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Household Wood Fuel Usage and Lung Cancer Predictor Symptoms in Primary Care: A Retrospective Cross-Sectional Study for Lung Cancer Early Detection

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Abstract

Biomass fuel combustion is a major contributor to household air pollution, posing risks to various health concerns, including lung cancer (LC). In Yogyakarta, 13.68% of households still depend on firewood as their primary source of cooking fuel. This retrospective cross-sectional study involved 302 patients attending the outpatient department at Pundong District Health Centre between July and August 2023. The primary outcomes were the number of reported LC predictor symptoms and LC suspicion referral status, based on the NG12 referral criteria. Wood fuel usage (WFU), respiratory disease history, and smoking history were the independent factors. Significant symptoms associated with high-risk WFU were cough (OR = 3.16, $p < 0.001$), dyspnoea (OR = 3.66, $p = 0.001$), fatigue (OR = 2.26, $p = 0.016$), and weight loss (OR = 4.46, $p = 0.043$). WFU and respiratory disease history were significantly associated with the number of LC predictor symptoms ($p < 0.001$). WFU, respiratory disease history, and smoking history demonstrated a significant relationship with LC suspicion referral status ($p < 0.001$). This study highlights the association between WFU and LC predictor symptoms, as well as the need for LC suspicion referral in limited resources settings. Further research is needed to validate the LC predictor symptoms with radiologic findings and final diagnosis.

Introduction

The utilisation of solid fuels, particularly biomass fuels, remains widespread among the majority of rural households primarily for cooking purposes (Ravindra *et al*., 2020). Approximately 2.8 billion people worldwide still depend on solid fuels. The highest prevalence was observed in the regions of Africa and Southeast Asia, constituting 77% and 61% respectively (Bonjour *et al*., 2013). According to the 2023 report from the Indonesian Central Statistics Agency (Badan Pusat Statistik), 9.19% of households still rely on firewood as their primary source of cooking fuel. In Yogyakarta, this percentage rises to 13.68% (Badan Pusat Statistik, 2023). Biomass fuel combustion is a significant contributor to household air pollution (HAP), posing risks to various health concerns, particularly non-communicable diseases (NCDs) such as stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD), and lung cancer (Aunan *et al*., 2019; Fullerton *et al*., 2008; WHO, 2022). HAP alone accounted for 3.2 million deaths in 2020, including 237,000 deaths in children under 5 years of age (WHO, 2022). Children, the elderly, and women are the groups at the highest risk of exposure to biomass fuel combustion byproducts, particularly through cooking and heating, leading to a range of acute to chronic respiratory symptoms (Das *et al*., 2017; Desalu *et al*., 2010; Enyew *et al*., 2021; Van Vliet *et al*., 2019). These are compounded by factors such as the type of fuel and stove utilised, inadequate

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ventilation, integrated kitchen within living spaces, and the practice of mothers carrying children while cooking in the kitchen (Das *et al*., 2017; Enyew *et al*., 2021; Fullerton *et al*., 2008).

Lung cancer (LC) is the leading cause of cancer-related mortality worldwide, accounting for 1,796,144 global deaths. According to the Global Cancer Observatory (GLOBOCAN) report in 2020, LC ranks as the third most common cancer in Indonesia, with the highest number of new cases occurring in males, totalling 25,953 cases per year (14.1%) (Sung *et al*., 2021). Based on the 2018 Basic Health Research, the prevalence of cancer in Indonesia stands at 1.79%. The province with the highest recorded cancer diagnoses is Yogyakarta, reporting 14,602 cases (4.86%) (Kemenkes RI, 2018). The primary cause of lung cancer is smoking, contributing to over 60% of global LC deaths (*Global Burden of Disease*, 2019). To date, more than one in three adults in Indonesia smoke, according to the 2021 Global Adult Tobacco Survey (GATS) report (GATS, 2021). Based on a 2018 meta-analysis, the relative risk of LC is not significantly different between male and female smokers, with values of 8.78 and 7.48, respectively. However, the prevalence of LC among non-smokers is found to be higher in females (O'Keeffe *et al*., 2018).

The proportion of LC cases among smokers has decreased in comparison to never-smokers. This decline may be associated with the global reduction in tobacco smokers over the past three decades (Dai *et al*., 2022; Pelosof *et al*., 2017). Risk factors for LC among non-smokers include age, passive smoking, biomass fuel combustion, air pollution, asbestos exposure, radon exposure, genetic factors, a history of radiation therapy, lung disease history, oestrogen, dietary factors, and obesity (Akhtar & Bansal, 2017; David M Mannino, 2021; Dubin & Griffin, 2020). Individuals who have never smoked still carry a relatively high risk and may benefit from LC screening (Kerpel-Fronius *et al*., 2022). Numerous studies have investigated the risk of LC from biomass fuel smoke exposure, particularly wood fuel, yet have not yielded conclusive findings (Lim & Seow, 2012). A systematic review conducted by Bruce *et al* identified a stronger association, particularly in the context of biomass fuel use for cooking, compared to previous research studies (Bruce *et al*., 2015). A retrospective cohort study in China reported an increased lifetime risk of LC associated with exposure to household coal smoke (Barone-Adesi *et al*., 2012). Furthermore, a meta-analysis in 2012 concluded that coal usage is significantly linked to LC compared to other biomass fuels (Kurmi *et al*., 2012). A systematic review conducted in Sub-Saharan Africa in 2020 did not mention LC as a health consequence of wood smoke exposure but rather emphasised the risk of oesophageal cancer (Bede-Ojimadu & Orisakwe, 2020). Nevertheless, based on recent case-control research in 2021, exposure to wood smoke has been established as a risk factor for LC (Báez-Saldaña *et al*., 2021).

Primary care plays a crucial role in the early diagnosis of LC. Primary care physicians need to identify symptoms that raise suspicion of LC and make referrals for further examination (Bradley *et al*., 2019). Early diagnosis is vital because most cases of LC are diagnosed at an advanced stage, leading to poor prognosis and limited therapeutic management options (Okoli *et al*., 2018). Symptomatic diagnosis of LC was not feasible due to the lack of systematic studies measuring the predictive value of symptoms (Shim *et al*., 2014). However, several extensive studies, including meta-analyses, established possible predictive symptoms of LC (Iyen-Omofoman *et al*., 2013; Levitsky *et al*., 2019; Okoli *et al*., 2018; Shim *et al*., 2014).

Haemoptysis is a pre-diagnostic symptom of LC with the highest predictive value across all studies (Iyen-Omofoman *et al*., 2013; Levitsky *et al*., 2019; Okoli *et al*., 2018; Shim *et al*., 2014). Symptoms such as cough, dyspnoea, and chest pain also exhibit high and consistent diagnostic value (Okoli *et al*., 2018; Shim *et al*., 2014). Levitsky *et al* identified 63 symptom descriptors and 7 background variables, reporting symptoms consistent with previous research, including haemoptysis (blood-mixed/brown sputum), dyspnoea (breathing worse upon exertion), cough problems (cough that varied over the day), appetite loss, and voice hoarseness (Levitsky *et al*., 2019). Patient backgrounds such as smoking history, chronic obstructive pulmonary disease (COPD), and

recent respiratory infections are also important predictor variables (Iyen-Omofoman *et al.*, 2013; Levitsky *et al.*, 2019).

Recommendations for LC referrals in primary care have been developed by the National Institute for Health and Care Excellence (NICE) in 2015 (NG12), with the latest update in 2021. This guideline includes referral criteria for performing chest X-ray (CXR) examinations on patients with suspected LC symptoms (NICE Guideline, 2015). The listed symptom criteria were consistent with the LC predictor symptoms identified in other studies (Iyen-Omofoman *et al.*, 2013; Okoli *et al.*, 2018; Shim *et al.*, 2014). Computed Tomography scans (CT scans) offer higher sensitivity for early LC diagnosis compared to CXRs, but their access is considerably more limited (Bradley *et al.*, 2019). The systematic implementation of LC referral systems has yet to be established in Indonesia, while early detection and diagnosis protocols need to be developed to enable earlier LC diagnosis (Dewi *et al.*, 2021).

Based on direct observations during visits to several households in the Pundong District of Bantul, it is evident that many households still use firewood for indoor cooking. Even though only 8.72% of households in Bantul use wood as their primary source of cooking fuel, it is estimated that some households have transitioned to gas as their primary fuel but still use firewood, particularly for boiling water (Badan Pusat Statistik, 2023). Considering household wood fuel usage (WFU) as one of the potentially impactful risk factors for LC, the medical staff of the Pundong District Health Centre aim to assess the relationship between household WFU and predictor symptoms, as well as the LC suspicion referral status in patients at the Pundong District Health Centre.

Methods

This study employed a retrospective cross-sectional design with convenience sampling. The participants were recruited from the medical records of patients attending the outpatient clinic at Pundong District Health Centre who underwent lung cancer (LC) screening between July and August 2023. Eligible subjects were identified by primary care doctors through medical record reviews. Approval from the Health Department of Bantul Regency was acquired to conduct this study as a part of Pundong District Health Centre's healthcare program. The inclusion criteria were individuals aged 40 and above who have never smoked or have not smoked in the last 28 days. The history of persistent cardiovascular symptoms and other notable systemic diseases

NICE Guideline (NG12) on Lung Cancer Recognition and Referral
Refer people using a suspected cancer pathway referral for lung cancer if they: • have chest X-ray findings that suggest lung cancer or • are aged 40 and over with unexplained haemoptysis. [2015]
Offer an urgent chest X-ray (to be done within 2 weeks) to assess for lung cancer in people aged 40 and over if they have 2 or more of the following unexplained symptoms, or if they have ever smoked and have 1 or more of the following unexplained symptoms: • cough • fatigue • shortness of breath • chest pain • weight loss • appetite loss [2015]
Consider an urgent chest X-ray (to be done within 2 weeks) to assess for lung cancer in people aged 40 and over with any of the following: • persistent or recurrent chest infection • finger clubbing • supraclavicular lymphadenopathy or persistent cervical lymphadenopathy • chest signs consistent with lung cancer • thrombocytosis. [2015]

FIGURE 1. NICE Guideline (NG12) on Lung Cancer Recognition and Referral (NICE Guideline, 2015)

were excluded. The primary outcome measures were the number of reported LC predictor symptoms and LC suspicion referral status. The independent factors were wood fuel usage (WFU), respiratory disease, and smoking history. The secondary outcome measures were age group, gender, education levels of participants, and whether these characteristics predicted wood fuel usage.

High-risk group was defined as wood fuel users who use wood fuel combustion for cooking and heating in the household at regular intervals of at least twice a week, located inside the house (indoor), or partially outdoors or close to the house's ventilation. The low-risk group was defined as users with regular usage intervals and located outdoors. Non-users were defined as participants who had never used wood fuel or had only used it occasionally. Other household air pollution (HAP) factors, like indoor smoking, were not accounted for this study. LC predictor symptoms and LC suspicion referral status were established based on the NG12 referral guideline from the National Institute for Health and Care Excellence (NICE), as shown in **FIGURE 1.** (NICE Guideline, 2015). The listed "unexplainable symptoms" were adjusted to be either "unexplainable or persistent symptoms" as stated in the older version of the NG12 guideline, considering the feasibility of screening and the relatively low-educated participants, ensuring a more representative reporting of symptoms.

Data collection was through the medical records of patients who underwent LC screening by primary care doctors with a previously arranged set of questions. Interview answers were systematically transcribed into the medical record. Patients who matched the referral criteria were labeled as being referred for LC suspicion. Data were analysed using the IBM SPSS 26.0. Descriptive statistics were used to describe the participants' demographic characteristics and other study data. Chi-square tests were used to explore the differences in the demographic characteristics and WFU. Nonparametric independent tests were used to identify the relationship between WFU, respiratory disease history, smoking status, number of lung predictor symptoms, and the differences among the WFU groups. Bivariate analysis was executed to compare each LC predictor symptom among the WFU groups. In addition, the LC suspicion referral status was compared with the WFU groups using the Chi-square test.

Results and Discussions

A total of 302 patients who attended the outpatient clinic were included in the study. The mean age was 60 years, ranging from 41 to 89 years (SD = 9.36). The majority of the patients were female (n = 221, 73.2%) and demonstrated a lack of formal education. Most patients had only completed primary school (n = 135, 44.7%). Wood fuel usage (WFU) was found in 38.4% of participants (n = 116), whereas the percentage of low-risk users and high-risk users was 10.3% (n = 31) and 28.1% (n = 85). There was a significant difference in gender on WFU (p = 0.005, chi-square), with 72 (84.7%) females in the high-risk group compared to males. Education level was found to have a significant difference (p = 0.005, linear-by-linear association) on WFU. The primary school group showed the highest percentage in the high-risk group (56.8%). The age groups divided among participants also showed significant differences in WFU (p = 0.035, linear-by-linear association). The age group of 60 to 69 years old was the most prevalent in the high-risk group (n = 41, 48.2%). Respiratory disease history, ranging from

TABLE 1. Pairwise Comparisons of Wood fuel usage.

	Test statistic	**Raw p-value**	**Adj. p-value[a]**
Non-user - Low-risk	0.422	0.516	1.000
Non-user - High-risk	16.206	0.000	0.000
Low-risk - High-risk	8.460	0.004	0.011

[a] Bonferroni correction

TABLE 2. Comparison Between Demographic Characteristics of Patients on Wood Fuel Usage

Demographic Characteristics	Low-risk / Non-user n = 217	High-risk n = 85	p-value
	n (%)	n (%)	
40-49	33 (15.2)	9 (10.6)	0.035[a]
50-59	82 (37.8)	21 (24.7)	
60-69	71 (32.7)	41 (48.2)	
≥70	31 (14.3)	14 (16.5)	
Male	68 (31.3)	13 (15.3)	0.005[b]
Female	149 (68.7)	72 (84.7)	
No Education	16 (7.4)	8 (9.4)	0.005[a]
Primary School	87 (40.1)	48 (56.5)	
Middle School	42 (19.4)	13 (15.3)	
High School	61 (28.1)	14 (16.5)	
College/diploma	11 (5.1)	2 (2.3)	

[a] Linear-by-linear association
[b] Chi-square

Source: Primary Data, 2023

asthma, chronic obstructive pulmonary disease (COPD), respiratory Tuberculosis (TB) history, and recent lung infection, was documented in 22 (7.3%) patients. Past smoking history was reported in 46 (15.2%) patients, all male patients, with active smokers excluded.

Pairwise comparisons between groups of WFU on the number of symptoms were executed and adjusted with Bonferroni correction, as shown in **TABLE 1.** The result showed that the non-user group and the low-risk group showed no significant difference in the number of symptoms ($p = 1.000$), while both groups, when compared to the high-risk group, showed significant differences ($p = 0.000$ and $p = 0.011$). The non-user and low-risk groups were assigned to the same group in **TABLE 2** to simplify comparisons between demographic characteristics. WFU, respiratory disease history, and smoking history were identified as factors affecting the LC predictor symptoms. Mann-Whitney test was assigned to assess associations between the covariates and the number of LC predictor symptoms as shown in **TABLE 3.** Both WFU and respiratory disease history showed significant association ($p < 0.001$) with the number of symptoms, while smoking history showed no significant

TABLE 3. Association Between Covariates and the Number of Lung Cancer Predictor Symptoms

Covariates		n (%)	Z	p-value
Wood Fuel Usage	Low-risk / Non-user	217 (71.9)	-4.505	<0.001
	High-risk	85 (28.1)		
Respiratory Disease History	No	280 (92.7)	-4.481	<0.001
	Yes	22 (7.3)		
Smoking History	Never smoker	256 (84.8)	-0.996	0.319
	Past smoker	46 (15.2)		

Source: Primary Data, 2023

TABLE 4. Lung Cancer Predictor Symptoms Distribution in Wood Fuel Usage Groups

Lung Cancer Predictor Symptoms	No. of Cases n = 94	Outcome	WFU Group		OR	p-value
			Low-risk / Non-user	High-risk		
	n (%)		n = 217	n = 85		
Haemoptysis	4 (4.3)	Yes	2 (0.9)	2 (2.4)	2.59	0.315[a]
		No	215 (99.1)	83 (97.6)		
Cough	48 (51.1)	Yes	24 (11.1)	24 (28.2)	3.16	<0.001[b]
		No	193 (88.9)	61 (71.8)		
Dyspnoea	27 (28.7)	Yes	12 (5.5)	15 (17.6)	3.66	0.001[b]
		No	205 (94.5)	70 (82.4)		
Chest pain	13 (13.8)	Yes	6 (2.8)	7 (8.2)	3.16	0.054[a]
		No	211 (97.2)	78 (91.8)		
Fatigue	41 (43.6)	Yes	23 (10.6)	18 (21.2)	2.26	0.016[b]
		No	194 (89.4)	67 (78.8)		
Weight loss	8 (8.5)	Yes	3 (1.4)	5 (5.9)	4.46	0.043[a]
		No	214 (98.6)	80 (94.1)		
Appetite loss	20 (21.3)	Yes	12 (5.5)	8 (9.4)	1.77	0.222[b]
		No	205 (94.5)	77 (90.6)		

[a]Fisher's Exact

[b]Chi Square

Source: Primary Data, 2023

association (p = 0.319).

Cough (n = 48, 15.9%) and fatigue (n = 41, 13.6%) were the most common Lung Cancer (LC) predictor symptoms reported in the population. Among symptomatic patients, the prevalence of cough and fatigue is 51.1% and 43.6% respectively. The other symptoms, in order of case frequency, were dyspnoea (n = 27, 8.9%), appetite loss (n = 20, 6.6%), chest pain (n = 13, 4.3%), weight loss (n = 8, 2.6%), and haemoptysis (n = 4, 1.3%). **TABLE 4** demonstrates the percentage of cases among symptomatic patients and the number of each LC predictor symptom reported among WFU groups, enabling comparison between the low-risk/non-user group vs. the high-risk group. The symptoms that were observed to be significantly associated with high-risk WFU were cough (p < 0.001), dyspnoea (p = 0.001), fatigue (p = 0.016), and weight loss (p = 0.043). The odds ratio (OR) of "weight loss" was 4.46 (1.4% vs. 5.9%), which was comparably highest among other symptoms. It was followed by "dyspnoea" with an OR of 3.66 (5.5% vs. 17.6%), "cough" with an OR of 3.16 (11.1% vs. 28.2%), and "chest pain" with an OR of 3.16 (2.8% vs. 8.2%). The OR for "haemoptysis" was 2.59 with only 4 cases reported (0.9% vs. 2.4%). "Fatigue" had an OR of 2.26 (10.6% vs. 21.2%) and "appetite loss" had an OR of 1.77 (5.5% vs. 9.4%). The relationship of each LC predictor symptom among WFU groups was analysed using the Chi-square and Fisher's exact test.

The number of LC predictor symptoms and smoking history were assessed using the NG12 guideline. A total of 45 (14.9%) patients were assigned to be referred for CXR. Among these, 22 patients (48.9%) were in the low-risk group and 23 patients (51.1%) were in the high-risk group. In the respiratory disease history group, 11 (24.4%) patients were referred to respiratory disease. In the smoking history group, 16 (35.6%) were past smokers. The association between referral status and covariates was analysed using the Chi-square test. WFU, respiratory disease history, and smoking history all demonstrated significant association (p <0.001) as shown in **TABLE 5.**

This study demonstrated the association between WFU and Lung cancer (LC) predictor

TABLE 5. Association Between Covariates and Lung Cancer Suspicion Referral Status

		No Refer n = 257	Refer for CXR n = 45	p-value
		n (%)	n (%)	
Wood Fuel Usage	Low-risk / Non-user	195 (75.9)	22 (48.9)	<0.001
	High-risk	62 (24.1)	23 (51.1)	
Respiratory Disease History	No	246 (95.7)	34 (75.6)	<0.001
	Yes	11 (4.3)	11 (24.4)	
Smoking History	Never smoker	227 (88.3)	29 (64.4)	<0.001
	Past smoker	30 (11.7)	16 (35.6)	

symptoms and LC suspicion referral status. The two main factors related to an increased number of LC predictor symptoms in this study were wood fuel usage (WFU) and respiratory disease history. WFU was reported in 38.4% of patients, a relatively high number compared to the national survey in 2023, which documented the primary source of cooking fuel in the Indonesian household. In Bantul (the same region where this study took place), only 8.72% of households still rely on wood fuel for cooking (Badan Pusat Statistik, 2023). The secondary source of cooking fuel was not reported in the survey, concealing the number of households still using wood fuel with cleaner fuels concurrently. WFU as a type of biomass fuel was often used together with other biomass ones, such as grass or straw (Bonjour *et al.*, 2013; Bruce *et al.*, 2015). During several short interviews, some households use painted wood scraps and plastic wastes incorporated with firewood combustion.

Older patients, female gender, and lower education level were associated with high-risk WFU in this study. Older populations used to rely on wood fuel before the twenty-first century and might not be accustomed to converting to modern or safer fuel combustion methods (Bonjour *et al.*, 2013). The female gender was reported to be significantly associated with high-risk WFU, but this may lead to potential bias since the gender majority in this study was female. Considering gender role distinction, females were reported to be at risk for more exposure to household air pollution (HAP), including biomass fuel combustion like WFU for cooking and heating (Van Vliet *et al.*, 2019; Vermeulen *et al.*, 2019). HAP does not only include indoor biomass fuel combustion. Fumes from outdoor combustion can penetrate houses exposing connecting rooms to harmful gases, including neighbourhood air pollution. Poor ventilation, low-quality inefficient cookstoves, and the choice of cooking fuel contribute significantly in HAP (Aunan *et al.*, 2019; Das *et al.*, 2017; Fullerton *et al.*, 2008; Ravindra *et al.*, 2020). A 2019 study revealed that women who cook using cleaner fuels such as liquefied petroleum gas (LPG) have improved lung function and respiratory health status compared to those who use solid biomass fuel (Kaur-Sidhu *et al.*, 2019). While these factors were not documented comprehensively in this study, we identified several factors that might alter the risk of wood fuel combustion exposure through short interviews: house ventilation, frequency of WFU (not all households use wood fuel daily), stove location (inside, outside, or near the house), and type of stove. Outdoor WFU and sporadic WFU were estimated to be low-risk in terms of HAP exposure, while indoor or partially outdoor WFU and frequent WFU were considered high-risk (Goldstein *et al.*, 2021).

Cough, dyspnoea, fatigue, and weight loss are the LC predictor symptoms most consistent with the high-risk WFU group. Cough, dyspnoea, and chest pain were LC predictor symptoms with the highest predictive value, after haemoptysis, based on recent systematic reviews and meta-analysis (Okoli *et al.*, 2018; Shim *et al.*, 2014). While this may

suggest a correlation between the established symptoms and LC, common respiratory symptoms could also arise from acute exposure to fumes from biomass fuel combustion (Das *et al*., 2017; Desalu *et al*., 2010; Van Vliet *et al*., 2019). Cough was the most common symptom found in all groups. Cough and dyspnoea were also common respiratory symptoms frequently reported among the geriatric population, even in non-smokers (Enright *et al*., 1994). Older age is also a major risk factor for LC (Akhtar & Bansal, 2017; David M Mannino, 2021).

A previous study of 269 adult women in Nigeria with similar mean age and educational background to this study reported that 59.9% of respondents used biomass fuel for cooking. The OR for the presence of respiratory symptoms, particularly "cough" in the biomass fuel group, was 4.82 ($p = 0.01$) compared to the non-biomass fuel group (13.7% vs. 3.7%). The OR of chest pain and breathlessness were 3.82 ($p = 0.09$) and 1.54 ($p = 0.35$), respectively (Desalu *et al*., 2010). In this study, the OR of "cough" was 3.16 ($p < 0.001$), comparing the low-risk/non-user group vs. the high-risk group (11.1% vs. 28.2%). The OR of chest pain and breathlessness had a different ratio, which was 3.16 ($p = 0.054$) and 3.66 ($p = 0.001$), respectively. The quality of firewood was also compared to the presence of respiratory symptoms in a 2017 study. It was revealed that low-quality firewood was positively associated with shortness of breath, phlegm at night, and other non-respiratory symptoms (Das *et al*., 2017).

There was a significant difference between high-risk and low-risk WFU in the number of LC predictor symptoms ($p < 0.001$). High-risk WFU also showed a significant association with LC suspicion referral status, as determined by the NICE guideline (NG12) referral pathway. It suggested the need to further CXR examination, which had not been implemented for all subjects during the time of this study. Smoke exposure from biomass fuel combustion, especially wood fuel, has been hypothesised as a potential LC risk (Dean Hosgood *et al*., 2010). It was revealed in a 2015 systematic review that the strength of association between wood smoke and LC was weak. On the contrary, when restricted to studies among the majority of women, larger ORs were seen in the range of 1.6 to 2 (Bruce *et al*., 2015). A 2021 case-control study concluded that exposure to wood smoke is a risk factor for LC (Báez-Saldaña *et al*., 2021), in contrast to several other studies that did not mention the significance of WFU. It was highlighted several times that coal was a solid biomass fuel associated with LC (Barone-Adesi *et al*., 2012; Bede-Ojimadu & Orisakwe, 2020; Kurmi *et al*., 2012).

Respiratory disease history showed a significant correlation with LC predictor symptoms ($p < 0.001$). Certain respiratory diseases like chronic obstructive pulmonary disease (COPD) can exacerbate symptoms like dyspnoea and cough. Moreover, decreased lung function (Miravitlles & Ribera, 2017). The history of tuberculosis was also a strong predictor of respiratory symptoms (Van Kampen *et al*., 2019). It is also worth noting that the respiratory disease record, including COPD and recent lung infection, was established as one of the predictors of LC based on recent studies (Levitsky *et al*., 2019; Okoli *et al*., 2018). Smoking history (past smoking) was observed to have a significant difference between referral status groups, but had no significant association with the number of LC predictor symptoms. It might be influenced by the NG12 criteria, which include smoking history as one of the scoring factors for LC suspicion status (NICE Guideline, 2015). In this study, current or active smokers were excluded, leaving past smokers and never smokers for comparison. Conversely, the majority of the patients in this study were females living in a relatively rural region of Indonesia. Smoking history in women is uncommon, which may cause disproportion when comparing never smokers and past smokers. Furthermore, any history of smoking is considered a significant risk of LC (David M Mannino, 2021; O'Keeffe *et al*., 2018).

Conclusions

We have established a positive association between wood fuel usage (WFU) and the presence of lung cancer (LC) predictor symptoms in primary care patients. Symptoms such as cough, dyspnoea, fatigue, and weight loss are common in individuals with high-risk WFU. A history of respiratory disease

not only increases the risk of these symptoms but may also contribute as an LC predictor variable. Additionally, high-risk WFU are more frequently referred for LC suspicion compared to low-risk WFU and non-users. Further research is needed to confirm the association between the reported LC predictor symptoms and the radiologic findings, as well as the final diagnosis. The idea of implementing symptom-based early LC detection could be of great value in Indonesia, especially in limited-resource areas where access to standard diagnostic tools is still limited.

Finally, it is crucial to acknowledge the potential impact of firewood quality and other supplementary solid fuel sources in exacerbating air pollution, potentially increasing the risk of developing LC. Future research should adopt a more detailed yet practical approach in reporting WFU, particularly in rural households.

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