidence that their social relationship and environmental quality of life was better than women. Years of living with COPD, anxiety, depression, self-care self-efficacy, self-care management, self-care monitoring, and self-care maintenance were stronger predictors of women's quality of life. Anxiety and depression only predicted men's psychological quality of life, but predicted women's psychological, social relationships, and environmental quality of life.
Conclusions: The findings contribute to literature highlighting sex-based differences in anxiety, depression, and quality of life among South Asian men and women with COPD. Men generally reported higher levels of quality of life than women across all domains. Women's social relationships and environmental quality of life were greatly impacted by anxiety and depression. Quality of life interventions for women should be targeted at improving their social relationships and environmental satisfaction and addressing anxiety and depression.

1. Introduction

An estimated global prevalence of Chronic Obstructive Pulmonary Disease (COPD) in 2019 was 10.3% (391·9 million individuals) (Adeloye et al., 2022). The estimated point prevalence was 2638.2 per 100,000, along with 74.4 million disability-adjusted life years (DALYs) (Safiri et al., 2022). While COPD is often considered a disease of men, it is also prevalent among women. Ntritsos et al. (2018), based on a systematic review, identified that the summary prevalence of COPD was 9.23% in men and 6.16% in women. COPD can lead to deteriorating impact on

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general well-being, personal, and family life and decreased Quality of Life of individuals (QOL) (Hurst et al., 2020; Miravitlles and Ribera, 2017; Loughran et al., 2020; Selzler et al., 2020). The range of symptoms affecting general well-being and QOL of individuals may include physiological (i.e., decreased lung function, breathlessness, limited activity, and poor sleep) and psychological symptoms (i.e., depression, anxiety, anticipated stress of deteriorating symptoms) (Hurst et al., 2020; Miravitlles and Ribera, 2017; Christiansen et al., 2023). Increasing symptom burden can affect the self-care and regulation among individuals living with COPD (Selzler et al., 2020; Bringsvor et al., 2018), resulting in an increased likelihood of hospitalization, complications, and comorbidities (Hurst et al., 2021; Zareifopoulos et al., 2019).

Several qualitative studies and reviews of qualitative research explored the experiences of men (Disler et al., 2014; Zeb et al., 2021) and women (Steindal et al., 2017; Ekdahl et al., 2022, 2023; Ekdahl, 2021) living with COPD and its impact on their personal, social, and family lives (de Sousa Pinto et al., 2013). These studies highlighted that the impact of COPD on men and women is contingent on their life circumstances and socio-cultural contexts. Previous quantitative studies also explored sex-based differences in men and women with COPD (Raghavan et al., 2017; DeMeo et al., 2018; Zhang et al., 2021; Perez et al., 2020). Raghavan et al. (2017) noted that women with COPD are more likely to experience dyspnea, chronic bronchitis, anxiety, and depression compared to men. DeMeo et al. (2018) reported that women are more prone to experience severe dyspnea, airflow limitation, and greater risk for exacerbations. Zhang et al. (2021) identified the symptom cluster differences among men and women and found that women experienced more anxiety, depression, and poor sleep, but these differences were not statistically significant. They identified two symptom clusters comprising nine symptoms in women: mood-general symptom cluster (i.e., anxiety, depression, poor sleep, fatigue, and frailty) and respiratory symptom cluster (i.e., chest tightness, dyspnea, cough, and sputum). Among men, three symptom clusters were identified, namely: respiratory-general symptoms cluster (i.e., chest tightness, dyspnea, poor sleep, fatigue, and frailty), mood symptom cluster (i.e., anxiety and depression), and cough-sputum symptom cluster (i.e., cough and sputum). The qualitative and quantitative evidence among men and women highlight that anxiety and depression are among the common symptoms in both sexes and affect their general QOL. There are ample qualitative and quantitative studies on QOL and its determinants in men and women with COPD (Raherison et al., 2014; Ståhl et al., 2005; Cleland et al., 2007; Fazekas-Pongor et al., 2021; de Torres et al., 2006; Esteban et al., 2020; Buttery et al., 2021). These studies also note that depression and anxiety are critical factors in affecting the QOL of individuals with COPD (Raherison et al., 2014; Fazekas-Pongor et al., 2021; de Torres et al., 2006; Esteban et al., 2020; Buttery et al., 2021).

To address anxiety, depression, and QOL, it is important that individuals with COPD perform self-care (Zeb et al., 2021; Younas et al., 2024; Schrijver et al., 2022). The Middle-Range Theory of Self-Care of Chronic Illness outlines self-care as a complex process entailing three domains: self-care maintenance, which focuses on taking proactive steps to improve one's overall mental and physical health and being attentive to one's own needs for physical, emotional, and psychological well-being. Second, self-care monitoring refers to meticulous observation, identification, and categorizing of symptoms (e.g., monitoring breathlessness or tracking daily weight). Finally, self-care management includes engagement in behaviours for responding to symptoms and quickly accessing necessary and sufficient care (Riegel et al., 2012, 2017). In addition, self-care efficacy is also seen to be an essential factor in self-care for COPD and denotes individuals' confidence to engage in self-care maintenance, monitoring, and management (Matarese et al., 2020; Allegrante et al., 2019).

While ample evidence, as highlighted above, is available on sex-based differences in anxiety, depression, and QOL in COPD, there are three key research gaps. First, much of the literature on sex-differences in COPD includes European, North American, and Asian individuals with a dearth of literature among South Asians (e.g., Pakistani, Indian, Bangladeshi) individuals with COPD. A limited number of existing studies are either qualitative (Zeb et al., 2021; Younas et al., 2024) or quantitative studies that only focus on anxiety and depression without in-depth sex-based comparison (Husain et al., 2021). There are also limited mixed methods studies about COPD, anxiety, depression, and their predictors and how various dimensions of self-care affect the QOL of individuals with COPD. The socio-cultural conditions, determinants, and lifestyles of South Asians are distinct from other populations. For example, religion, traditional medicine, and gender roles can affect the anxiety, depression, and QOL of men and women differently in South Asian contexts (Zeb et al., 2021; Younas et al., 2024), hence a need exists to examine sex-based differences in anxiety, depression, and QOL in this population. Second, there are no studies examining anxiety, depression, self-care maintenance, self-care monitoring, self-care management, and self-care efficacy as predictors of QOL among men and women with COPD. Finally, global quantitative research on sex differences in COPD primarily use frequentist statistics (i.e., relying on p-value, hypothesis testing based on the only the null hypothesis). The frequentist statistical methods have been criticized for over-relying on p-value, which offers limited information about the relationship of variables and offers weak strength of evidence concerning the plausibility, presence, certainty, or importance of associations among variables as well as contributing to replication crisis in science (Wasserstein et al., 2019; Ioannidis, 2019; van de Schoot et al., 2021). Therefore, this study uses Bayesian analysis to examine sex-based differences and QOL predictors among men and women with COPD. Bayesian statistics offer an alternate method to analyze data for dealing with the complexity inherent in clinical decision-making and social policy making. The essential characteristic feature of Bayesian statistics is that they allow researchers to integrate their prior knowledge during the estimation process to generate plausible evidence supporting or against both the null and alternate hypotheses by generating the Bayes factor, which is a more clinically relevant measure to inform decision making compared to p-value because they are derived from actual data (Wasserstein et al., 2019; van de Schoot et al., 2021).

2. Purpose

The purpose of the study was three-fold. First, to determine the levels of anxiety, depression, and QOL among men and women with COPD. Second, to identify the sex-based differences in depression, anxiety, and QOL. Third, to determine if age, years of living with COPD, anxiety, depression, and varied domains of self-care were predictors of QOL among South Asian men and women with COPD.

3. Methods

3.1. Design and setting

This study is a part of a multiphase mixed methods study named Self Care in COPD. A convergent mixed methods project was used for the original study, including parallel qualitative and quantitative data collection (Creswell et al., 2018). A cross-sectional design was used for this quantitative phase. We used the Sex and Gender Equity in Research (SAGER) guidelines for reporting this study (Heidari et al., 2016). The data were collected at five large tertiary care hospitals in two cities (Peshawar and Swat) from June 2022 to January 2023, in Khyber Pakhtunkhwa, Pakistan. These hospitals had 14 outpatient departments, and approximately 500 individuals with COPD visited these departments every week.

3.2. Sample and sampling

The target population includes patients affected by COPD who visited the outpatient pulmonary clinic for follow-up appointments. A

convenience sampling technique was used because of the lack of sampling frame as the exact number of patients and their list could not be obtained. Patients were selected based on the following inclusion criteria: a) at least 30 years of age at any stage of COPD, b) having confirmed diagnosis of COPD and receiving the treatment, c) patients who were engaged in self-care at their homes or communities, and d) patients who showed an interest to participate and were able to provide informed consent. The diagnosis of COPD was confirmed after reviewing patients' medical records from the outpatient clinics. Medical records indicated that spirometry was used at the time of admission as a diagnostic test to assess airflow obstruction as per Global Initiative for Chronic Obstructive Disease (GOLD)'s diagnostic criteria of forced expiratory volume in 1 s (FEV1)/forced vital capacity (FVC) less than 0.7 after bronchodilator use (GOLD, 2020). For this study, we did not collect the data on FEV1/FVC ratio for each patient because it was not available in their outpatient files and many of these patients were diagnosed several years ago.

Apriori sample size estimation is generally not required in Bayesian analysis as the sampling plan is flexible (Visser et al., 2024; Stefan et al., 2019). However, since we intended to perform both frequentist and Bayesian analysis in this multiphase mixed methods study, we estimated sample size using both Frequentist and Bayesian approaches. The frequentist sample size estimation was completed using the using the formula ($n = z^2\ [p \times q]/d^2$), where n = sample size, p = estimated proportion of primary variable (i.e., QOL) was approximate (50%), $q = 1 - p$ (50%), and d = margin of error (5%). The estimated sample size was 384 + 10% non-response rates. The final estimated sample was 408. The Bayesian sample size estimation was completed using Bayes Factor Design Analysis (BFDA) with Fixed-N procedure using the Shiny App (https://shinyapps.org/apps/BFDA/). BFDA uses Monte Carlo Simulations. In Fixed-N procedure, a pre-determined sample size and/or effect size is used to seek answers on what Bayes factor can be expected, what is the probability of misleading evidence, and what is appropriate sample size to obtain true positive or true negative results (Stefan et al., 2019). Drawing from the frequentist sample size, we specified at least 110 observations per group (men and women), an upper boundary of 10 and a lower boundary of 1/10, and Cauchy prior (0, $\sqrt{2}/2$). This analysis showed that at least 103 observations per group would be needed to obtain a Bayes factor larger than 10 with a probability of 0.8.

3.3. Data collection instruments

Demographic information was collected using a questionnaire consisting of 13 items about age, gender, ethnicity, smoking, addiction, socioeconomic status, educational status, type of family, primary decision maker in the family, type of residential community, number of years living with COPD, number of family caregivers, and type of health care services utilized. Anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS). HADS comprises two subscales and 14 items. The Hospital Anxiety and Depression Scale Depression Subscale [HADS-D]) and the Hospital Anxiety and Depression Scale Anxiety Subscale [HADS-A]). A three-point Likert scale is used as the response set:'0' (not at all) to '3' (most of the time). Items 1, 3, 5, 7, 9, 11, and 13 are designed to assess HADS-A and items 2, 4, 6, 8, 10, 12, and 14 to determine HADS-D. The total HADS-A and HADS-D score is the sum of all the items. During scoring, eight items are reversed scored (1, 3, 5, 11, 13, 6, 8, 10). The total score for the subscales ranges from 0 to 21 (0–7 = normal, 8–10 = borderline, and 11–21 = either anxious or depressed) (Zigmond and Snaith, 1983). The Urdu-translated HADS developed by Lodhi et al. (2020) was used in this study. The Urdu version has acceptable validity and reliability. In this study, the Cronbach's alpha for the anxiety subscale was 0.82 and 0.64 for the depression subscale. The overall alpha was 0.84.

The Urdu version of WHOQOL-BREF was used to measure QOL. It is a 26-item valid, and reliable instrument measuring QOL in four domains: physical health (7 items), psychological health (6 items), social relationships (3 items), and environmental health (8 items). The scale also includes two general items about QOL and general health. The items are scores on 1 to 5-point Likert scale. The average possible scores for the physical domain ranges from 7 to 35, for the psychological the score is 6–30, for the social relationship domain the score ranges from 3 to 15, and for the environmental domain the score ranges from 8 to 40. (World Health Organization's QOL group [World Health Organization's Quality of Life group, 1992]; WHOQOL Group, 1995).

The valid and reliable Urdu version of the Self-care of Chronic Obstructive Pulmonary Disease Inventory (SC-COPDI) was used to measure three self-care domains: maintenance, monitoring, and management. The SC-COPDI is a 5-point Likert-type instrument that comprises 32 items divided into three scales. The 13-item Self-Care Maintenance Scale measures the behaviours performed by people with COPD to maintain stability of their disease. The 8-item Self-Care Monitoring Scale evaluates the monitoring of different clusters of symptoms in COPD, mainly the triad symptom (i.e., dyspnea, coughing and sputum). The 10-item Self-Care Management Scale describes the behaviours that people with COPD are able to perform autonomously on appearance of symptoms. The total standardized score for each scale ranges from o to 100 with higher score meaning better self-care (Matarese et al., 2020). In this study, Cronbach's alpha coefficient for the self-care maintenance scale was 0.92, self-care monitoring was 0.91, and self-care management was 0.92. The Self-Care Self-Efficacy Scale in COPD (SCES-COPD) was used to assess self-efficacy levels (Matarese et al., 2020). SCES-COPD is a 7-item scale designed to determine patient confidence in performing self-care behaviours. The items are rated on a 5-point scale from 1 (not confident) to 5 (extremely confident). The total standardized score ranges from 0 to 100 and higher score means greater self-care self-efficacy. The Cronbach's alpha coefficient for the scale in this study was 0.94.

3.4. Data collection procedures

The researcher put the flyers, posters, and information sheets in the outpatient units, designated places in the hospital, and nursing stations of the outpatient units. The nurses and health care professionals notified potential participants of the ongoing research study. The interested participants contacted the researcher and completed the scales during their subsequent hospital visit. Before completing the scales, the participants were provided with complete study information and they signed an informed consent and gave permission to review their medical file to confirm the diagnosis of COPD. Some patients took the scales with them to their homes and returned those to the researchers on their next visit. However, others completed the scales in the researcher's presence. The researcher answered any questions that the patients may had during scale completion.

3.5. Data analysis

The data analyses were conducted in Jeffreys's Amazing Statistics Program (JASP.18.3.0). Descriptive statistics were used to determine the mean scores for each of the scales. The independent Bayesian T-test was used to compare the differences in the mean score of anxiety, depression, physical, psychological, social relationships, and environmental QOL for men and women. Cauchy's prior (0.707) distribution, which centers on 0 with a scale parameter of $1/\sqrt{2}$, assumes that null and alternate hypotheses equally explain the data was used. The Cauchy prior denotes a 50% probability that the effect size lies between −0.707 and 0.707 (van Ravenzwaaij and Etz, 2021). Bayes Factor robustness tests were completed for each *t*-test to examine how change in Cauchy prior affects the Bayes factor.

Two separate Bayesian regression analyses were conducted to determine the predictors of all four domains of QOL for men and women. The selection of variables for entry in the model was based on previous literature about self-care among individuals with COPD, highlighting

that age, years of living with COPD, anxiety, depression, and varied domains of self-care can affect the overall QOL (Zeb et al., 2021; Younas et al., 2024; Husain et al., 2021). We applied a uniform prior for all models, assuming that all models are equally likely before observing any data. We applied a Jeffreys Zellner-Siow (JSZ) prior (r = 0.354) to regression coefficients. The JSZ prior assigns a normal distribution to each co-efficient (Andraszewicz et al., 2015). The generated models for each domain were compared with the best model indicated by BF_{01} rather than comparing each model with the null model.

3.6. Ethical Considerations

The Ethical Review Board of Saidu Medical College and Saidu Group of Teaching Hospitals approved the study protocol (IRB#15-ERB/2022). The patients completed the informed written consent. They were assured of data confidentiality and privacy, and their information was encrypted for storage. Permission to use the data collection instruments was obtained from the authors.

4. Findings

4.1. Demographic data

In total, 408 enrolled individuals with COPD were enrolled, including 72.1% were men (n = 294) and 27.9% were women (n = 114). The mean age for men was 57.14 ± 10.06, and the mean age for women was 54.96 ± 13.41 years. Most of the participants lived in rural communities (n = 228, 59.9%) and the remaining lived in urban communities (44.1%, n = 180). The detailed demographic characteristics of men and women are provided in Table 1.

4.2. Sex-based differences in anxiety and depression

The mean anxiety score among men was 10.09 ± 2.83 compared to women 9.47 ± 2.23 (Table 2). A BF_{10} of 1.033 (error % 0.02) indicates anecdotal evidence supporting the alternative hypothesis relative to the null hypothesis, indicating that alternative hypothesis that men and women differ in their anxiety levels is weakly better at explaining the data than the null hypothesis of no difference among men and women. However, while the mean score of anxiety for men is higher than for women, the robustness test indicated that the Bayes factor is unstable and weak when the width of the Cauchy prior was varied (Fig. 1).

The mean depression score among men was 10.88 ± 2.30 compared to women 11.00 ± 2.71 (Table 2). A BF_{10} of 0.14 (error % 0.12) indicates anecdotal evidence supporting the null hypothesis relative to the alternative hypothesis, demonstrating that null hypothesis that men and women do not differ in their depression levels is moderately better at explaining that data than the alternate hypothesis of difference between men and women. The robustness test indicated that the Bayes factor lowers when the width of the Cauchy prior was varied, offering strong evidence in favour of the null hypothesis (Fig. 1).

4.3. Sex-based differences in quality of life

4.3.1. Physical domain

The mean physical QOL score among men was 11.13 ± 2.71 compared to women 10.21 ± 1.88 (Table 2). A BF_{10} of 21.25 (error % 0.001) indicates that there is strong evidence in support of the alternative hypothesis relative to the null hypothesis. Simply put, the alternative hypothesis that men and women differ in their physical QOL is better at explaining that data than the null hypothesis of no difference between men and women. The robustness test indicated that the Bayes factor stays relatively stable when the width of the Cauchy prior was varied, offering strong evidence in favour of the null hypothesis (Fig. 1).

Table 1
Demographic information.

Variables		Men (N = 294)		Women (N = 114)	
Age		57.14 (SD 10.06)		54.96 (SD 13.41)	
		Number	%	Number	%
Residential Community	Rural	139	47.3	89	78.1
	Urban	155	52.7	25	21.9
Ethnicity	Pashtoon	275	93.5	104	91.2
	Other	10	3.4	0	0
	Prefer not to say	9	3.1	10	8.78
Socioeconomic class	Upper class (Rs. 7769 or more income/month)	12	4.1	9	7.9
	Upper middle class (Rs. 3808–7769 income/month)	84	28.6	23	20.2
	Middle class (Rs. 2253–3808 income/month)	38	12.9	35	30.7
	Lower middle class (Rs. 1166–2253 income/month)	145	49.3	41	35.9
	Lower class (Rs. 1166 or below income/month)	14	4.8	6	5.3
	Prefer not to say	1	0.3	0	0
Education	No education	54	18.4	72	63.2
	Primary	127	43.2	33	28.9
	Middle	12	4.1	0	0.0
	High	21	7.1	0	0.0
	Bachelor degree	65	22.2	0	0.0
	Master degree	15	5.1	9	7.9
Family type	Nuclear	80	27.2	19	16.7
	Joint	209	71.1	95	83.3
	Prefer not to say	5	1.7	0	0.0
Primary decision maker	Men	273	92.9	105	92.1
	Woman	21	7.1	9	7.9
Years of living with COPD	1–2 years	136	46.3	48	42.1
	3–4 years	74	25.2	31	27.2
	5 or above years	71	24.2	35	30.7
	Prefer not to say	13	4.4	0	0.0
Smoking	Smoker	221	75.2	0	0.0
	Non-smoker	62	21.1	102	89.5
	Prefer not to say	11	3.7	12	10.5
Addiction	Chewing tobacco (Niswar)	100	34.0	0	0.0
	No	97	32.9	18	15.8
	Prefer not to say	97	32.9	96	84.2
Number of family caregivers	1–2	76	25.9	31	27.2
	3–4	163	55.4	35	30.7
	4 0r above	55	18.7	48	42.1
Type of health care services used	Public	163	55.4	70	61.4
	Private	119	40.5	44	38.6
	Community care	12	4.1	0	0.0

Table 2
Levels of anxiety, depression, and quality of life.

					95% Credible Interval	
	Group	N	Mean	SD	Lower	Upper
Anxiety	Male	294	10.09	2.83	9.760	10.410
	Female	114	9.47	2.23	9.052	9.878
Depression	Male	294	10.88	2.30	10.613	11.142
	Female	114	11.00	2.71	10.498	11.502
Physical Domain	Male	294	11.13	2.73	10.814	11.440
	Female	114	10.21	1.88	9.863	10.558
Psychological Domain	Male	294	12.51	1.28	12.361	12.655
	Female	114	12.19	1.01	12.006	12.380
Social relationship domain	Male	294	12.54	1.51	12.362	12.708
	Female	114	11.93	1.58	11.638	12.222
Environment domain	Male	294	10.96	2.62	10.653	11.255
	Female	114	9.94	2.10	9.548	10.329

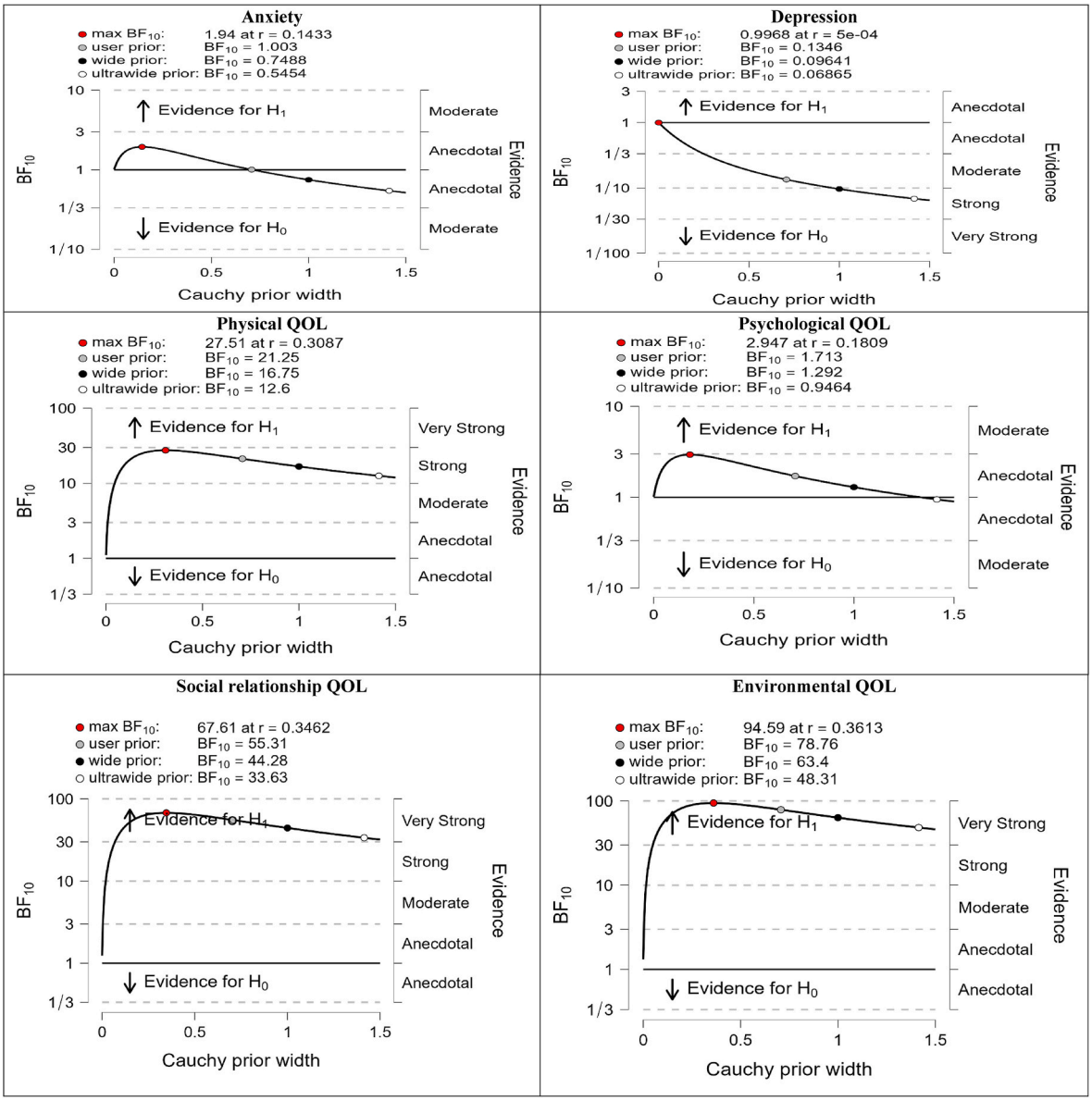

Fig. 1. Bayes factor robustness tests.

4.3.2. Psychological domain

The mean psychological QOL among men was 12.51 ± 1.28 compared to women 12.19 ± 1.01 (Table 2). A BF_{10} of 1.71 (error % 0.011) indicates anecdotal evidence supporting the alternative hypothesis relative to the null hypothesis. The alternative hypothesis that men and women differ in their psychological QOL is weakly better at explaining that data than the null hypothesis of no difference between men and women. The robustness test indicated that the Bayes factor is slightly stable when the width of the Cauchy prior was varied, offering weak evidence in favour of the alternate hypothesis (Fig. 1).

4.3.3. Social relationship domain

The mean social relationship QOL among men was 12.54 ± 1.51 compared to women 11.93 ± 1.58 (Table 2). A BF_{10} of 55.31 (error % 4.651×10^{-4}) indicates that there is very strong evidence in support of the alternative hypothesis relative to the null hypothesis. The alternative hypothesis that men and women differ in their social relationship QOL strongly explains the data than the null hypothesis of no difference between men and women. The robustness test indicated that the Bayes factor stays stable when the width of the Cauchy prior was varied, offering very strong evidence in favour of the alternative hypothesis (Fig. 1).

4.3.4. Environmental domain

The mean environmental QOL score among men was 10.96 ± 2.62 compared to women 9.94 ± 2.10 (Table 2). A BF_{10} of 78.76 (error % 3.340×10^{-4}) indicates strong evidence in support of the alternative hypothesis relative to the null hypothesis. The alternative hypothesis that men and women differ in environment QOL very strongly explains the data more than the null hypothesis of no difference between men and women. The robustness test indicated that the Bayes factor stays relatively stable when the width of the Cauchy prior was varied, offering very strong evidence in favour of the alternate hypothesis (Fig. 1).

4.4. Predictors of quality of life among men

The physical QOL was predicted by age, years with COPD, self-care self-efficacy, self-care management, and self-care monitoring, explaining a large variance $R^2 = 0.844$ (BF = 98.31). The $BF_{inclusion}$ values of the variables provide strong evidence for inclusion in the model: age (BF

$_{inclusion}$ = 228.41), self-care self-efficacy (BF $_{inclusion}$ = 390.88), self-care management (BF $_{inclusion}$ = 31.87), and self-care monitoring (BF $_{inclusion}$ = 55.38). There is weak evidence for including years with COPD (BF $_{inclusion}$ = 1.10) in the model.

Years of living with COPD, anxiety, depression, self-care self-efficacy, self-care management, self-care monitoring, and self-care maintenance predicted the psychological QOL explain a large amount of variance R^2 = 0.567 (BF = 37.249). The BF $_{inclusion}$ values of the variables provide strong evidence for inclusion in the model: years with COPD (BF $_{inclusion}$ = 15.355), self-care self-efficacy (BF $_{inclusion}$ = 390.88), self-care management (BF $_{inclusion}$ = 962159.576), and self-care monitoring (BF $_{inclusion}$ = 27330.436), and self-care maintenance (BF $_{inclusion}$ = 3.378 × 10^{+6}). There is weak evidence for including anxiety (BF $_{inclusion}$ = 1.71) and depression (BF $_{inclusion}$ = 1.75) in the model.

Age, years with COPD, anxiety, self-care self-efficacy, self-care monitoring, and self-care maintenance predicted the social relationship QOL explaining a moderate variance R^2 = 0.425 (BF = 41.352). The BF $_{inclusion}$ values of the variables provide strong evidence for inclusion in the model: self-care self-efficacy (BF $_{inclusion}$ = 765.91) and anxiety (BF $_{inclusion}$ = 4.867 × 10^{+7}). There is weak evidence for including age (BF $_{inclusion}$ = 1.923), years with COPD (BF $_{inclusion}$ = 2.68), self-care monitoring (BF $_{inclusion}$ = 2.68), and self-care maintenance (BF $_{inclusion}$ = 0.172) in the model.

Environmental QOL was predicted by years with COPD, anxiety, self-care self-efficacy, and self-care management, with the model explaining a large amount of variance R^2 = 0.843 (BF = 279.67). The BF $_{inclusion}$ values of the variables provide strong evidence for inclusion in the model: years with COPD (BF $_{inclusion}$ = 48.065), anxiety (BF $_{inclusion}$ = 1.786 × 10^{+11}), self-care self-efficacy (BF $_{inclusion}$ = 48.816), and self-care management (BF $_{inclusion}$ = 592.895). The top five Bayesian regression models for each domain of the QOL for men are presented in Table 3.

4.5. Predictors of quality of life among women

The physical QOL in women was predicted by years with COPD, self-care monitoring, anxiety, and depression which explained a large amount of variance R^2 = 0.896 (BF = 98.075). The BF $_{inclusion}$ values of the variables provide strong evidence for inclusion in the model: years with COPD (BF $_{inclusion}$ = 1.637 × 10^{+12}), anxiety (BF $_{inclusion}$ = 9.852 × 10^{+12}), and self-care monitoring (BF $_{inclusion}$ = 1.334 × 10^{+6}). There is weak evidence for including depression (BF $_{inclusion}$ = 0.845) in the model.

Years with COPD, self-care monitoring, anxiety, depression, and self-care maintenance predicted the psychological QOL explains a large amount of variance R^2 = 0.761 (BF = 227.117). The BF $_{inclusion}$ values of the variables provide strong evidence for inclusion in the model: years with COPD (BF $_{inclusion}$ = 4830.650), depression (BF $_{inclusion}$ = 1.431 × 10^{+6}), anxiety (BF $_{inclusion}$ = 108.053), self-care monitoring (BF $_{inclusion}$ = 1.779 × 10^{+13}), and self-care maintenance (BF $_{inclusion}$ = 3.247 × 10^{+20}).

Age, anxiety, self-care self-efficacy, self-care management, and self-care maintenance predicted the social relationship QOL, explaining a large amount of variance R^2 = 0.609 (BF = 67.799). The BF $_{inclusion}$ values of the variables provide strong evidence for inclusion in the model: self-care self-efficacy (BF $_{inclusion}$ = 2.068 × 10^{+7}), self-care maintenance (BF $_{inclusion}$ = 954.935), and self-care management (BF $_{inclusion}$ = 1097.175). There is weak to moderate evidence for including age (BF $_{inclusion}$ = 1.136) and anxiety (BF $_{inclusion}$ = 3.671) in the model.

Environmental QOL was predicted by years with COPD, anxiety, depression, self-care self-efficacy, self-care maintenance, and self-care management, with the model explaining a large variance R^2 = 0.965 (BF = 1360.45). The BF $_{inclusion}$ values of the variables provide strong evidence for inclusion in the model: years with COPD (BF $_{inclusion}$ = 49147.53), anxiety (BF $_{inclusion}$ = 6.067 × 10^{+9}), depression (BF $_{inclusion}$ = 1.449 × 10^{+6}), self-care self-efficacy (BF $_{inclusion}$ = 8.291 × 10^{+13}),

Table 3
Five best models for Bayesian regression for quality of life domains in men.

Model Comparison – Physical Domain					
Models	P(M)	P (M| data)	BF_M	BF_{01}	R^2
Age + years with COPD + Self-care self-efficacy + Self-care management + Self-care monitoring	**0.004**	**0.278**	**98.312**	**1.000**	**0.844**
Age + Depression + Self-care self-efficacy + Self-care management + Self-care monitoring	0.004	0.275	96.811	1.011	0.844
Age + Years with COPD + Depression + Self-care self-efficacy + Self-care management + Self-care Monitoring	0.004	0.143	42.674	1.941	0.847
Age + Self-care self-efficacy + Self-care management + Self-care monitoring	0.004	0.106	30.316	2.619	0.840
Age + Anxiety + Depression + Self-care self-efficacy + Self-care management + Self-care monitoring	0.004	0.026	6.789	10.731	0.845
Model Comparison – Psychological Domain					
Models	**P(M)**	**P(M| data)**	**BF_M**	**BF_{01}**	**R^2**
Years with COPD + Anxiety + Depression + Self-care self-efficacy + Self-care management + Self-care monitoring + Self-care maintenance	**0.004**	**0.127**	**37.249**	**1.000**	**0.567**
Age + Years with COPD + Anxiety + Depression + Self-care self-efficacy + Self-care management + Self-care monitoring + Self-care maintenance	0.004	0.115	33.255	1.105	0.573
Years with COPD + Anxiety + Self-care self-efficacy + Self-care management + Self-care monitoring + Self-care maintenance	0.004	0.084	23.263	1.525	0.559
Years with COPD + Anxiety + Depression + Self-care management + Self-care monitoring + Self-care maintenance	0.004	0.074	20.334	1.726	0.558
Age + Years with COPD + Anxiety + Depression + Self-care management + Self-care monitoring + Self-care maintenance	0.004	0.058	15.646	2.205	0.564
Model Comparison - Social relationship domain					
Models	**P(M)**	**P(M| data)**	**BF_M**	**BF_{01}**	**R^2**
Age + Years with COPD + Anxiety + Self-care self-efficacy + Self-care monitoring + Self-care maintenance	**0.004**	**0.140**	**41.352**	**1.000**	**0.425**
age + Anxiety + Self-care self-efficacy + Self-care monitoring + Self-care maintenance	0.004	0.123	35.927	1.130	0.416
Years with COPD + Anxiety + Self-care self-efficacy + Self-care monitoring + Self-care maintenance	0.004	0.092	25.953	1.511	0.415
Years with COPD + Anxiety + Depression + Self-care self-efficacy + Self-care maintenance	0.004	0.067	18.268	2.087	0.414

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Table 3 (*continued*)

Model Comparison – Physical Domain					
Models	P(M)	P (M| data)	BF_M	BF_{01}	R^2
Age + Years with COPD + Anxiety + Depression + Self-care self-efficacy + Self-care monitoring + Self-care maintenance	0.004	0.063	17.256	2.202	0.429
Model Comparison – Environment domain					
Models	**P(M)**	**P(M| data)**	**BF_M**	**BF_{01}**	**R^2**
Years with COPD + Anxiety + Self-care self-efficacy + Self-care management	**0.004**	**0.523**	**279.666**	**1.000**	**0.843**
Years with COPD + Anxiety + Self-care self-efficacy + Self-care management + Self-care maintenance	0.004	0.239	80.023	2.190	0.846
Years with COPD + Anxiety + Depression + Self-care self-efficacy + Self-care management	0.004	0.051	13.711	10.251	0.844
Age + Years with COPD + Anxiety + Self-care self-efficacy + Self-care management	0.004	0.037	9.928	13.958	0.843
Years with COPD + Anxiety + Self-care self-efficacy + Self-care management + Self-care monitoring	0.004	0.029	7.536	18.223	0.843

and self-care management ($BF_{\text{inclusion}} = 6.876 \times 10^{+10}$), and self-care maintenance ($BF_{\text{inclusion}} = 4.477 \times 10^{+7}$). The top five Bayesian regression models for each domain of the QOL for women are presented in Table 4.

5. Discussion

COPD is increasingly contributing to chronic disease burden in Pakistan (Sana et al., 2018). The multicounty BREATHE study of 2187 individuals with confirmed diagnosis of COPD noted a prevalence of COPD to be 2.1% in Pakistan (Tageldin et al., 2012), with higher in prevalence in men (3.3%) compared to women (0.8%). The higher prevalence of COPD in men is because of smoking which is among the leading cause of COPD (Rehman et al., 2019) and Pakistani men smoke 7 times (OR 6.94, 95% CI 5.68–8.49) more than women (Basit et al., 2020). The factors associated for COPD development in women mainly include living in rural areas and exposure to biomass fuel (Sana et al., 2018). Living with COPD greatly impacts the physical, mental, and emotional well-being and self-care behaviours among men and women (Zeb et al., 2021; Raghavan et al., 2017; DeMeo et al., 2018). This is the first study to determine sex-based differences in anxiety, depression, and QOL and determine the predictors of QOL among Pakistani South Asian men and women using Bayesian analysis.

Bayesian analysis showed anecdotal evidence that women had higher levels of depression but lower levels of anxiety compared to men. Anecdotal evidence also indicated that men's physical quality of life was better than women's, but strong evidence demonstrated that men's social relationships and environmental QOL were better than women. These findings are consistent with previous global literature about COPD (Raghavan et al., 2017; DeMeo et al., 2018; Zhang et al., 2021; Perez et al., 2020) and Pakistani literature on general population (Mirza and Jenkins, 2004; Farooq et al., 2019; Waqas et al., 2015; Godil et al., 2017). These studies also highlighted that women experience more depression and reduced QOL due to socio-cultural factors such as traditional gender roles, patriarchal culture, low educational status, less autonomy in decision-making, increased family responsibilities,

Table 4
Five best models for Bayesian regression for quality of life domains in women.

Model Comparison – Physical Domain					
Models	P(M)	P (M| data)	BF_M	BF_{01}	R^2
Years with COPD + Self-care Monitoring + Anxiety + Depression	**0.004**	**0.278**	**98.075**	**1.000**	**0.896**
Years with COPD + Self-care Monitoring + Anxiety	0.004	0.174	53.604	1.599	0.889
Years with COPD + Self-care Monitoring + Self-care Maintenance + Anxiety	0.004	0.101	28.799	2.737	0.894
Age + Years with COPD + Self-care Monitoring + Anxiety	0.004	0.098	27.849	2.821	0.894
Age + Self-care Monitoring + Anxiety + Depression	0.004	0.066	18.054	4.201	0.898
Model Comparison – Psychological domain					
Models	**P(M)**	**P(M| data)**	**BF_M**	**BF_{01}**	**R^2**
Years with COPD + Self-care monitoring + Self-care Maintenance + Anxiety + Depression	**0.004**	**0.471**	**227.117**	**1.000**	**0.761**
Age + Years with COPD + Self-care monitoring + Self-care maintenance + Anxiety + Depression	0.004	0.160	48.671	2.939	0.765
Age + Years with COPD + Self-care self-efficacy + Self-care monitoring + Self-care maintenance + Anxiety + Depression	0.004	0.120	34.864	3.917	0.773
Years with COPD + Self-care self-efficacy + Self-care monitoring + Self-care maintenance + Anxiety + Depression	0.004	0.104	29.448	4.550	0.763
Years with COPD + Self-care management + Self-care monitoring + Self-care maintenance + Anxiety + Depression	0.004	0.070	19.241	6.714	0.761
Model Comparison – Social relationship domain					
Models	**P(M)**	**P(M| data)**	**BF_M**	**BF_{01}**	**R^2**
Age + Self-care self-efficacy + Self-care management + Self-care maintenance + Anxiety	**0.004**	**0.210**	**67.799**	**1.000**	**0.609**
Self-care self-efficacy + Self-care management + Self-care monitoring + Self-care maintenance + Anxiety	0.004	0.134	39.442	1.568	0.606
Age + Self-care self-efficacy + Self-care management + Self-care maintenance + Anxiety + Depression	0.004	0.081	22.529	2.587	0.615
Age + Self-care self-efficacy + Self-care management + Self-care monitoring + Self-care maintenance + Anxiety	0.004	0.076	20.902	2.772	0.615

(*continued on next page*)

Table 4 (*continued*)

Model Comparison – Physical Domain					
Models	P(M)	P (M| data)	BF_M	BF_{01}	R^2
Years with COPD + Self-care self-efficacy + Self-care management + Self-care maintenance + Anxiety	0.004	0.049	13.026	4.322	0.598
Model Comparison – Environmental domain					
Models	**P(M)**	**P(M| data)**	**BF_M**	**BF_{01}**	**R^2**
Years with COPD + Self-care self-efficacy + Self-care management + Self-care maintenance + Anxiety + Depression	**0.004**	**0.842**	**1360.45**	**1.000**	**0.965**
Age + Years with COPD + Self-care self-efficacy + Self-care management + Self-care maintenance + Anxiety + Depression	0.004	0.098	27.759	8.578	0.966
Years with COPD + Self-care self-efficacy + Self-care management + Self-care monitoring + Self-care maintenance + Anxiety + Depression	0.004	0.054	14.555	15.596	0.966
Age + Years with COPD + Self-care self-efficacy + Self-care management + Self-care monitoring + Self-care maintenance + Anxiety + Depression	0.004	0.006	1.451	148.793	0.966
Self-care self-efficacy + Self-care management + Self-care monitoring + Self-care maintenance + Anxiety + Depression	0.004	1.926×10^{-5}	0.005	43720.088	0.958

especially in joint families, and the need to care for families despite living with chronic disease (Mirza and Jenkins, 2004; Farooq et al., 2019; Waqas et al., 2015; Godil et al., 2017). Previous studies also noted that women in Pakistan experience more health disparities and inequities, regressive norms towards health care decision making, and lack autonomous decision making concerning their health and social care (Hou and Ma, 2013; Jafree, 2020). These factors also affect women's participation in social activities and community mobility, thereby affecting the availability of social support, which in turn can affect social relationships QOL (Waqas et al., 2015; Younas et al., 2024). Given these findings, a need exists for designing more social support and coping programs tailored to the contextual needs of women in line with complex socio-cultural factors. Community-based peer support programs including women who can support other women with similar chronic conditions, can be promising. Healthcare professionals and community workers can collaborate to design and implement primary, secondary, and tertiary prevention programs for addressing anxiety and depression, as well as rehabilitation programs with active engagement of women with COPD.

Regarding predictors of QOL among men, the findings suggested that self-care self-efficacy was among the common predictors of physical, psychological, social relationship, and environmental QOL as demonstrated by large BF and $BF_{inclusion}$ values. However, in women, self-care self-efficacy mainly predicted the social relationship and environmental domains of QOL. Self-care self-efficacy is the confidence to engage in self-care (Matarese et al., 2020, 2023). Previous studies reported that self-care self-efficacy can be an important factor of QOL among women with chronic conditions such as diabetes, renal failure, and heart failure (Ebrahimi Belil et al., 2018) and chronic pain (Yazdi-Ravandi et al., 2013). This is the first study to show that self-care self-efficacy strongly predicts QOL in men across four domains while women in two domains. There appears to be limited research on men and their self-care self-efficacy in chronic conditions. Therefore, future research should examine the protective role of self-care self-efficacy among men living with other chronic conditions. Research is also warranted to examine differences in self-care self-efficacy of men and women in other chronic conditions in South Asian and global contexts using qualitative, quantitative, and mixed methods designs. Interventions can be developed and tested to promote self-care self-efficacy among men and women, particularly those living in low- and middle-income countries and low-resource settings, in line with the results of this study.

In women, self-care maintenance appeared to be one of the common predictors of psychological, social relationships, and environmental QOL, whereas self-care monitoring predicted the physical QOL. Self-care maintenance refers to taking proactive steps to improve one's overall mental and physical health and being attentive to personal needs for physical, emotional, and psychological well-being (Riegel et al., 2012; Riegel et al., 2017). Self-care maintenance emerging as a significant predictor for women could be explained by the cultural phenomenon that women are predominant caregivers for their families and for themselves, they tend to work mostly at home, care for their families, and can take proactive actions to care for self and their families (Sharma et al., 2016; Younas et al., 2024). This type of behaviour may plausibly explain their habit focus on self-care maintenance more so than actual self-management because they are expected to care for their families; thereby, despite taking proactive actions to engage in self-care, they are unable to sustain their self-care management. On the other hand, South Asian men focus more on earning livelihood for their families and engage more in social activities (Patel et al., 2012; Fikree and Pasha, 2004), which could explain that they have confidence that they can take care of themselves (i.e., self-care self-efficacy), and maintain that confidence despite failure due to hegemonic masculinity or patriarchal culture (Younas et al., 2024). Studies have reported that South Asian men with chronic conditions often continue to demonstrate their confidence in taking care of their chronic illness to maintain their dominant role and decision-making in their family and fail to seek help to engage in self-management and maintenance (Galdas et al., 2007; Younas, 2017; Syed, 2021).

Years of living with COPD was generally a predictor of men's physical, psychological, and social relationship QOL. However, $BF_{inclusion}$ value indicated that it was only a strong predictor for psychological QOL. These findings could indicate that more time living with COPD may offer some degree of internal emotional and mental strength that the disease could be effectively managed with more experiential knowledge in South Asian men living with chronic diseases (Younas, 2017; Younas et al., 2024). Nevertheless, with advanced stages of COPD disease, individuals' physical and social relationship, QOL may deteriorate due to the inability to carry out physical and social networking activities (Zeb et al., 2021). Further research can generate more insights into the differences in QOL predictors at varied COPD stages in men and women. Such comparative and stage-based analysis can be useful to design more stage and gender-specific and predictor-targeted interventions to enhance the QOL of individuals with COPD. In women, years of living with COPD was a strong predictor of physical QOL. Nevertheless, this finding cannot be plausibly explained through any cultural beliefs or interpretations. Therefore, more research can help understand if this relationship is plausible in other chronic conditions.

5.1. Limitations

We used a cross-sectional design and convenience sampling and recruited participants from Northern Pakistan. Therefore, due to

cultural differences across different regions of Pakistan, the findings may not be generalizable to contexts within Pakistan, and particularly across the globe. Nevertheless, the study offers insights into sex-based differences in anxiety, depression, and QOL in COPD and may serve as the basis for future global research addressing gender and sex-based disparities. Our definition of socioeconomic status was limited to monthly household income. Nevertheless, other structural and social factors, such as transport and health care access, may also affect socioeconomic status. Therefore, future studies can include additional indicators of socioeconomic status when examining sex and gender-based differences.

6. Conclusions

The findings contribute to literature highlighting sex-based differences in anxiety, depression, and QOL among South Asian men and women with COPD. Men generally reported higher levels of QOL than women across all domains. Women's social relationships and environmental QOL were greatly impacted by anxiety and depression. Self-care self-efficacy was among the main predictors of QOL across all domains in men, but self-management and maintenance were weak predictors. In women, self-care maintenance was one of the critical predictors of QOL across all domains. QOL interventions for women should be targeted at improving their social relationships and environmental satisfaction and addressing anxiety and depression. The study findings indicate the need to be more sensitive to sex-based differences in COPD and its management, and the need for more tailored interventions specific to both sexes and based on strong predictors to promote the QOL among these individuals. There is also a dire need for greater recognition and management of depression and anxiety among women with COPD compared to men in the South Asian context and more nuanced practice, public health, and policy agenda for enhancing the QOL of women and men living with COPD.

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Ethical approval

The Ethical Review Board of Saidu Medical College and Saidu Group of Teaching Hospitals approved the study protocol (IRB#15-ERB/2022).

CRediT authorship contribution statement

Ahtisham Younas: Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization. **Hussan Zeb:** Writing – review & editing, Writing – original draft, Validation, Project administration, Data curation, Conceptualization. **Angela Durante:** Writing – review & editing, Writing – original draft, Validation, Supervision. **Ercole Vellone:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology.

Data availability

Data will be made available on request.

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