



Article

Tobacco Dust Exposure Among Tobacco Workers in Jember Reduces Lung Function Capacity

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Abstract: This study investigated the association between urinary cotinine levels and lung function among tobacco workers in Jember Regency, a major tobacco-producing region in Indonesia. A total of 48 respondents were included based on specific inclusion and exclusion criteria. Urinary cotinine levels were measured using enzyme-linked immunosorbent assay (ELISA), and lung function was assessed via spirometry. Based on FEV1/FVC ratios, 58% of participants exhibited restrictive lung patterns, 29% showed obstructive patterns, and 13% had normal pulmonary function. Statistical analysis conducted using SPSS, with a significance level set at $p < 0.05$, indicated **no statistically significant correlation** between urinary cotinine levels and lung function.

Keywords: cotinine, lung function, tobacco dust exposure

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1. Introduction

Jember Regency is one of the largest tobacco-producing regions in Indonesia, with a total output of 24,331.80 tons in 2021 [1]. While the tobacco industry contributes significantly to the local economy—especially by providing employment for women who play a central role in processing—there are substantial occupational health risks associated with prolonged tobacco dust exposure. Women employed in tobacco factories are often exposed daily to nicotine-laden dust, which poses a risk for respiratory disorders. Importantly, women may be physiologically more vulnerable to respiratory impacts from particulate exposure due to having smaller lungs and narrower airways than men [2]. This sex-based anatomical difference may amplify the negative effects of occupational inhalants, such as tobacco dust, yet remains underrepresented in current research. Nicotine, absorbed through the skin or inhaled, is metabolized in the liver into cotinine, a compound commonly used as a biomarker for tobacco exposure. Elevated urinary cotinine levels have been associated with reduced lung function, particularly through their link to chronic obstructive pulmonary disease (COPD), as measured by the FEV1/FVC ratio [3,4]. Although several studies have explored the relationship between cotinine levels and lung function, few have focused specifically on female tobacco workers in developing regions. This presents a critical research gap, as gender-specific vulnerabilities and exposure contexts may influence both the extent of nicotine absorption and its respiratory effects.

2. Materials and Methods

This study employed an observational analytic design with a cross-sectional approach to investigate the relationship between urinary cotinine levels and lung function among female tobacco workers in Jember Regency. Data collection occurred from July to December 2024 at the PTPN X Ajong Gayasan tobacco processing factory. The study population consisted of 50 female workers aged 18 to 59 years who met the inclusion criteria of being non-smokers (both active and passive), working at least eight hours per

day, six days per week, and willing to participate with informed consent. Participants were excluded if they had a fever at the time of assessment or a prior history of lung diseases such as bronchitis, pneumonia, pleuritis, tuberculosis, or asthma. After obtaining informed consent, participants completed a structured baseline questionnaire to gather demographic and health information, including age, marital status, education, occupation, and body weight. Midstream urine samples were then collected in sterile, pre-labeled containers filled to approximately 75% capacity and analyzed for urinary cotinine using an Enzyme-Linked Immunosorbent Assay (ELISA) with the Human Cotinine ELISA Kit (Catalog No. MDBE0026Hu). Lung function was assessed using a Contec Medical System Co., Ltd., SP10 spirometer, following standardized protocols in which participants performed at least three acceptable and reproducible forced exhalations. Key parameters measured included forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and the FEV1/FVC ratio, with lung function classified as normal, restrictive, or obstructive based on these results. Data analysis was conducted using SPSS version 25; continuous variables were tested for normality with the Shapiro-Wilk test, and correlations between urinary cotinine levels and lung function parameters were evaluated using Pearson's or Spearman's correlation tests depending on data distribution. Statistical significance was set at $p < 0.05$.

3. Results and Discussion

All respondents in this study were female, selected due to their genetic role as carriers of color blindness; hence, male participants were excluded. Participant characteristics—including age, education level, husband's smoking status, cigarette smoke exposure, and years of service—are summarized in the relevant tables.

As shown in **Table 1**, the youngest respondent was 22 years old, and the oldest was 53 years old. The majority of participants ($n = 31$; 65%) were aged 40–59 years, while the remaining 35% were between 18–39 years. The mean age of respondents was 43 years. Additional characteristics, such as education level and occupational exposure, are detailed in **Table 2** and subsequent tables.

A correlation analysis was conducted to determine the relationship between urinary cotinine levels and lung function (FEV1/FVC ratio). The results indicated **no statistically significant correlation** between these variables (Pearson's $r =$ [insert r value], $p =$ [insert p -value]). This suggests that within the sample, variations in urinary cotinine levels were not significantly associated with differences in lung function.

Table 1. Sample Distribution Based on Age

Characteristics Age	Total n (%)
18 – 39	17 (35.4)
40 – 59	31 (65.6)

* Statistical descriptive test

Table 2. Sample Distribution Based on Level of Education

Level of Education	Total n (%)
Not attending formal education	1 (2.0)
Elementary school	26 (54.0)
Junior High school	10 (21.0)
Senior High school	11 (23.0)
Higher Education	0 (0)

* Statistical descriptive test

Based on Table 2, it is known that the education level of the respondents is divided into 5 categories. One respondent in the study had no formal education (2%). There were 26 respondents with an elementary school (SD) education (54%), 10 respondents with a junior high school (SMP) education (21%), 11 respondents with a senior high school (SMA/SMK) education (23%), and no respondents with a higher education degree.

Table 3. Sample Distribution Based on Smoker Husbands

Smoker Husbands	Total n (%)
Yes	33 (69.0)
No	15 (31.0)

* Statistical descriptive test

Based on Table 3, it is known that 33 respondents had husbands who were active smokers (69%), while 15 respondents had husbands who were non-smokers (31%).

Table 4. Sample Distribution Based on Cigarettes Exposure

Cigarettes Exposure (hours)	Total n (%)
< 1	31 (65.0)
1 – 3	8 (17.0)
> 3	9 (19.0)

* Statistical descriptive test

Based on Table 4, 31 respondents were exposed to cigarette smoke for less than 1 hour (65%), 8 respondents were passively exposed for 1–3 hours (17%), and 9 respondents were passively exposed for more than 3 hours (19%). This study shows that, on average, respondents were passively exposed to cigarette smoke for less than 1 hour.

Table 5. Sample Distribution Based on Length of Service

Length of Service (years)	Total n (%)
1 – 10	18 (37.5)
11 – 20	7 (14.5)
21 – 30	20 (41.5)
31 – 40	3 (6.5)

* Statistical descriptive test

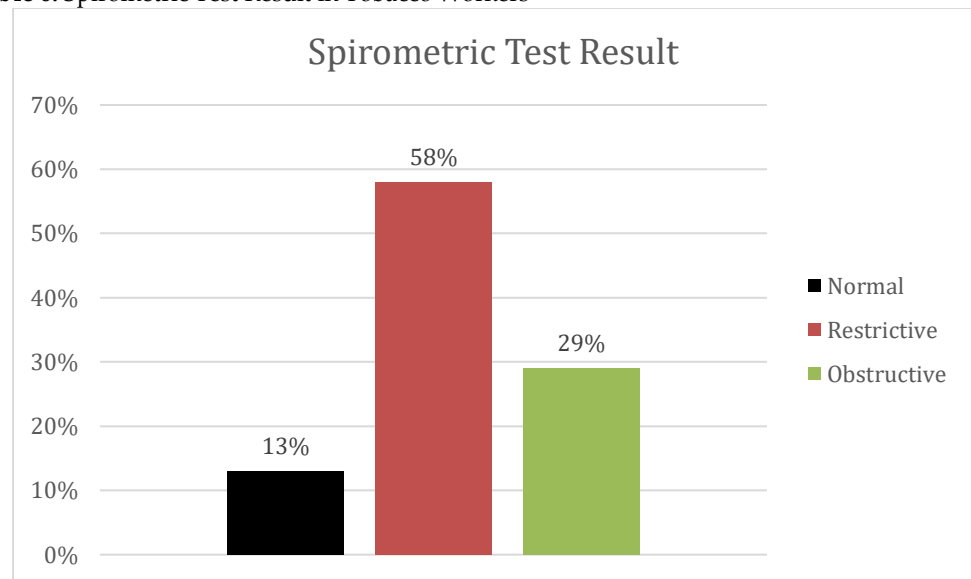
Based on Table 5 above, the distribution of respondents' years of service shows their length of employment over several years. The classification is divided into four categories with 10-year intervals: 1–10 years with 18 respondents (37.5%), 11–20 years with 7 respondents (14.5%), the majority of respondents having worked for 21–30 years with 20 respondents (41.5%), and 31–40 years with 3 respondents (6.5%).

The results of urine cotinine level measurements in 48 respondents showed an average urine cotinine level of 61.278 ng/mL, with the highest level being 139.5 ng/mL and the lowest level being 27.38 ng/mL. These levels are equivalent to urine cotinine levels in active smokers, as reported by Kim (2016), which states that urine cotinine levels in active smokers range from 30 to 550 ng/mL.

The spirometry measurements indicated that most respondents had an average FEV1 value of <80%, at 38%. The average FVC value was <80%, at 44.57%. The FEV1/FVC

ratio was >80%, at 85.25%. These results indicate that the majority of respondents have restrictive lung disorders.

Table 6. Spirometric Test Result in Tobacco Workers



To see or analyze the metabolic of nicotine taken the sample tobacco workers that always been exposure to tobacco. The metabolic of nicotine changed to cotinine with several mechanism and the results is called cotinine that can be seen and obtained in urine. We found that there were high concentration of cotinine indicates that there is nicotine content in the body.

In this study, lung capacity percentages (FEV1/FVC) revealed that 58% of workers experienced restrictive airway disorders, 29% had obstructive airway disorders, and 13% were normal. This aligns with research by Aziz et al. (2020), which found that menopausal female tobacco factory workers are eight times more likely to develop restrictive lung disorders than their reproductive-age counterparts. Tobacco dust exposure leads to mucus buildup in alveolar cells, causing obstruction and lung damage. The results indicate a higher prevalence of restrictive airway disorders, caused by reduced lung elasticity from reactive oxygen species (ROS) exceeding the body's antioxidant defenses, contributing to chronic inflammation and tissue changes (Seo et al., 2023). This supports Sari et al. (2017), which reported that tobacco dust exposure damages lung tissue, impairing lung expansion.

While cotinine is a biomarker for tobacco exposure, measurement can be affected by individual differences in nicotine metabolism. Variability in CYP2A6 enzyme activity and genetic factors influence cotinine conversion rates (Kunutsor et al., 2024). Additionally, diluted urine from excessive fluid intake before sampling can lower detected cotinine levels (Schoen et al., 2013). Serum cotinine is considered a better marker in some populations due to its lower variability compared to urine (Ware et al., 2020).

Lung capacity is also influenced by work duration. Longer employment increases exposure to tobacco dust, accumulating in the lungs (Haque et al., 2017). Although the women in this study were non-smokers, external secondhand smoke exposure could still impact respiratory muscles through free radicals. Reproductive factors also play a role; estradiol in reproductive-age women provides anti-inflammatory protection, which diminishes post-menopause, increasing vulnerability to lung inflammation from tobacco dust (Aziz et al., 2020; Triebner et al., 2017).

4. Conclusions

This study found that 58% of tobacco factory workers experienced restrictive lung disorders, 29% had obstructive disorders, and only 13% had normal lung function. These results indicate a high prevalence of impaired lung capacity likely associated with prolonged exposure to tobacco dust. Key contributing factors may include long working hours, increased susceptibility in post-menopausal women due to reduced estradiol levels, and cumulative exposure to airborne particulates leading to inflammation and respiratory tissue damage.

Although urinary cotinine levels were used as a biomarker for nicotine exposure, no significant correlation was found between cotinine concentration and lung function (FEV1/FVC ratio). This may be attributed to individual differences in nicotine metabolism, sample dilution, or transdermal absorption. Future studies should consider using more stable, long-term biomarkers such as hair cotinine to better assess chronic exposure.

5. Patents

Author Contributions: Conceptualization, J.F. and C.N.; Data collection A.C.; Methodology, J.F. and C.N.; software, C.N.; Validation, J.F., C.N., S.R.; formal analysis, C.N. and S.R.; investigation, A.C. and C.N.; resources, C.N.; data curation, C.N.; writing—original draft preparation, C.N.; writing—review and editing, J.F. and S.R.; visualization, C.N.; Supervision, S.R.; project administration, J.F.; all authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The ethical suitability test was carried out by the Ethics Commission of the Faculty of Dentistry, Jember University. It is a non-invasive study.

Informed Consent Statement: All subjects have filled out and signed a consent form to become participants in the research. They were given detailed information about this research before the research was carried out. Subjects also have the right to ask questions and discontinue participation at any time during the test. The participation of the sample was voluntary, and the researcher's identity information was given in order for the members to be able to contact them at any given time.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Alegantina, S. (2017). Penetapan Kadar Nikotin dan Karakteristik Ekstrak Daun Tembakau (*Nicotiana tabacum* L.) Determination of Nicotine Levels in Tobacco Leaves and Characteristics of Tobacco Leaves Extract (*Nicotiana tabacum* L.). *Jurnal Penelitian Dan Pengembangan Pelayanan Kesehatan*, 1(2), 113–119.
2. Aziz, A. M., Srisurani W. A., I., & Tursina, M. Q. (2020). Perbedaan Forced Vital Capacity (FVC) pada Wanita Menopause dan Wanita Usia Subur Pekerja Pabrik Tembakau. *Jurnal Kesehatan*, 8(1), 63–70. <https://doi.org/10.25047/j-kes.v8i1.145>
3. Dominelli, P. B., & Molgat-Seon, Y. (2022). Sex, gender and the pulmonary physiology of exercise. *European Respiratory Review*, 31(163). <https://doi.org/10.1183/16000617.0074-2021>
4. Indriani, A., Wijayanti, I., & Awalia, H. (2023). Peran Perempuan dalam Usaha Tani Tembakau di Desa Sakra Selatan. *Proceeding Seminar Nasional Mahasiswa Sosiologi*, 1(1), 373–386.
5. Kumboyono, K., Chomsy, I. N., Hidayat, W. S., Hakim, A. K., Shalshabilla, N. N., Sujuti, H., Tjahjono, C. T., Srihardyastutie, A., Hariyanti, T., & Wihastuti, T. A. (2023). Factors Affecting the Serum Cotinine Level of Male Smokers in Malang, Indonesia. *International Journal of Medical Toxicology and Forensic Medicine*, 13(3), E40130. <https://doi.org/10.32598/ijmtfm.v13i3.40130>
6. Maulidiyah, A. A., & Darsono, D. (2024). Analisis Faktor-Faktor Yang Memengaruhi Ekspor Tembakau Di Kabupaten Jember. *Agricultural Socio-Economic Empowerment and Agribusiness Journal*, 2(2), 68. <https://doi.org/10.20961/agrisema.v2i2.74829>

7. Maulidiyah, A. A., & Darsono, D. (2024). Analisis Faktor-Faktor Yang Memengaruhi Ekspor Tembakau Di Kabupaten Jember. *Agricultural Socio-Economic Empowerment and Agribusiness Journal*, 2(2), 68. <https://doi.org/10.20961/agrisema.v2i2.74829>
8. Tanner, J. A., Prasad, B., Claw, K. G., Stapleton, P., Chaudhry, A., Schuetz, E. G., Thummel, K. E., & Tyndale, R. F. (2017). Predictors of variation in CYP2A6 mRNA, protein, and enzyme activity in a human liver bank: Influence of genetic and nongenetic factors. *Journal of Pharmacology and Experimental Therapeutics*, 360(1), 129–139. <https://doi.org/10.1124/jpet.116.237594>
9. Wang, J., Xue, T., Ye, H., Sang, C., Wu, S., & Li, S. (2021). Study of the common activating mechanism of apoptosis and epithelial-to-mesenchymal transition in alveolar type II epithelial cells. *Respiratory Physiology and Neurobiology*, 284(October 2020), 103584. <https://doi.org/10.1016/j.resp.2020.103584>
10. Zagà, V., Dell’Omo, M., Murgia, N., & Mura, M. (2021). Tobacco Worker’s Lung: A Neglected Subtype of Hypersensitivity Pneumonitis. *Lung*, 199(1), 13–19. <https://doi.org/10.1007/s00408-020-00416-4>
11. Zysman, M., & Raheison-Semjen, C. (2022). Women’s COPD. *Frontiers in Medicine*, 8(January), 13–16. <https://doi.org/10.3389/fmed.2021.600107>

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