

# Smoking and Obesity Paradox in North Sulawesi, Indonesia: A Cross-Sectional Study of Males Adult

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**Abstract.** Smoking and obesity are major global public health concerns, each linked to various adverse health effects. This study aims to explore the complex relationship between smoking and obesity among adult males in North Sulawesi Province, Indonesia. Using data from the 2018 Indonesia Basic Health Survey, we conducted a cross-sectional study involving 4,994 male participants aged 18 years and older. Smoking status was classified as regular, irregular, or former smokers based on the subjects' habits in the previous month. Multinomial logistic regression, analysis of variance, and chi-square tests were applied to examine the association between smoking and obesity. The results showed that ex-smokers had a higher likelihood of obesity compared to current smokers, with an adjusted relative risk ratio (RRR) of 1.63 (95% CI: 1.18–2.24). Irregular smokers were also more likely to be obese than regular smokers, with an adjusted RRR of 1.42 (95% CI: 1.11–1.88). However, no statistically significant association was found between smoking and being overweight. A positive association was observed between smoking and obesity, indicating that former smokers may face an increased risk of becoming obese.

## 1 Introduction

Obesity and smoking are major public health concerns. Smoking increases the risk of developing cardiovascular disease, cancer, and respiratory illnesses [1,2] while obesity is linked to several comorbidities, including type 2 diabetes, cancer, and cardiovascular disorders [3].

Overweight and obesity are global health issues, with prevalence rates increasing annually in both developed and developing countries, including Southeast Asia. The obesity rates among adults in Southeast Asian countries are as follows: Indonesia (28%), Cambodia (50.2%), Laos (20.9% for Class I or Class II obesity), Malaysia (15.4%), Myanmar (8.4%), Singapore (44.1%), Thailand (12.7%), Vietnam (2.53%), and Brunei Darussalam (29.5%) [4].

Over the past few decades, the prevalence of overweight and obesity has risen across all age groups. In Indonesia, data from the Basic Health Survey (Riset Kesehatan Dasar-

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RISKESDAS) indicates a sharp increase in recent years, particularly among adults, rising from 28.9% in 2013 to 35.4% in 2018. Adult women are disproportionately affected; in 2018, 44.4% of women were overweight or obese, compared to 26.6% of men. North Sulawesi Province had the highest obesity rate in Indonesia, with 30.2% of adults being classified as obese, according to the 2018 RISKESDAS. Indonesia ranks among the top 10 countries globally for obesity prevalence [5].

Several factors contribute to adult obesity, including smoking status. Smoking is typically associated with lower body weight, whereas smoking cessation often leads to weight gain [6]. Post-cessation weight gain is influenced by an individual's body mass index (BMI) before quitting, though this effect varies across sociodemographic groups. Krukowsky et al. (2016) [7], suggest that individuals who were of normal weight or overweight before quitting are more likely to experience substantial weight gain after smoking cessation. This highlights the importance of considering BMI when evaluating the relationship between smoking and obesity.

Despite this, there is limited research comparing smoking status among individuals who are overweight, obese, or of normal weight. For example, a cross-sectional study in Scotland found that current smokers are less likely to be overweight compared to former smokers [7]. This supports the hypothesis that smoking cessation may increase BMI and obesity risk.

Nevertheless, the relationship between smoking and obesity remains complex and poorly understood. Some studies have failed to find any significant association between smoking and BMI [8, 9] while others suggest that smoking is associated with lower BMI, and quitting smoking is linked to higher BMI [10]. These inconsistencies underscore the need for further research to clarify this relationship. This study aims to explore the association between smoking and obesity among male smokers using data from the Indonesia Basic Health Survey, providing more robust evidence on the subject and addressing the discrepancies found in previous research.

## **2 Methods**

This cross-sectional study utilized data from the 2018 Indonesia Basic Health Survey (Riset Kesehatan Dasar-RISKESDAS). RISKESDAS, conducted by the Indonesian Ministry of Health, is a nationally representative epidemiological survey aimed at improving public health. The survey includes three primary components: the nutrition survey, the health interview, and the health assessment. Data from the health interview and health assessment were used in this study, including anthropometric measures and information on age, education, residence, intake of unhealthy foods, alcohol consumption, and fruit and vegetable consumption. A total of 17,511 individuals aged 18 and above were surveyed in North Sulawesi Province. Of these, 243 participants were excluded due to missing anthropometric data, and 8,852 were excluded because they were female. Additionally, 2,189 participants were omitted due to missing or incomplete smoking status data. Participants with missing information on their intake of unhealthy foods, alcohol, or fruit and vegetable consumption were also excluded. The final analytical sample consisted of 4,994 adults aged 18 years and older.

Before height and weight measurements were taken, participants were asked to remove their shoes and heavy outer clothing. Height was measured to the nearest 0.1 cm and weight to the nearest 0.1 kg. Body mass index (BMI) was calculated by dividing weight in

kilograms by the square of height in meters. Participants were classified into three groups based on their obesity status: obese (BMI > 27 kg/m<sup>2</sup>), overweight (BMI 25–27 kg/m<sup>2</sup>), and normal weight (BMI 18.5–25.0 kg/m<sup>2</sup>) [9,10]. Smoking habits were assessed through a self-administered survey, which gathered information on participants' current smoking status. Participants were classified into three categories based on whether they smoked regularly (daily), irregularly (occasionally), or had stopped smoking [5]. Self-reported data on the consumption of fruits and vegetables, alcohol, and high-risk foods were also collected. High-risk foods included sugary drinks, sugary foods, fatty foods, burned foods, processed foods, food seasoning, instant noodles, energy drinks, and soft drinks. Frequency of high-risk food consumption was categorized into three groups: less than three times per month, one to six times per week, and more than once per day. Alcohol consumption was self-reported and categorized as either yes or no. Fruit and vegetable consumption was also self-reported and categorized into two groups: low and high. Low consumption was defined as fewer than five servings per day for seven days a week, and high consumption met the criteria of at least five servings per day for seven days a week.

All statistical analyses were conducted using Stata 15 (StataCorp LLC, College Station, TX). Statistical significance was determined using two-tailed p-values of less than 0.05. Survey weights were applied to the data to account for the complex survey design, non-response rate, and post-stratification, making the results representative of the population. The chi-square test (for categorical variables) and analysis of variance (for continuous variables) were used to compare the characteristics of regular, irregular, and former smokers. The relationship between smoking status and obesity was analyzed using multinomial logistic regression, adjusting for confounding factors such as age, education, employment, residential status, alcohol consumption, high-risk food intake, and fruit and vegetable consumption. The association between smoking status and BMI was further examined using analysis of covariance, controlling for the aforementioned confounding factors.

3 Results

3.1 BMI and Socio-demography characteristics

Table 1 presents the body mass index (BMI) and socio-demographic characteristics of the participants, categorized by their smoking status. Among the participants, 72.1% were regular smokers, 15.4% were irregular smokers, and 12.5% had quit smoking. On average, regular smokers were 40.58 years old, irregular smokers were 39.40 years old, and former smokers were 50.32 years old. Former smokers had the highest BMI, while current smokers had the lowest. A statistically significant correlation was observed between smoking status and age, residential status, education level, and employment status ( $p < 0.05$ ).

Table 1 BMI and Socio-demography characteristics of the subjects

Variables	Smoking status			p-value <sup>1</sup>
	Regular	Irregular	Former smokers	
Height (cm)	163.13±0.15	163.49±0.32	162.75±0.34	< 0.001
Weight (kg)	64.49±0.29	66.24±0.51	67.08±0.68	< 0.001
BMI (kg/m <sup>2</sup> )	24.18±0.09	24.76 ±0.18	25.26±0.23	< 0.001
BMI categories				

Variables	Smoking status			p-value <sup>1</sup>
	Regular	Irregular	Former smokers	
Normal	46.87 (1.05)	8.89 (0.50)	6.50 (0.47)	<0.001
Overweight	11.51 (0.56)	2.57 (0.28)	2.21 (0.26)	
Obese	13.69 (0.64)	3.92 (0.37)	3.83 (0.40)	
Age (yr)	40.58±0.27	39.40±0.0.64	50.32±0.71	< 0.001
Age (years old)				< 0.001
18-24	9.09 (0.35)	2.96 (0.14)	0.62 (0.66)	
25-59	55.67 (0.57)	10.97 (0.54)	7.88 (0.75)	
60+	7.32 (0.19)	1.46 (0.33)	4.05 (0.56)	
Residential				
Urban	39.09 (0.97)	7.98 (0.047)	5.31 (0.39)	< 0.001
Rural	32.99 (0.97)	7.41 (0.56)	7.23 (1.02)	
Education				< 0.001
Incomplete elementary school, elementary school graduate or junior high school graduate	41.62 (0.44)	7.17 (0.42)	6.20 (1.06)	
Senior high school graduate or higher university education graduate	30.45 (0.57)	8.21 (0.49)	6.34 (1.06)	
Occupation				0.1262
Non civil servant (non PNS/BUMN/BUM D)	3.31 (0.17)	0.88 (0.19)	0.87 (0.42)	
Civil servant (PNS/BUMN/BUM D)	68.76 (0.68)	14.5 (0.62)	11.67 (0.42)	
Residential				< 0.001
Urban	19.2 (1.0)	38.4 (1.1)	42.4 (1.1)	
Rural	86.9 (1.0)	7.1 (1.1)	6.0 (1.1)	

Values are presented as Mean±SE or proportions (SE).

Table 2 presents the alcohol and food intake characteristics according to smoking status. Among regular smokers, 35.6% consumed alcohol, while 36.4% did not. A significant difference was observed between smoking status and alcohol consumption, as well as between smoking status and the intake of high-risk foods such as sugary drinks, salty foods, fatty foods, soft drinks, energy drinks, and instant noodles ( $p < 0.05$ ).

Table 2 Alcohol and food consumption of the subjects

Variables	Smoking status			
	Regular	Irregular	Former smokers	p-value <sup>1</sup>
Alcohol consumption				<0.001
Yes	35.61 (1.01)	6.14 (0.46)	2.27 (0.30)	
No	36.46 (1.00)	9.25 (0.54)	10.27 (0.59)	
Risky food consumption				0.037
Sweet food				
less than 3 times per months	7.93 (0.57)	1.29 (0.20)	1.57 (0.25)	
1-6 times per weeks	39.26 (1.03)	9.41 (0.54)	7.31 (0.53)	
more than 1 time per days	24.89 (0.94)	4.68 (0.43)	3.65 (0.37)	
Sweet drink				<0.001
less than 3 times per months	3.80 (0.35)	1.04 (0.21)	1.61 (0.49)	
1-6 times per weeks	18.21 (0.80)	5.40 (0.44)	3.31 (0.34)	
more than 1 time per days	50.07 (1.05)	8.95 (0.52)	7.63 (0.51)	
salty food				<0.001
less than 3 times per months	40.83 (1.08)	8.51 (0.52)	9.11 (0.59)	
1-6 times per weeks	23.93 (0.97)	5.28 (0.43)	2.72 (0.30)	
more than 1 time per days	7.32 (0.56)	1.60 (0.24)	0.72 (0.16)	
fatty food				0.0112
less than 3 times per months	6.40 (0.49)	1.20 (0.20)	1.50 (0.21)	
1-6 times per weeks	37.52 (1.04)	9.07 (0.47)	6.80 (1.14)	
more than 1 time per days	28.15 (1.03)	5.12 (0.42)	4.24 (0.41)	
burnt food				0.154
less than 3 times per months	18.81 (0.85)	3.92 (0.37)	3.40 (0.37)	
1-6 times per weeks	45.34 (1.05)	9.66 (0.49)	7.51 (0.49)	

Variables	Smoking status			
	Regular	Irregular	Former smokers	p-value <sup>1</sup>
more than 1 time per days	7.93 (0.52)	1.81 (0.24)	1.03 (0.67)	
processed food				0.163
less than 3 times per months	51.58 (1.17)	10.41 (0.56)	8.62 (0.55)	
1-6 times per weeks	18.05 (0.87)	4.38 (0.47)	3.68 (0.41)	
more than 1 time per days	2.43 (0.36)	0.60 (0.14)	0.24 (0.08)	
food seasoning				0.2975
less than 3 times per months	6.14 (0.53)	1.70 (0.22)	2.46 (0.30)	
1-6 times per weeks	11.47 (0.68)	3.12 (0.35)	4.59 (0.44)	
more than 1 time per days	44.64 (1.08)	11.48 (0.56)	14.41 (0.65)	
energy drink				<0.001
less than 3 times per months	56.57 (0.96)	12.31 (0.63)	11.52 (0.63)	
1-6 times per weeks	13.29 (0.67)	2.40 (0.18)	0.83 (0.18)	
more than 1 time per days	2.22 (0.32)	0.68 (0.17)	0.19 (0.36)	
soft drink				<0.001
less than 3 times per months	54.52 (1.07)	11.54(0.61)	11.18 (0.58)	
1-6 times per weeks	15.49 (0.79)	3.464 (0.36)	1.293(0.27)	
more than 1 time per days	2.069 (0.30)	0.38 (0.12)	0.07(0.04)	
instant noodle				<0.001
less than 3 times per months	31.09 (0.95)	7.24 (0.53)	8.15 (0.55)	
1-6 times per weeks	37.03 (0.98)	7.55 (0.47)	4.18 (0.42)	
more than 1 time per days	3.96 (0.37)	0.60 (0.14)	0.22 (0.07)	
Fruits consumption				0.571
High	0.34 (0.022)	0.03 (0.033)	0.046 (0.10)	
Low	71.73 (0.68)	15.35 (0.66)	12.5 (0.10)	
Vegetables consumption				0.968
High	0.83 (0.08)	0.19 (0.10)	0.16 (0.21)	
Low	71.24 (0.67)	15.19 (0.64)	12.38 (0.22)	

Values are presented as Mean±SE or proportions (SE).

3.2 Smoking status

Obesity was most common among regular smokers and least common among former smokers. The same trend was observed for the prevalence of overweight individuals, with the lowest prevalence among ex-smokers and the highest among current smokers (Table 3). Although there was no statistically significant difference between the groups, multinomial logistic regression analysis indicated that irregular smokers were more likely to be overweight than regular smokers (RRR, 1.18; 95% CI, 0.89 to 1.56), as shown in Table 4. There was a significant association between being overweight and being a former smoker (RRR, 1.39; 95% CI, 1.03 to 1.89), compared to current smokers, and this finding had a substantial statistical impact ( $p < 0.05$ ). The odds of being overweight were 1.51 (95% CI, 1.17 to 1.95) for irregular smokers and 1.17 (95% CI, 0.84 to 1.63) for regular smokers and nonsmokers, after controlling for age, residence, education, employment status, risky food intake, alcohol consumption, and fruit and vegetable consumption. Following adjustments, these outcomes did not reach statistical significance. Regular smokers were less likely to be obese than irregular smokers (RRR, 1.42; 95% CI, 1.11 to 1.82), and former smokers were more likely to be obese than current smokers (RRR, 1.63; 95% CI, 1.18 to 2.24), even after adjusting for age, housing, education, employment status, and the consumption of unhealthy foods, alcohol, and fruits and vegetables. After these adjustments, the data remained statistically significant.

Table 3 Distribution of obesity by smoking status

Smoking status	Normal		Overweight		Obese	
	Yes	No	Yes	No	Yes	No
Regular	46.87 (1.05)	25.21 (0.82)	11.51 (0.56)	60.56 (0.98)	13.69 (0.64)	58.38 (1.01)
Irregular	8.89 (0.50)	6.50 (0.47)	2.57 (0.28)	12.8 (0.64)	3.93 (0.38)	11.46 (0.56)
Former smokers	6.5 (0.47)	6.04 (0.51)	2.21 (0.26)	10.3 (0.56)	3.83 (0.40)	8.71 (0.55)
p-value <sup>1</sup>	<0.001		0.676		<0.001	

Table 4 Risk of obesity by smoking status, compared to regular-smokers<sup>1</sup>

	Overweight		Obese	
Smoking status	Crude	Adjusted <sup>2</sup>	Crude	Adjusted <sup>2</sup>
Regular	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Irregular	1.18 (0.89, 1.56)	1.15 (0.86,1.54)	1.51 (1.17, 1.95)	1.42 (1.11,1.82)
p-value <sup>1</sup>	0.249	0.337	0.002	0.006
Regular	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Former smokers	1.39 (1.03, 1.89)	1.17 (0.84-1.63)	2.02 (1.51, 2.69)	1.63 (1.18,2.24)
p-value <sup>2</sup>	0.032	0.350	< 0.001	0.003

Values are presented as relative risk ratio (95% confidence interval).

<sup>1</sup> Data were analysed using multinomial logistic regression analysis

<sup>2</sup> Adjusted for age, residential, education, working status, alcohol and food consumption. Normal BMI as a reference.

## 4 Discussion

We examined whether there was a correlation between smoking and obesity using RISKESDAS data. Compared to current smokers, those who had smoked in the past were more likely to be overweight. After controlling for factors such as age, residence, education, employment status, intake of unhealthy foods, alcohol, and fruits and vegetables, the correlation between smoking status and obesity was reduced but remained statistically significant. Even after controlling for these potential confounders, the risk of obesity was still higher for ex-smokers compared to current smokers. Consistent with other research, this study indicated that current smokers had a lower risk of obesity compared to former smokers[7, 10]

It is commonly observed that some individuals experience weight gain after quitting smoking. However, it is important to note that not everyone who quits smoking gains weight, and the relationship between smoking cessation and body mass index (BMI) can vary among individuals [3]. Several factors may explain why some people who quit smoking may have a higher BMI compared to regular smokers: 1) Increased appetite: Nicotine, the addictive substance in cigarettes, can act as an appetite suppressant. When a person quits smoking, their sense of taste and smell may improve, leading to increased food intake and potentially higher calorie consumption. This increased appetite can contribute to weight gain. 2) Altered metabolism: Nicotine also has metabolic effects that can increase the body's metabolic rate and reduce the rate of weight gain. When a person stops smoking, their metabolic rate may decrease, leading to a slower calorie burn and potential weight gain. 3) Substituting smoking with eating: Some individuals may replace the oral gratification they previously received from smoking with food. This can lead to an increase in snacking or overeating, resulting in weight gain. 4) Changes in physical activity: People who quit smoking may experience changes in their physical activity levels. Some individuals may become less active, either due to withdrawal symptoms or lifestyle changes, which can contribute to weight gain. It is important to remember that quitting smoking offers numerous health benefits that far outweigh the potential for temporary weight gain. While weight gain can be a concern for some individuals, it is crucial to focus on maintaining a healthy lifestyle overall, including a balanced diet and regular exercise, to manage weight effectively. Consulting healthcare professionals can also provide personalized advice and support during the smoking cessation process.

This study has several limitations. First, smoking was not objectively validated using biochemical tests such as urine cotinine. Since the data was derived from individuals' self-reported actions, recall bias is a possibility. Second, the study may have been subject to selection bias. Only 4,994 individuals (21.6% of the total) remained after excluding those with incomplete data. People whose data was missing or incomplete may have been different from those whose data was included. Third, the data did not reflect the number of years a person smoked or their total cigarette intake in pack-years. This limitation meant we could not test for a dose-dependent association between cigarette consumption and weight gain. Fourth, as this was a cross-sectional study, we could not establish a cause-and-effect relationship. Correlations do not imply causation. Lastly, while we controlled for several confounding variables, we cannot completely rule out the influence of factors such as stress, sleep, mood, energy consumption, physical activity, and secondhand smoke.



Despite these limitations, the use of the large RISKESDAS dataset, which is representative of the total Indonesian population, is a major strength of this study. The dataset included assessments of fruit and vegetable consumption, alcohol use, and unhealthy food intake, allowing us to account for these potential confounders. Another strength of this study is the use of anthropometric measurements instead of self-reported weight and height. Self-reported BMI is often underestimated because individuals tend to overestimate their height and underestimate their weight [5]. Overestimating the relationship between health behaviours and obesity can occur when using self-reported anthropometric measurements to define obesity. Compared to current smokers with normal weight, former smokers are more likely to be overweight. Given the limitations of the study and its cross-sectional design, we cannot definitively establish a causal link between smoking and obesity. However, smokers should be aware that they may be at higher risk of becoming overweight.

## 5 Conclusion

This study found that obesity is more common among former smokers and irregular smokers compared to regular smokers. Due to the limitations and cross-sectional design of the study, we cannot definitively establish a cause-and-effect relationship between smoking and obesity. Nonetheless, smokers should be informed that they may be at an increased risk of becoming overweight.

Effective interventions should consider the potential differences in weight status and obesity risk among former smokers and irregular smokers. Additionally, identifying sociodemographic factors and food consumption patterns that influence this relationship can help target specific populations for interventions and preventive measures.

## Conflict of interest disclosure

The authors have no conflicts of interest to declare for this study.

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