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The Relationship Between Smoking and Blood Glucose Levels in Active Smoking Fishermen in Banggae Sub-District, Majene District

Andi Aldita Nitamapia Zulkifli[1], Asrini Safitri[2*], Pratiwi Nasir Hamzah[3], Dararianti Iskandar[3], Sri Wahyuni Gayatri[4]

[1]*Faculty of Medicine, Universitas Muslim Indonesia, Makassar, Indonesia*
[2]*Department of Clinical Nutrition, Faculty of Medicine, Universitas Muslim Indonesia*
[3]*Department of Internal Medicine, Faculty of Medicine, Universitas Muslim Indonesia*
[4]*Department of Biochemistry, Faculty of Medicine, Universitas Muslim Indonesia*

Email Corresponding:
Asrini.safitri@umi.ac.id

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Abstract

Background: Smoking is a major risk factor for non-communicable diseases such as diabetes mellitus, and fishermen may have specific smoking habits that influence blood glucose levels. **Objective:** To analyze the relationship between smoking activity and random blood glucose levels among active fishermen in Banggae Sub-District, Majene District. **Methods:** This quantitative analytical study with a cross-sectional design involved 100 active fishermen selected using the Slovin formula, with data analyzed using Spearman correlation in SPSS. **Results:** Most respondents were young (45%) and middle-aged adults (46%), and 94% smoked filter cigarettes. A significant positive correlation was found between smoking activity and random blood glucose levels ($r = 0.295$, $p = 0.003$), indicating that higher smoking frequency and dependency were associated with elevated glucose levels. Conversely, no significant relationship was observed between dietary patterns and glucose levels ($r = -0.081$, $p = 0.422$). These findings suggest that smoking intensity, rather than food type, plays a more dominant role in glucose dysregulation among fishermen. **Conclusion:** Increased smoking activity is significantly correlated with higher random blood glucose levels, emphasizing the urgent need for smoking cessation interventions to reduce diabetes risk in this high-risk occupational group.

Keywords: *Smoking; Blood Glucose Levels; Fishermen; Smoking Activity; Cigarette Type.*

Introduction

Smoking is a pervasive public health crisis and a major preventable cause of mortality worldwide. It is defined as the act of inhaling smoke from a rolled preparation of tobacco, which contains thousands of harmful chemicals, including nicotine, tar, and carbon monoxide[1]. According to the World Health Organization (WHO), tobacco use kills more than 8 million people each year, with more than 7 million of those deaths resulting from direct tobacco use and around 1.2 million resulting from non-smokers being exposed to secondhand smoke[2]. In Indonesia, the burden is particularly staggering. Data from The ASEAN Tobacco Control Atlas (SEACTA) highlighted that Indonesia contributes the largest number of smokers in the ASEAN region, with approximately 57.5 million smokers [3]. This alarming figure is projected to rise, placing an immense strain on the nation's healthcare system. One of the most significant, yet often overlooked, consequences of smoking is its detrimental impact on metabolic health, particularly its role in the development of

insulin resistance and type 2 diabetes mellitus (DM)[4].

The pathophysiological link between smoking and impaired glucose metabolism is well-documented in general populations. Smoking induces oxidative stress and chronic inflammation, which are key contributors to insulin resistance[5]. Nicotine, the primary addictive component in cigarettes, stimulates the release of catecholamines (like adrenaline and noradrenaline) and cortisol, which are counter-regulatory hormones that raise blood glucose levels by promoting gluconeogenesis and reducing insulin secretion[6]. While this relationship is established, its manifestation and magnitude can vary significantly across different demographic and occupational groups due to variations in lifestyle, diet, stress levels, and genetic predisposition. Fishermen represent a unique and understudied population in this context. Their occupation is often characterized by high physical stress, irregular eating patterns, potential limited access to healthcare, and a cultural normalization of smoking as a coping mechanism for fatigue and boredom at sea[7]. A report from the Indonesian Ministry of Health noted a stagnation in smoking prevalence in West Sulawesi Province, where Majene is located, at around 25-27% from 2020 to 2022[8]. Within Majene, the Banggae Sub-District recorded 6055 family members who smoke, making it a significant contributor to the district's high smoking rates[9]. Despite this clear public health concern, there is a distinct lack of research specifically investigating how smoking impacts the metabolic health of fishermen in this region. This study addresses the scientific gap by focusing on a high-risk, yet neglected, occupational group to provide localized evidence on the relationship between smoking behavior and blood glucose levels.

This research carries high urgency given the convergence of two major public health issues: high smoking prevalence and the growing burden of diabetes in Indonesia. Understanding this relationship within the specific context of fishermen in Banggae is critical for designing effective, community-specific health interventions. The novelty of this study lies in its targeted focus. While numerous studies have examined the link between smoking and glucose metabolism, few have concentrated on a coastal fishing community in Indonesia. This research provides new insights into how occupational and cultural factors may influence this relationship. By examining not just the presence of smoking, but also the *activity* (level of dependency) and *type* of cigarettes used, the study offers a more nuanced perspective than previous research. Furthermore, by investigating the potential confounding role of diet, the study aims to isolate the specific impact of smoking on glucose levels. This focused, community-based approach is novel and will generate data that is directly relevant and actionable for local health authorities and community health workers in Majene.

The main research question guiding this study is: Is there a significant relationship between smoking activity and random blood glucose levels among active fishermen in Banggae Sub-District, Majene District? To answer this overarching question, the study has the following specific objectives: 1) To identify the types of cigarettes predominantly consumed by active fishermen. 2) To describe the distribution of smoking activity levels across different age groups. 3) To determine the relationship between the type of food most frequently consumed and random blood glucose levels. 4) To analyze the primary relationship between the level of smoking activity and random blood glucose levels. By systematically addressing these objectives, the research aims to build a comprehensive profile

of smoking behavior and its metabolic consequences in this specific population.

The findings of this study have the potential for significant impact across multiple domains. Academically, it contributes valuable data to the fields of public health and occupational medicine, enriching the literature on non-communicable disease risk factors in unique populations. For healthcare policy and practice, the results can provide the empirical evidence needed to justify and design targeted interventions. If a strong link between smoking and high blood glucose is confirmed, it would provide a powerful argument for integrating blood glucose screening into smoking cessation programs or routine health check-ups for fishermen at local community health centers (Puskesmas). The findings can inform the development of culturally sensitive health education materials that specifically address the risks of diabetes for smokers, moving beyond generic anti-smoking messages. For the community of fishermen themselves, this research can raise awareness about a direct health consequence they may not have previously considered, potentially motivating behavior change. Ultimately, this study aims to provide a foundation for evidence-based public health strategies that can reduce the dual burden of smoking and diabetes in coastal communities.

Materials and Methods

Study Design

This research employed a quantitative method with an analytical correlational research design. An analytical correlational design was chosen because its primary purpose is to determine the existence and degree of a relationship between two or more variables in a situation where the variables are not manipulated by the researcher[10]. Specifically, this study sought to analyze the relationship between the independent variable (smoking activity) and the dependent variable (random blood glucose level). The study was conducted with a cross-sectional approach, meaning that data on all variables smoking activity, food type, and blood glucose levels were collected from the participants at a single point in time**.** This design is efficient and suitable for establishing associations and generating hypotheses for future, more extensive research, such as cohort studies.

Sample

The population in this study was all active fishermen identified as smokers in the Banggae Sub-District, Majene District. Based on data from the local Healthy Family Index (IKS) recapitulation, the total population of smokers in the area was 6055 individuals.[9] To determine a representative sample size from this large population, the Slovin formula was used with a predetermined margin of error of 10% (e = 0.1). The calculation is as follows: $n = N / (1 + Ne^2)$ $n = 6055 / (1 + 6055 * (0.1)^2)$ $n = 6055 / (1 + 60.55)$ $n = 6055 / 61.55 \approx 98.4$ Thus, the sample size was rounded up to 100 respondents. The sampling technique used was accidental sampling, a type of non-probability sampling where fishermen who met the criteria and were available at the time of data collection were invited to participate. The inclusion criteria were: (1) male fishermen aged 18 years and above; (2) having a smoking history of at least one year; (3) actively working as a fisherman; and (4) willing to provide informed consent. The exclusion criteria were: (1) fishermen with a prior diagnosis of diabetes mellitus; (2) those who were acutely ill at the time of data collection; and (3) those who refused to have their blood glucose measured.

Data Collection Technique

Data were collected through a combination of direct interviews and anthropometric/clinical measurements. A structured questionnaire was

developed and validated to gather information on demographic characteristics (age), smoking behavior (type of cigarette, number of cigarettes smoked per day, and duration of smoking), and dietary patterns (type of food most frequently consumed: carbohydrates, protein, or fiber). The level of smoking activity or dependency was categorized based on the Brinkman Index, which calculates the number of cigarettes smoked per day multiplied by the number of years of smoking. For this study, dependency was categorized as low (Brinkman Index < 200), moderate (200-399), and high (> 400). Random blood glucose levels were measured using a portable, calibrated glucometer (e.g., Accu-Chek Active) with a fresh lancet and test strip for each participant. A finger-prick capillary blood sample was taken, and the reading was recorded in mg/dL. The data collection process was carried out over two weeks in January 2024 at several strategic locations, including the fish landing port and local community gathering spots in the Banggae Sub-District, to ensure accessibility for the fishermen.

Data Analysis Technique

The collected data were processed and analyzed using SPSS software (version 25.0 for Windows). The analysis involved two main stages:

Univariate Analysis

This was performed to describe the frequency distribution of each variable individually. For categorical variables like type of cigarette, age group, smoking dependency level, and type of food, frequency (n) and percentage (%) were calculated. For the continuous variable of random blood glucose, descriptive statistics such as mean, standard deviation, minimum, and maximum values were calculated. The results were presented in tables to summarize the characteristics of the study population.

Bivariate Analysis

This was conducted to test the hypotheses and analyze the relationships between variables. The Spearman's rank-order correlation test was used to analyze the relationship between the ordinal independent variable (smoking activity level) and the continuous dependent variable (random blood glucose level). Spearman's test was chosen because it does not assume a linear relationship or normality of data distribution. Similarly, the Spearman test was used to analyze the relationship between the type of food (ordinal) and blood glucose level. For all statistical tests, a significance level (alpha) of 0.05 was set. A p-value of less than 0.05 was considered to indicate a statistically significant relationship.

Ethical Consideration

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Prior to data collection, ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Muslim Indonesia with the permit number 2401/KEPK/FK-UMI/2024. All participants were provided with a detailed explanation of the study's purpose, procedures, potential risks, and benefits. Written informed consent was obtained from every participant before their inclusion in the study. Participants were assured that their involvement was voluntary and that they could withdraw at any time without penalty. All collected data were anonymized by replacing names with codes to ensure confidentiality and privacy. The data were used solely for research purposes and were stored securely to prevent unauthorized access.

Results

This section presents the main findings of the research, corresponding to the study's

objectives. The results are presented in descriptive and analytical forms, using frequency distribution tables and correlation test outputs to facilitate understanding.

Respondent Characteristics The first paragraph provides an overview of the demographic and behavioral characteristics of the 100 respondents. This includes the type of cigarette used, age distribution, level of smoking dependency, random blood glucose levels, and the type of food most frequently consumed. This descriptive data is essential for understanding the baseline profile of the study population.

Table 1. Univariate Analysis of Respondent Characteristics

Variable	Category	Frequency (n)	Percentage (%)
Type of	Filter	94	94.0
Cigarette	Non-Filter	6	6.0
Age Group	Young Adult (25-40)	45	45.0
	Middle Adult (41-60)	46	46.0
	Early Adult (18-24)	9	9.0
Smoking	Moderate Dependency	59	59.0
Activity Level	High Dependency	27	27.0
	Low Dependency	14	14.0
Random Blood	Normal (<200 mg/dL)	93	93.0
Glucose	High (≥200 mg/dL)	7	7.0
Type of Food	Protein	51	51.0
Consumed	Fiber	25	25.0
	Carbohydrates	24	24.0
Total		**100**	**100.0**

Source: *Primary Data 2024*

Data from Table 1 shows that the vast majority of fishermen (94.0%) consumed filter cigarettes. In terms of age, the respondents were predominantly from the young adult (25-40 years) and middle adult (41-60 years) groups, constituting 45.0% and 46.0% of the sample, respectively. Regarding smoking activity, more than half of the respondents (59.0%) were classified as having a moderate dependency on smoking. Most respondents (93.0%) had random blood glucose levels within the normal range (<200 mg/dL), while 7.0% had high levels. The most frequently consumed type of food was protein (51.0%), followed by fiber (25.0%) and carbohydrates (24.0%).

Relationships Between Variables The second paragraph presents the results of the statistical tests performed to answer the research questions. The primary focus was on the relationship between smoking activity and random blood glucose levels, with a secondary analysis on the relationship between food type and blood glucose levels.

Table 2. Spearman Correlation Test for Smoking Activity and Blood Glucose

		Random Blood Glucose	Smoking Activity
Random Blood Glucose	Correlation Coefficient	1.000	
	Sig. (2-tailed)	.	
	N	100	
Smoking Activity	Correlation Coefficient	0.295	
	Sig. (2-tailed)	0.003	
	N	100	

**. Correlation is significant at the 0.01 level (2-tailed).*

The results in Table 2 demonstrate a significant and positive relationship between smoking activity and random blood glucose levels. The Spearman correlation coefficient is 0.295, with a p-value of 0.003. Since the p-value (0.003) is less than the significance level of 0.05, the null hypothesis is rejected. This indicates that there is a statistically significant correlation. The positive sign of the coefficient means the relationship is unidirectional: as the level of smoking activity (dependency) increases, the random blood glucose level also tends to increase. The strength of the correlation (0.295) can be interpreted as weak to moderate.

In contrast, Table 3 shows that there is no significant relationship between the type of food consumed and random blood glucose levels. The correlation coefficient is -0.081, with a p-value of 0.422. Because the p-value (0.422) is greater than 0.05, we fail to reject the null hypothesis. This means there is no

statistically significant correlation between the type of food predominantly consumed (carbohydrate, protein, or fiber) and the random blood glucose levels in this study population. The negative sign of the coefficient is not meaningful as the result is not statistically significant.

Table 3. Spearman Correlation Test for Food Type and Blood Glucose

	Random Blood Glucose	**Type of Food**
Random Blood Glucose	Correlation Coefficient	1.000
	Sig. (2-tailed)	.
	N	100
Type of Food	Correlation Coefficient	-0.081
	Sig. (2-tailed)	0.422
	N	100

In summary, the research results provide a clear answer to the main research question. There is a significant, positive, and weak-to-moderate correlation between the level of smoking activity and random blood glucose levels among active fishermen in Banggae Sub-District. This means that fishermen with higher smoking dependency tend to have higher blood glucose readings. Conversely, the type of food most frequently consumed did not show any significant association with blood glucose levels. This suggests that within the context of this study, smoking activity is a more influential factor on immediate blood glucose levels than the primary category of food consumed.

Discussion

The primary finding of this study is the significant positive relationship between smoking activity and random blood glucose levels ($r = 0.295$, $p = 0.003$). This result aligns with the proposed hypothesis and is supported by a strong body of scientific literature explaining the underlying pathophysiological mechanisms. The act of smoking introduces nicotine into the bloodstream, which triggers the adrenal medulla to secrete catecholamines, particularly epinephrine[11]. These hormones activate the glycogenolysis and gluconeogenesis pathways in the liver, leading to an increased output of glucose into the bloodstream. Simultaneously, catecholamines and cortisol, another hormone elevated by smoking-induced stress, directly inhibit the function of pancreatic beta-cells and promote peripheral insulin resistance[12]. This means that even if insulin is present, the body's cells (particularly muscle and fat cells) become less responsive to its signal to uptake glucose, causing glucose to remain in the blood. The cumulative effect of these processes is an acute and, with chronic exposure, a more sustained elevation in blood glucose levels, as observed in the fishermen with higher smoking dependency.

The secondary finding that there was no significant relationship between the type of food consumed and blood glucose levels ($r = -0.081$, $p = 0.422$) is also noteworthy. This result could be interpreted in several ways. First, the dietary assessment in this study was simplistic, categorizing food into only three broad types (carbohydrate, protein, fiber). It did not account for the quantity of food consumed, the glycemic index of specific foods, meal timing, or overall dietary pattern, all of which are critical determinants of postprandial glucose response[13]. It is plausible that the fishermen's diets, while dominated by protein (likely from fish), were sufficiently mixed or the overall caloric intake was not extreme enough to cause significant variations in random glucose readings. Second, the potent metabolic effect of smoking might have overshadowed the more subtle influence of the primary food type. In a population of heavy smokers, the acute hyperglycemic effect of nicotine could be the dominant factor determining random glucose levels, masking any potential impact from diet.

Our finding of a significant positive correlation between smoking and blood glucose levels is consistent with numerous previous studies conducted in diverse populations. For instance, a study by Sutrisna and Amin on university students found a significant association between smoking status and blood glucose levels[14]. Similarly, research by Harahap on adult males also demonstrated that smokers had higher average blood glucose levels compared to non-smokers[15]. These consistent findings across different age groups and demographics reinforce the robustness of the relationship between smoking and impaired glucose metabolism. The strength of the correlation in our study (r = 0.295) is comparable to other cross-sectional studies, which often report weak-to-moderate correlations, reflecting the multifactorial nature of blood glucose regulation where genetics, diet, physical activity, and stress all play a role.

However, some nuances exist when comparing our results. While the direction of the relationship is consistent, the magnitude might differ. A study by Rivan et al. on adults found a weaker correlation, which they attributed to better overall health awareness and dietary control in their urban sample[16]. Our study population of fishermen may face higher occupational stress and less regulated lifestyles, potentially amplifying smoking's impact. The lack of a significant finding for food type contrasts with some dietary research that underscores the importance of macronutrient composition for glucose control[17]. This discrepancy likely stems from methodological differences; our study was not designed as a detailed nutritional analysis but rather as a broad examination of lifestyle factors in the context of smoking.

The findings of this study have profound implications for public health practice and clinical interventions in coastal communities like Banggae. Clinically, it serves as a strong warning to healthcare providers at local Puskesmas to not view smoking as merely a risk factor for respiratory or cardiovascular disease, but also as a direct threat to metabolic health. It is recommended that routine health check-ups for fishermen, especially those who are smokers, should include blood glucose screening. This could lead to earlier detection of prediabetes or diabetes, allowing for timely intervention.

From a public health perspective, these results provide compelling evidence for designing targeted health promotion campaigns. Generic anti-smoking messages may be less effective. Instead, campaigns should explicitly communicate the link: "Smoking can increase your risk of high blood sugar and diabetes." This message, framed in terms of a tangible and feared disease, may have a greater impact. Health education sessions can be held at the fish landing ports or community halls, involving community leaders and respected figures. Interventions should also be holistic, combining smoking cessation support with basic nutritional counseling and promoting physical activity, as these combined approaches are more effective in mitigating metabolic risks[18]. The high prevalence of moderate to high smoking dependency (86%) indicates that simple advice may not be enough, and more structured cessation programs may be needed.

The strength of this research lies in its specific focus on a high-risk and often-neglected occupational group. By studying fishermen, the study provides valuable insights into a population with unique lifestyle challenges. The use of a cross-sectional design allowed for efficient data collection and hypothesis generation. Furthermore, the combination of questionnaire data with objective blood glucose measurements strengthens the validity of the findings.

However, the study has several limitations that must be acknowledged. First, the cross-sectional design cannot establish causality. While it shows an association, it cannot prove that smoking *causes* the increase in blood glucose; it only shows they are related. A longitudinal study would be required to track changes over time. Second, the measurement of smoking dependency using the Brinkman Index, while common, is a proxy measure and does not capture all aspects of addiction, such as behavioral dependence. Third, the dietary assessment was very basic and may have failed to detect important dietary influences on glucose levels. Fourth, the use of random blood glucose measurements instead of standardized tests like Fasting Blood Glucose (FBG) or HbA1c means that the results are subject to variability based on the time of the last meal. Finally, the study was conducted in only one sub-district, which may limit the generalizability of the findings to other fishing communities with different cultural or socioeconomic backgrounds.

Based on the findings and limitations, several recommendations for future research are proposed. First, a longitudinal cohort study should be conducted to track the incidence of new-onset diabetes among smokers and non-smokers in fishing communities. This would provide stronger evidence for causality. Second, future studies should employ more robust methodologies, including using HbA1c as a more stable indicator of long-term glycemic control and conducting detailed dietary assessments using food frequency questionnaires or 24-hour recalls. Third, qualitative research is recommended to explore the sociocultural factors, beliefs, and barriers that influence smoking behavior among fishermen. Understanding *why* they smoke and what prevents them from quitting is crucial for designing effective, culturally sensitive interventions. Finally, interventional studies should be designed and implemented to test the efficacy of combined smoking cessation and diabetes prevention programs specifically tailored for fishermen. This would move the research from observation to action, directly contributing to improving the health of this vulnerable population.

Conclusion

In conclusion, this study provides clear evidence of a significant positive relationship between the level of smoking activity and random blood glucose levels among active fishermen in the Banggae Sub-District, Majene District. As the intensity of smoking increases, so do the blood glucose levels, indicating a heightened risk for hyperglycemia and potentially diabetes mellitus. The type of food most frequently consumed did not demonstrate a significant association with blood glucose, suggesting that smoking itself is a more dominant and immediate factor in glucose dysregulation within this population. These findings underscore the critical need for integrated public health strategies that address smoking not only as a risk for cardiovascular and respiratory diseases but also as a direct threat to metabolic health. Targeted screening, health education, and cessation programs for fishermen are urgently needed to curb the rising tide of diabetes in this vital yet vulnerable community.

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