ORIGINAL RESEARCH ARTICLE

The association of second-hand smoke with hypertension among adult males in Bali, Indonesia

DOI: 10.29063/ajrh2024/v28i10s.16

Nyoman I. Purnawan[1,3], Sigit A. Saputro[2], Muji Sulistyowati[2], Chatarina U. Wahyuni[2], Santi Martini[2] and Sri Widati[2]*

Doctorate Degree Program in Public Health, Faculty of Public Health, Universitas Airlangga, Surabaya 60115, Indonesia[1]; Faculty of Public Health, Universitas Airlangga, Surabaya, 60115, Indonesia[2]; Faculty of Health and Science, Universitas Dhyana Pura, Bali, 80351, Indonesia[3]

***For Correspondence:** Email: *i.nyoman.purnawan-2021@fkm.unair.ac.id*; Phone: +6281236764961

Abstract

Second-hand smoke (SHS), also known as passive smoking, is a widely accepted risk factor for hypertension. This study aimed to determine the association of SHS and hypertension among a cohort of adult males in Bali, Indonesia. A nation-wide cross-sectional study of males aged ≥18 years was included in the study. We included 7,087 males in this study out of 14,494 subjects in Bali, that participated in the Indonesian Basic Health Survey (IBHS) 2018. Multivariate logistic regression was used to assess the association. The prevalence of hypertension among male adults was 32.3%. Among the hypertensive males, about 20.9% of the subjects was exposed to SHS. Multivariate logistic regression showed significant association between SHS (OR=1.16; 95%CI,1.02-1.32) and hypertension with adjusted odd ratio of age (aOR=1.03; 95%CI,1.02-1.04) and residence (aOR=1.10; 95%CI,0.99-1.23). The prevalence of hypertension among older males who were exposed to SHS was higher among urban residents. A public health campaign of anti-smoking is urgently needed to increase awareness of SHS exposure among older males who live in urban areas. *(Afr J Reprod Health 2024; 28 [10s]: 134-140)*

Keywords: Hypertension; second-hand smoke; urban; male; Bali; Indonesia

Résumé

La fumée secondaire (SHS), également connue sous le nom de tabagisme passif, est un facteur de risque largement reconnu d'hypertension. Cette étude visait à déterminer l'association entre SHS et hypertension parmi une cohorte d'hommes adultes à Bali, en Indonésie. Une étude transversale nationale portant sur des hommes âgés de ≥ 18 ans a été incluse dans l'étude. Nous avons inclus 7 087 hommes dans cette étude sur 14 494 sujets à Bali, qui ont participé à l'Enquête indonésienne sur la santé de base (IBHS) 2018. Une régression logistique multivariée a été utilisée pour évaluer l'association. La prévalence de l'hypertension chez les hommes adultes était de 32,3 %. Parmi les hommes hypertendus, environ 20,9 % des sujets ont été exposés au SHS. La régression logistique multivariée a montré une association significative entre SHS (OR=1,16 ; IC à 95 %, 1,02-1,32) et l'hypertension avec un rapport de cotes ajusté en fonction de l'âge (aOR=1,03 ; IC à 95 %, 1,02-1,04) et de la résidence (aOR=1,10 ; 95). %IC,0,99-1,23). La prévalence de l'hypertension chez les hommes âgés exposés au SHS était plus élevée parmi les résidents urbains. Une campagne de santé publique antitabac est nécessaire de toute urgence pour sensibiliser davantage les hommes âgés vivant dans les zones urbaines à l'exposition au SHS. *(Afr J Reprod Health 2024; 28 [10s]: 134-140).*

Mots-clés: Hypertension ; fumée secondaire; urbain; mâle; Bali; Indonésie

Introduction

Smoking behaviour and its impacts are still a major public health problem throughout the world. This is known from a literature review of several studies that investigated the impact of active smoking and the toxic effects of cigarettes on health[1]. Based on data from the World Health Organization (WHO), there are ten countries with the largest cigarette consumption, namely China, Russia, the United States, Indonesia, Japan, Germany, India, Turkey, Korea and Vietnam. Current global data indicate that one in three adults is a smoker, 80% of whom live in low and middle income countries[2]. By contrast, the impact of passive smoking on health has not been fully investigated. Existing data suggest that around 44.8% of non-smoking adults (20.3 million adults) are exposed to tobacco smoke at work; 59.3% of non-smoking adults (121.6 million adults) are exposed to tobacco smoke in their homes; 74.2% of

non-smoking adults (56.1 million adults) are exposed to tobacco smoke when they visit public places[3].

Data from Oxford University show that the prevalence of passive smoking (SHS) in low income countries like Indonesia is very high, namely 78.4% compared to other countries such as Bangladesh 46.7%, and Thailand which is only 46.8%[4–6]. Based on the National Health Survey, the population of SHS in Indonesia has reached 96.9 million people, consisting of 30.2 million males and 66.7 million females[7]. About 85% of non-smokers are exposed to cigarette smoke in public places, while 78% of people are exposed at home. A smoking habits survey conducted by WHO in Indonesia in 2021 found that 74.2% of residents aged 18 years and over who were non-smokers were exposed to cigarette smoke in public places. The Indonesian Ministry of Health explains that one of the public health targets is to reduce exposure to cigarette smoke in non-smokers[8]. SHS exposure, similar to active smoking, is a known risk factor for various cardiovascular diseases[9,10]. The relationship between SHS and hypertension has shown significance results in previous studies[11–15]. The risk factors for hypertension in adults include age, unhealthy diet, tobacco use, lack of physical activity, obesity, etc. Exposure to cigarette smoke in non-smokers has also been reported as a non-negligible factor influencing the development of high blood pressure[16,17].

Previous research in Bali Indonesia has investigated the relationship between SHS exposure and hypertension, and found a mostly positive relationship between the two. However, the previous research used a small sample size[18,19]. Therefore, the aim of this study is to determine the association of secondhand smoke and hypertension among adult males in Bali based on the National Health Survey (*Riskesdas*) that used a larger sample size.

Methods

The research data source uses data from the National Health Survey (*Riskesdas*) conducted by the Indonesian Ministry of Health from 2007-2018 to collect basic data and health indicators for Indonesian people representing national, provincial and district/city areas[8]. The study was a quantitative study with a cross sectional design. A research design was carried out to determine the relationship between passive smoking and hypertension in adult men in Bali. This study represents the entire population domiciled and registered in Bali aged ≥ 18 years. We involved 7,087 men in the study from 14,494 subjects in Bali province with 2,290 with hypertension and 4,797 with no hypertension (states on table 1)[20]. The research framework consists of hypertension risk factors.

My data were secondary data collected from the National Health Survey of all households in Indonesia including Bali over 1 year. The national health survey recruited some enumerators to collect the data using questionnaires. The households were chosen by stratified random sampling and the respondent from each household was chosen by simple random sampling. The questionnaire was a structural questionnaire which had questions about whether the person was a smoker or non-smoker and if they were exposed to smoke from lit cigarettes or other tobacco products. Other questions were sociodemographic, such as age, place of residence, marital status and education. The hypertension status was measured with a digital tensimeter using JNC VIII criteria: the respondents must be ≥18 years, must be currently undergoing pharmacologic treatment to lower SBP ≥140 or DBP ≥90 mmHg and must have BP higher than 140/90 mmHg.

We constructed independent variables consisting of SHS (SHS and no SHS), age (18-25, 26-35, 36-45, >45), place of residence (rural and urban), marital status (single, married, divorced) and education (uneducated, primary, secondary, university). The dependent variable consisted of hypertension status. Data were analyzed using the Stata program version 17.0. There are 3 stages of data analysis, namely univariate analysis, bivariate analysis and multivariate analysis.

There were no ethical issues related to this study. Udayana University in Bali provided us with an ethical clearance certificate https://drive.google.com/file/d/1zBVMBigSZPnotsQDgKWYEohYEfhjfzyW/view?usp=sharing.

Results

Hypertension prevalence among male adults ≥ 18 years in Bali was 32.3%. Among the hypertensive

Table 1: Association between SHS exposure-related variable with hypertension among male adults ≥ 18 years in Bali

Variable	Hypertension (%) n = 2,290 (32.3%)	No Hypertension (%) n = 4,797 (67.6%)	p-value
SHS			
Yes	34.7	65.3	0.034*
No	31.7	68.3	
Age			
≤ 25 years	18.3	81.7	
26-35 years	23.3	76.7	0.000*
36-45 years	28.5	71.5	
≥ 46 years	41.1	58.0	
Residence			
Urban	32.5	67.5	0.621
Rural	31.1	68.0	
Marital status			
Single	23.1	76.1	
Married	34.1	65.9	0.000*
Divorced	39.5	60.5	
Education			
Uneducated	36.8	63.2	
Primary	32.1	67.0	0.000*
Secondary	29.1	70.9	
University	33.6	66.4	

males, 20.9% were exposed to SHS, while 79.1% were not exposed to SHS. Based on the relationship between the independent variables and hypertension, SHS, age, marital status, and education have p-values <0.05 (See Table 1). This means that there is a significant relationship between these variables and the incidence of hypertension in adult men in Bali. Other results show that place of residence has no relationship with hypertension (p-value ≥ 0.05). Table 1 below shows the relationship between independent variables and the incidence of hypertension in adult men ≥ 18 years in Bali.

Multivariate analysis was used to analyze multiple relationships between independent variables together with the dependent variable. Multivariate analysis was also used to find out which independent variables were most dominantly associated with the dependent variable. The following are the stages of the multivariate analysis: a) we chose independent variables with p-value <0.25. If the bivariate test results had a p-value <0.25, it should be entered into the multivariate model. b) We tested five different models by removing each independent variable one by one which had a p-value > 0.05. c) The Goodness of Fit test was used. It uses the Bayesian Information Criterion (BIC), where the smallest BIC value indicates the best model. In addition to indicating the ability of the model to make predictions, this test shows the difference in BIC values between models with several provisions. d) A collinearity test was conducted to find out whether there is a significant relationship among the independent variables. Testing collinearity is done using the collin in the Command Stata 17.0 program. The results obtained were VIF and tolerance values (1/VIF). A variable is said to have no suspicious collinearity if the tolerance value is > 0.1 and the VIF value is <10. The multivariate analysis displayed the best model among the five models we analyzed (states on table 2)[21,22]. Table 2 shows the results of the multivariate analysis between SHS exposure and hypertension according to age, marital status, education and place of residence[23]. The best model that was used in this research is the fifth model. There was a significant association between SHS (OR = 1.16; 95% CI, 1.02-1.32) and hypertension with an odds ratio adjusted for age (aOR = 1.03; 95% CI, 1.02-1.04) and residence in the urban area category (aOR = 1.10; 95%CI, 0.99-1.23).

Table 2: Multivariate analysis for relationships between SHS exposure and hypertension according to age, marital status, education and residence among male adults ≥ 18 years in Bali

Variable	Model 1 OR 95% CI p-value	Model 2 OR 95% CI p-value	Model 3 OR 95% CI p-value	Model 4 OR 95% CI p-value	Model 5** OR 95% CI p-value
SHS					
Yes	1.16 (1.02-1.32) 0.021	1.16 (1.02-1.32) 0.022	1.06 (0.98-1.14) 0.115	1.15 (1.01-1.31) 0.028	1.16 (1.02-1.31) 0.021
Age					
26-35 years	1.37 (1.11-1.68) 0.003	1.43 (1.14-1.80) 0.002	1.64 (1.39-1.94) 0.000	1.36 (1.10-1.68) 0.004	1.37 (1.12-1.69) 0.002
36-45 years	1.80 (1.48-2.18) 0.000	1.91 (1.53-2.39) 0.000	2.71 (2.33-3.17) 0.000	1.82 (1.50-2.21) 0.000	1.82 (1.50-2.21) 0.000
≥ 46 years	3.25 (2.73-3.86) 0.000	3.44 (2.81-4.22) 0.000	5.41 (4.67-6.27) 0.000	3.36 (2.80-4.02) 0.000	3.29 (2.76-3.92) 0.000
Marital status					
Single		1.08 (0.93-1.25) 0.277			
Education					
Uneducated			1.20 (1.07-1.33) 0.001	0.92 (0.79-1.08) 0.368	
Primary			1.15 (1.04-1.26) 0.003	1.00 (0.88-1.14) 0.913	
University			1.06 (0.94-1.21) 0.296	1.13 (0.96-1.33) 0.112	
Residence					
Urban				1.08 (0.97-1.20) 0.148	1.10 (0.99-1.22) 0.060

Education and marital status variables were ignored in the model; we only used 2 variables to make the odd ratio and 95% CI was included in the model.

Discussion

The definition of passive smoker (SHS) is a person who is a non-smoker and is exposed to smoke from a lit cigarette or other smoked tobacco products such as pipes, cigars, etc., and smoke exhaled by smokers. The proportion of passive smokers is relatively low in Bali because the law regarding non-smoking areas is very strict so that non-smokers are protected by this regulation[18]. According to regulations, non-smoking areas are designated in public areas and also in homes.

The results of bivariate analysis are the same as previous studies showing that the main factors associated with hypertension are some factors that can be modified and also other factors that cannot be modified[24,25]. In 2023, the WHO explained that the factors that influence hypertension are risk factors

that can be modified, including unhealthy eating patterns (excessive salt consumption, high fat diet, low fruit and vegetable intake), lack of physical activity, smoking, alcohol, and overweight or obesity. Non-modifiable risk factors include a family history of hypertension, age over 65 years, and comorbidities such as diabetes or kidney disease[26]. The residence variable in our research had a p-value ≥ 0.05 so there was no relationship with hypertension. This particular result is not in line with previous research which found that the prevalence of hypertension in developing countries had a relationship with the resident of the respondents[27]. Hypertension cases increased in the rural areas compared to urban area[28].

The results of the multivariate analysis of this study explain something different from the bivariate results, namely that the aOR value for age is 1.03, meaning that age influences the incidence of hypertension in men who are exposed to smoke passively. In addition the residence value is 1.10, meaning that the area of residence also influences the incidence of hypertension in men who are exposed to smoke passively[29,30]. These men in urban areas are at greater risk of developing hypertension as compared to non-smoking men who are exposed to smoke passively but live in rural areas[14]. Men who live in big cities as they get older have difficulty accessing natural environments, such as rural or other green environments. This could be another reason why urban men are more susceptible and at risk of being exposed to cigarette smoke and hypertension.

We realize the study still has many limitations[31]. For example, hypertension was measured only using blood pressure but the respondents were not asked about medication. In addition, we did not verify the behaviour of respondents to see if their responses were accurate regarding smoke exposure in public areas or at home. Nevertheless, we believe our research is meaningful because: 1) we are the first to conduct an epidemiological study using a large sample to assess the association between SHS exposure and hypertension in Bali and 2) we found the residence variable to be significant.

Conclusion

We believe our study on the relationship between SHS and hypertension is important and should be followed up with further studies. Because the prevalence of hypertension in non-smoking men aged ≥ 18 years who are exposed to cigarette smoke is higher among urban residents, we recommend increasing awareness of SHS exposure especially among men aged ≥ 18 years living in urban areas. Urban areas such as Denpasar City have become pilot smoke-free areas and many regulations regarding smoking have been implemented in this area. However, people in this urban area are still not aware of the relationship between SHS and hypertension. Therefore, we suggest that anti-smoking public health campaigns that will increase their awareness.

Contribution of authors

I Nyoman Purnawan: research topic, analysis data, writing original draft preparation, writing-review and editing and project administration; Sigit A. Saputro: concept, method, analysis data and editing the paper; Muji Sulistyowati: reviewed empirical studies, discussion and conclusion; Chatarina Umbul Wahyuni: research topic, designed the methodology; Santi Martini: reviewed empirical studies, discussion and conclusion; Sri Widati: reviewed empirical studies, discussion and conclusion.

Acknowledgement

We are thankful to *Kepala Badan Kebijakan Pembangunan Kesehatan* and *Kepala Badan Penelitian dan Pengembangan, Kesehatan* Ministry of Health, Republic Indonesia for data support.

References

1. Smith GD. Effect of passive smoking on health. *BMJ* 2003; 326: 1048 LP – 1049.
2. WHO. Smoking greatly increases risk of complications after surgery, https://www.who.int/news/item/20-01-2020-smoking-greatly-increases-risk-of-

complications-after-surgery (2020, accessed 15 June 2023).
3. WHO. Global Adult Tobacco Survey, https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/data-reporting/indonesia/indonesia-national-2021-factsheet.pdf?sfvrsn=53eac4fd_1 (2021, accessed 24 September 2023).
4. Trisnowati H, Kusuma D, Ahsan A, Kurniasih DE and Padmawati RS.. Smoke-free home initiative in Bantul, Indonesia: Development and preliminary evaluation. *Tob Prev Cessat* 2019; 5: 1–5.
5. Kilewo C, Natchu UC, Young A, Donnell D, Brown E, Read JS, Sharma U, Chi BH, Goldenberg R, Hoffman I, Taha TE and Fawzi WW. Hypertension in pregnancy among HIV-infected women in sub-Saharan Africa: prevalence and infant outcomes. *Afr J Reprod Health* 2009; 13 4: 25–36.
6. Loddenkemper R, Kreuter M (eds). The Tobacco Epidemic. Epub ahead of print 13 March 2015. DOI: 10.1159/isbn.978-3-318-02657-3.
7. Kemenkes RI. Riset Kesehatan Dasar (Riskesdas 2013) Diluncurkan, https://sehatnegeriku.kemkes.go.id/baca/rilis-media/20130208/047263/riset-kesehatan-dasar-riskesdas-2013-diluncurkan/ (2013, accessed 16 June 2023).
8. Kemenkes RI. Profil Kesehatan Indonesia Tahun 2018. Jakarta, https://www.kemkes.go.id/downloads/resources/download/pusdatin/profil-kesehatan-indonesia/profil-kesehatan-indonesia-2018.pdf (2018).
9. Esteche VT, Sposito P, Acosta C, et al. Association between smoking and hypertension control: descriptive and analytical study. *Eur Respir J* 2021; 58: PA2443.
10. David P Urassa, Lennarth Nystrom Anders Carlstedt GM and GL. Management of Hypertension in Pregnancy as a Quality Indicator of Antenatal Care in Rural Tanzania. *Afr J Reprod Health*; 7. Epub ahead of print 2017. DOI: 10.2307/3583291.
11. Lusno MFD. Association Between Smoking and Hypertension as Health Burden in Sidoarjo: A Case-Control Study. *J Appl Biol*; 4.
12. Saputri MI, Lailatul M and Sobhita P. Correlation Between Fat Consumption, Smoking Habit, And Stress With Hypertension Among Drivers. *Natl Nutr J* 2020; 15: 152–158.
13. Skipina TM, Soliman EZ and Upadhya B. Association between secondhand smoke exposure and hypertension: nearly as large as smoking. *J Hypertens*; 38, https://journals.lww.com/jhypertension/fulltext/2020/10000/association_between_secondhand_smoke_exposure_and.5.aspx (2020).
14. Kim BJ, Kang JG, Kim JH, Seo DC, Sung KC, Kim BS and Kang JH.. Association between Secondhand Smoke Exposure and Hypertension in 106,268 Korean Self-Reported Never-Smokers Verified by Cotinine. *Journal of Clinical Medicine*; 8. Epub ahead of print 2019. DOI: 10.3390/jcm8081238.
15. Martini S, Artanti KD, Hargono A, Widati S, Ahsan A and Prabandari YS. Association between percentage of smokers and prevalence of smoking attributable morbidity in Indonesia: one decade after implementation of smoke-free area regulation. *BMC Public Health* 2022; 22: 2202.
16. Jahangiry L, Ghanbari J, Abbasalizad Farhangi M, Sarbakhsh P and Ponnet K. Predictors of poor blood pressure control among Iranian hypertensive patients. *BMC Res Notes* 2017; 10: 668.
17. Kifle ZD, Adugna M, Chanie GS and Mohammed A. Prevalence and associated factors of hypertension complications among hypertensive patients at University of Gondar Comprehensive Specialized Referral Hospital. *Clin Epidemiol Glob Heal* 2022; 13: 100951.
18. Suarjana K, Astuti PAS, Artawan Eka Putra IWG, Duana MK, Mulyawan KH, Chalidyanto D, Qomaruddin MB and Wahyuni CU. Implementation of Smoke-Free Law in Denpasar Bali: Between Compliance and Social Norms of Smoking. *J Public health Res* 2020; 9: jphr.2020.1747.
19. Astuti PAS, Assunta M and Freeman B. Tobacco Control Stakeholder Perspectives on the Future of Tobacco Marketing Regulation in Indonesia: A Modified Delphi Study. *J Prev Med Public Heal* 2021; 54: 330–339.
20. Zhao X, Guo S, Zhang R, Liu L, Guo L, Liu G, Jiang L, Li Q, Pan B, Nie J and Yang J. The interaction effects of secondhand smoke exposure and overweight on the prevalence of hypertension in Chinese coke oven workers and NHANES participants (2013–2016). *Chemosphere* 2022; 303: 135120.
21. Jiang B, Liu H, Ru X, Zhang H, Wu S and Wang W.. Hypertension detection, management, control and associated factors among residents accessing community health services in Beijing. *Sci Rep*; 4. Epub ahead of print 2014. DOI: 10.1038/srep04845.
22. Buford TW. Hypertension and aging. *Ageing Res Rev* 2016; 26: 96–111.
23. Sun K, Lin D, Li M, Mu Y, Zhao J, Liu C, Bi Y, Chen L, Shi L, Li Q, Yang T, Wan Q, Wu S, Wang G, Luo Z, Qin Y, Tang X, Chen G, Huo Y, Gao Z, Su Q, Ye Z, Hu R, Wang Y, Qin G, Deng H, Yu X, Shen F, Chen L, Wang W, Ning G and Yan L. Association of education levels with the risk of hypertension and hypertension control: a nationwide cohort study in Chinese adults. *J Epidemiol Community Health* 2022; 76: 451 LP – 457.
24. Khoiry QA, Alfian SD and Abdulah R. Modifiable and Non-modifiable Factors Associated with Low Awareness of Hypertension Treatment in Indonesia: A Cross-Sectional Population-Based National Survey. *Glob Heart*. Epub ahead of print 2022. DOI: 10.5334/gh.1143.
25. Sudikno S, Mubasyiroh R, Rachmalina R, Arfines PP and Puspita T. Prevalence and associated factors for prehypertension and hypertension among Indonesian

adolescents: a cross-sectional community survey. *BMJ Open* 2023; 13: e065056.
26. WHO. Hypertension, https://www.who.int/news-room/fact-sheets/detail/hypertension#:~:text=Modifiable risk factors include unhealthy,and being overweight or obese. (2023, accessed 23 September 2023).
27. Heindl B, Howard G, Clarkson S, Kamin Mukaz D, Lackland D, Muntner P and Jackson EA. Urban-rural differences in hypertension prevalence, blood pressure control, and systolic blood pressure levels. *J Hum Hypertens*. Epub ahead of print 2023. DOI: 10.1038/s41371-023-00842-w.
28. Venkatesh U, Grover A, Vignitha B, Ghai G, Malhotra S, Kishore J, Jaswal N, Yashwanth RD, Durga R, Goel S and Kishore S.. Urban–rural disparities in blood pressure and lifestyle risk factors of hypertension among Indian individuals. *J Fam Med Prim Care*; 11, https://journals.lww.com/jfmpc/fulltext/2022/09000/urban_rural_disparities_in_blood_pressure_and.137.aspx (2022).
29. Tanaka K, Nishigori H, Watanabe Z, Tanoue K, Iwama N, Satoh M, Murakami T, Hoshiai T, Saito M, Mizuno S, Sakurai K, Ishikuro M, Obara T, Tatsuta N, Fujiwara I, Kuriyama S, Arima T, Nakai K, Yaegashi N and Metoki H. Secondhand smoke exposure is associated with the risk of hypertensive disorders of pregnancy: the Japan Environment and Children's Study. *Hypertens Res* 2023; 46: 834–844.
30. Liu SH, Liu B, Sanders AP, Saland J and Wilson KM. Secondhand smoke exposure and higher blood pressure in children and adolescents participating in NHANES. *Prev Med (Baltim)* 2020; 134: 106052.
31. Pusparina A, Alma LR and Nurrochmah S. A Cross Sectional Study of Determinants of Hypertension in Batu City, Indonesia BT - Proceedings of the 1st International Scientific Meeting on Public Health and Sports (ISMOPHS 2019). Atlantis Press, pp. 133–138.