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Original Article

Chronic obstructive pulmonary disease in women using biomass fuels attending Damanhour chest hospital

Pulmonology

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ABSTRACT

Background: Different studies showed an association between biomass fuel exposure and chronic respiratory symptoms than spirometric abnormalities in exposed women.

Objective: To assess the use of biomass fuel by women in rural areas at Damanhur, Egypt, as a contributing factor to chronic obstructive pulmonary disease (COPD) development.

Methodology: The present cross-sectional study was conducted on 80 females regularly use biomass fuel for years attended the Damanhour chest hospital during the period from November 2019 to August 2020. All of them were subjected to history taking including duration of biomass fuel exposure, respiratory symptoms, comorbidities, then spirometry was performed.

Results: A total of 49 (61.2%) females have COPD and 31 (38.8%) females had no COPD. Moreover, 56 (70%) females had small airway affection and 24 (30%) females had no small airway affection. Females having COPD had significantly longer duration of biomass exposure with a higher prevalence of Diabetes Mellitus (DM) than those with no COPD. The most significant predictive factors for COPD descending order were: dyspnea (β = - 3.9, p <0.001), cough, (β= - 2.55, p <0.001), and DM (β = - 2.3, p <0.003) and duration of biomass exposure (β = - 0.94, p <0.001).

Conclusion: COPD was prevalent among women who use biomass fuel and it was linked to the presence of respiratory symptoms, DM, and a longer duration of biomass exposure.

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Keywords: Biomass fuel; COPD; risk factors of COPD; chronic obstructive pulmonary disease; pulmonary function tests.

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INTRODUCTION

Solid fuels are used as the primary source of energy in many parts of the world, mostly in developing nations, leading to potentially hazardous exposures [1]. Using a traditional stove or open fire to burn biomass fuel (BMF) improperly produces significant amounts of respiratory irritants such as suspended particulate matter of respirable size, carbon monoxide, nitrous oxides, sulphur dioxide, formaldehyde, oxygenated substances, chlorinated organics, carcinogenic polyaromatic hydrocarbons [2]. The BMF smoke causes chronic obstructive pulmonary disease (COPD), lower quality of life, and higher mortality in non-smoking rural women, just like tobacco users [3]. indoor air contamination resulted from solid fuel use has been estimated by WHO that is accountable for 2.6% of the total global burden of disease [4]. The biomass use has responsible for >577000 early mortalities in Africa and 74000 in Latin Americas, in 2012. [5] Exposure to indoor pollutants created by biomass fuels burning is chiefly high among females and young kids leading to 2 million deaths annually . [6]

The COPD prevalence is twice to triple times more in rural exposed females to biomass smog compared to urban females who are noticeably less exposed**.** [7,8] The worldwide prevalence of COPD is rising quicker in women than in men. Over the past two decades, COPD-related death rates have also increased more rapid for women, and since the year 2000 more females than males have died from COPD. [9]

Although meta-analyses based on case-control and cross-sectional studies confirm the association between biomass exposure and airflow obstruction, more evidence exists for an association between biomass smoke inhalation and chronic bronchitis or respiratory symptoms than for spirometric abnormalities. The aim of the study is to assess the use of biomass fuel by

women in rural areas at Damanhur, Egypt, as a contributing factor to chronic obstructive pulmonary disease (COPD) development.

SUBJECT AND METHODS

This cross-sectional study was conducted at Damanhour chest hospital, Behheira governorate, Egypt. It was conducted during the period from November 2019 to August 2020**.**

One hundred twenty females using biomass fuel for years who attended outpatient clinic, Damanhour chest hospital were assessed for study eligibility. Twenty females were either active or passive smokers; therefore, they were excluded from the study. Ten females had symptoms consistent with COVID-19 and were excluded from the study. Ninety females were subjected to spirometry before and after bronchodilators (reversibility testing); ten of them were unable–to perform acceptable spirometric maneuver, therefore excluded from the study. Finally, 80 females enrolled in the study and were included in the data analysis. Smoking and risk factors other than biomass exposure were excluded (figure 1).

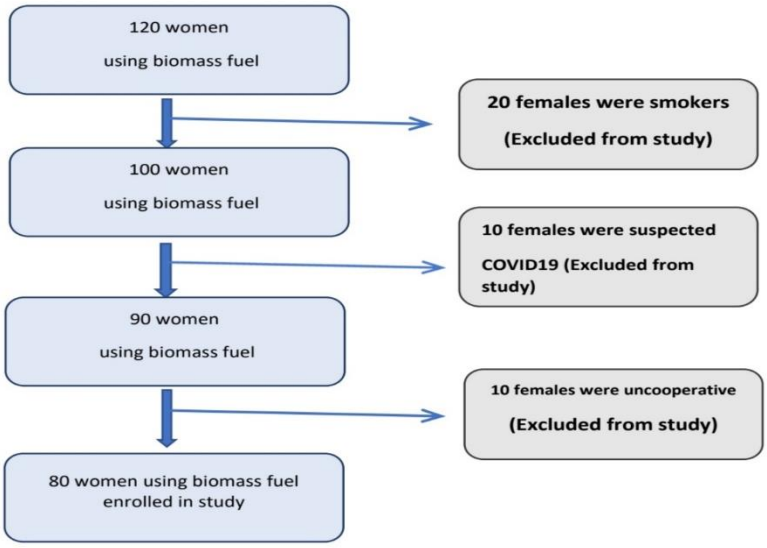

Figure (1): Flowchart for selection of study participants

All subjects were subjected to full history taken including occupation, presence of comorbidities, respiratory symptoms (e.g. cough, dyspnea, and wheezes) and duration of biomass fuel exposure in years.

Spirometry was carried out on (Minispir) (manufactured in India**)** before and after the short-acting B_2-agonist inhalation. The following indices were recorded: Forced vital capacity (FVC % predicted), forced expiratory volume in–first second (FEV_1% predicted), FEV_1\FVC ratio, and forced expiratory flow rate 25-75%predicted (FEF_{25-75} less than 65% of predicted is considered impaired [10] . Based on the FEF 25-75 % cutoff value of 65%, the studied females were classified as either having small airway obstruction (FEF25-75 < 65%) or having no small airway obstruction (FEF25-75 =>65%). COPD was diagnosed, was defined according to GOLD 2019· criteria [4]: had either irreversible or partially reversible airflow obstruction, post–bronchodilator FEV_1/FVC ratio < 0.7, FEV_1<80% predicted and increase in FEV_1<200 ml, or <12% of baseline measurements 20 minutes after inhalation 400mg salbutamol. Spirometric-indices were calculated in accordance with the recommendations of the European Respiratory Society [11].

This study was conducted after receiving permission from institutional review board of the faculty of medicine for girls, Cairo, AL-Azhar University, Egypt (IRB No. 2018122001). Prior to enrollment, each participant provided a written informed consent. Each woman had the freedom to opt out of the study at any moment without affecting her right of medical care. Additionally, all data were coded and nameless to ensure participant confidentiality.

Statistical analysis

Statistical Program for Social Science (SPSS) version 24 was used for data analysis. Quantitative data were presented as mean ±SD for normally distributed data. Median and interquartile range (IQR) were used for abnormally distributed data. Frequency and percentage were used to present qualitative data. Independent-samples t-test **(**t) was used to compare two means for normally distributed data. Mann–Whitney U test (MW) was used to compare two median (IQR) for abnormally distributed data. Chi-square test (X^2) was used to compare non-parametric data. Multivariate logistic regression analysis was used to identify the most significant predictive factors for COPD among females using biomass fuel. The strength of relevance between the predictive factors and the COPD was determined according to the value of Regression coefficient (β). The p-value < 0.05 was considered significant (95% confidence interval).

RESULTS

Table (1) showed that the mean age of studied females was 40.8 ± 8.5 years, with-a range from 24 to 60 years.

Among them70 (87.5%) were housewife and 10 (12.5%) were teachers The duration of biomass exposure ranged from 5-35 years with a mean of 16.6 ± 8.4 year of the studied females; 22 (27.5%) were diabetic, 13 (16.2%) were hypertensive, and 11 (13.7%) had HCV.

Table (2) showed that A total of 53 (66.2%) females had dyspnea, 25 (31.2%) had productive cough, and 9 (11.3%) had chest wheeze.

Table (3) showed that there were 49 patients (61.2%) of studied females had COPD and 31 (38.8%) had no COPD (figure 2). Moreover, 56 (70%) of studied females had small airway obstruction and 24 (30%) females had no small airway obstruction (figure 3).

Table (4) showed that the duration of biomass exposure was significantly longer in females with COPD than those with no COPD [20 (16 - 25) and 9 (7 -10) respectively, p-value < 0.001]. The DM was significantly more common in females with COPD than those with no COPD [40.8% and 6.5% respectively, p-value < 0.001] Here was no significant difference between both groups regarding age, occupation. HTN, and HCV (p>0.05).

Table (5) showed that the following factors were predictive for COPD in studied females exposed to biomass fuel in descending order were: dyspnea (β = - 3.9, p <0.001), cough, (β= - 2.55, p <0.001), and DM (β = - 2.3, p 0.003) and duration of biomass exposure (β = - 0.94, p <0.001).

Table (1): Age, occupation md comorbidities of females using biomass fuel

Characteristics		Studied patients n = 80
Age (years)	**Mean ± SD**	40.8 ± 8.5
	Min – Max	24 – 60
Occupation	**Housewife**	70 (87.5%)
	Teacher	10 (12.5%)
Duration of biomass exposure (years)	**Mean ± SD**	16.6 ± 8.4
	Min – Max	5 – 35
DM	**No**	58 (72.5%)
	Yes	22 (27.5%)
Hypertension	**No**	67 (83.8%)
	Yes	13 (16.2%)
HCV	**No**	69 (86.3%)
	Yes	11 (13.7%)

DM: Diabetes mellitus, HCV: Hepatitis C virus.

Table (2): Presenting symptoms and ventilatory functions parameters of females using biomass

Characteristics		Studied patients n = 80
Dyspnea	**No**	27 (33.8%)
	Yes	53 (66.2%)
Productive cough	**No**	55 (68.8%)
	Yes	25 (31.2%)
Chest wheeze	**No**	71 (88.7%)
	Yes	9 (11.3%)
Post-BDFEV$_1$/FVC ratio	**Mean ± SD**	73.5 ±± 22.0
FVC%	**Mean ± SD**	89.6 ± 21.2
FEV$_1$%	**Mean ± SD**	63.1 ± 20.6
FEF 25 – 75%	**Mean ± SD**	55.2 ±21.2

Post-BD FEV$_1$/FVC ratio: Post-bronchodilator forced expiratory volume in first second / forced vital capacity ratio, FVC%: Forced vital capacity percent predicted, FEV1%: Forced expiratory volume in first second percent predicted, FEF%: Forced expiratory flow rate percent predicted.

Table (3): Distribution of COPD and small airway obstruction among females using biomass fuel

Characteristic		Studied patients n = 80
Post-BD FEV$_1$/FVC ratio	< 70 % (COPD)	49 (61.2%)
	≥ 70 % (No COPD)	31 (38.8%)
FEF 25-75%	< 65% (Small airway-obstruction)	56 (70%)
	≥ 65% (No-small airway obstruction)	24 (30%)

COPD: Chronic obstructive pulmonary disease, Post-BD FEV$_1$/FVC ratio: Post-bronchodilator forced expiratory volume in first second / forced vital capacity ratio, FEF%: Forced expiratory flow rate 25-75% percent predicted.

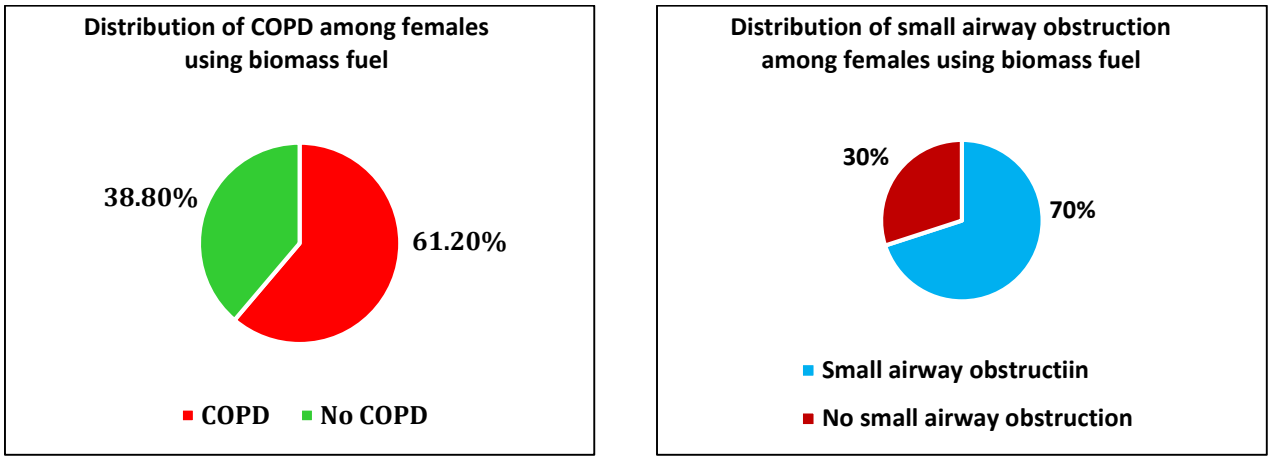

Figure (2): Distribution of COPD and small airway obstruction among females using biomass fuel

Table (4): Comparisons of demographic data between females using biomass fuel with and without COPD

Characteristic		Females using biomass fuel		Stat. test	p-value
		COPD n = 49	No COPD n = 31		
Age (years)	Mean ± SD	41.8 ± 9.1	39.3 ± 7.5	t= 1.2	0.213
Occupation	Housewife	44 (89.8%)	26 (83.9%)	X^2 = 0.6	0.435
	Teacher	5 (10.2%)	5 (16.1%)		
Duration of biomass exposure (years)	Median (IQR)	20 (16 - 25)	9 (7 -10)	MW = 24.5	< 0.001*
DM	No	29 (59.2%)	29 (93.5%)	X^2 = 11.2	< 0.001*
	Yes	20 (40.8%)	2 (6.5%)		
Hypertension	No	40 (81.6%)	27 (87.1%)	X^2 = 0.41	0.519
	Yes	9 (18.4%)	4 (12.9%)		
HCV	No	40 (81.6%)	29 (93.5%)	X^2 = 2.2	0.132
	Yes	9 (18.4%)	2 (6.5%)		

COPD: Chronic obstructive pulmonary disease, DM: Diabetes mellitus, HCV: Hepatitis C virus, IQR: Interquartile range, MW: Mann Whitney U test, T: Independent sample t test, X^2: Chi-square test, *: Significant p-value (<0.05).

Table (5): Multivariate logistic regression analysis for factors predictive of COPD in females using biomass fuel

Items	β	SE	p-value	Odds	95% CL	
Age	- 0.035		0.212	0.96	0.91	1.02
Duration of biomass exposure (years)	- 0.94	0.24	< 0.001*	0.38	0.23	0.63
Occupation	0.52	0.67	0.439	1.69	0.44	6.4
Dyspnea	- 3.9	0.73	< 0.001*	0.019	0.005	0.08
Productive cough	- 2.55	0.78	< 0.001*	0.078	0.017	0.36
Chest wheeze	- 20.9	13397	0.999	0.0	0.0	
DM	- 2.3	0.78	0.003*	0.1	0.021	0.46
HTN	- 0.41	0.65	0.521	0.65	0.18	2.35
HCV	- 1.18	0.81	0.149	0.3	0.062	1.52

β: Regression coefficient, SE: Standard error, CL: Confidence interval, COPD: Chronic obstructive pulmonary disease, DM: Diabetes mellitus, HTN: Hypertension, HCV: Hepatitis C virus, *: Significant p-value (<0.05).

DISCUSSION

In this study, we observed a notable prevalence of COPD and small airway obstruction among women residing in rural areas who use biomass fuels. Our results align with those of El-Essawy et al. who identified a significant association between biomass fuel usage and the occurrence of COPD in non-smoking women [12]. A lower prevalence had been reported in a study conducted in Upper Egypt that revealed that 13.6% of individuals exposed to biomass fuels developed COPD, which aligns with our findings on the impact of biomass exposure on respiratory health [13]. Another Egyptian study found that 11.2% of females exposed to biomass fuel developed COPD, and notably, 86.2% of all women in the exposed group were nonsmokers [13]. Kurmi et al. reported a higher prevalence of airflow obstruction among individuals exposed to biomass smoke in rural Nepal, which is consistent with our findings. [14]. The higher prevalence of COPD encountered in our studied Egyptian females in comparison to the aforementioned 2 Egyptian studies

may be attributed to that our study was a hospital-based study conducted on women already have respiratory symptoms and sought medical advice for it.

Our study revealed that the diagnosis of COPD was related to the duration of biomass exposure. Shengming et al. study did not identify a relationship between the duration of biomass exposure and FEV_1, FVC, or FEF25-75%, which contrasts with our findings. Despite urban women having a higher smoking rate than rural women , they observed a greater prevalence of COPD among non-smoking women in rural areas of southern China compared to urban areas .This led him to suggest that other significant factors might be contributing to the development of COPD in rural areas [15].

Moreover, research comparing biomass users to gas users revealed that biomass users experienced a higher prevalence of respiratory issues (29.9% vs. 11.2%) and had a lower mean peak expiratory flow rate. The study also found that older women using biomass fuel were more likely to experience respiratory problems than younger women, which aligns with our findings. Specifically, they observed that women aged 36-58 had a 6.90 and 3.46 times greater likelihood of lung involvement compared to those aged 15-25, respectively [16].

Our study also revealed an increased prevalence of (DM) among females with COPD, which aligns with Eltrawy et al. findings that lower spirometry-indices are associated with higher HbA_1C and fasting blood sugar (FBS) levels. Although the exact reasons for the high prevalence of DM in COPD patients remain unclear, factors such as inflammation and oxidative stress may play a role. Systemic inflammation, which is prevalent in both COPD and type-2-DM (T2DM), can lead to insulin resistance. Additionally, microvascular anomalies, glycosylation of tissue proteins, and abnormal respiratory muscle function due to autonomic neuropathy in DM may also contribute to these findings [17].

The current study had some limitation that need to be mentioned; first it was a hospital-based study not a community based study, therefore the study results is not conclusive to all users of biomass fuel. Second the result of the current study is underpowered by small sample size.

CONCLUSION

COPD was prevalent among women used biomass fuel and it was linked to presence of respiratory symptoms, DM, and longer duration of biomass exposure. A community based study conducted in rural areas to detect susceptible females to COPD before development of symptoms using spirometry is recommended.

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Conflict of Interest Declaration: The authors declare that they have no competing interests

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الملخص العربى

مرض ضيق الشعب الهوائية المزمن فى النساء اللاتي يستخدمن الوقود الحيوي المترددات علي مستشفى الأمراض الصدرية، دمنهور

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ملخص البحث

الخلفية: أظهرت دراسات مختلفة وجود ارتباط بين التعرض للوقود الحيوي والأعراض التنفسية المزمنة أكثر من الاضطرابات القياسية للتنفس لدى النساء المعرضات.

الهدف: تقييم استخدام الوقود الحيوي من قبل النساء في المناطق الريفية في دمنهور، مصر، كعامل مساهم في حدوث مرض ضيق الشعب الهوائية المزمن.

الطرق: أجريت هذه الدراسة المقطعية على 80 امرأة يستخدمن الوقود الحيوي بانتظام لسنوات، وقد حضرن إلى مستشفى الأمراض الصدرية، دمنهور خلال الفترة من نوفمبر 2019 إلى أغسطس 2020. خضعت جميعهن لأخذ التاريخ المرضي بما في ذلك مدة التعرض للوقود الحيوي، والأعراض التنفسية، والأمراض المصاحبة، ثم تم إجراء قياس وظائف الرئة.

النتائج: أظهرت النتائج أن 49 سيدة (61.2%) يعانين من مرض ضيق الشعب الهوائية المزمن ، بينما 31 سيدة (38.8%) لا يعانين منه. علاوة على ذلك، عانت سيدة (70%) من ضيق الشعب الهوائية الصغيرة، في حين لم تتأثر 24 سيدة (30%). كان لدى النساء المصابات بمرض لمرض ضيق الشعب الهوائية المزمن فترة تعرض أطول بشكل ملحوظ للوقود الحيوي مع ارتفاع معدل انتشار داء السكري مقارنة بأولئك اللاتي لا يعانين من المرض. كانت أهم العوامل التنبؤية لمرض ضيق الشعب الهوائية المزمن بالترتيب التنازلي هي: ضيق التنفس (معامل تنبؤ=-3.9، p <0.001)، السعال (معامل تنبؤ= -2.55،p<0.001)، داء السكري معامل تنبؤ =-2.3، p <0.003)، ومدة اطول للتعرض للوقود الحيوي (معامل تنبؤ= - 0.94، p <0.001).

الأستنتاجات: مرض ضيق الشعب الهوائية المزمن منتشرًا بين النساء اللاتي يستخدمن الوقود الحيوي، وارتبط بوجود أعراض تنفسية، وداء السكري، وطول مدة التعرض للوقود الحيوي.

الكلمات المفتاحية: الوقود الحيوي، مرض ضيق الشعب الهوائية المزمن، عوامل الخطر لمرض ضيق الشعب الهوائية المزمن، اختبارات وظائف الرئة.

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