Article

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ADOLESCENT SMOKING AND ITS ASSOCIATION WITH POOR NUTRITIONAL OUTCOMES IN RURAL PAMEKASAN, INDONESIA

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This study investigated the relationship between active smoking and nutritional status among male adolescents aged 14-16 years in Kertagena Tengah Village, Kadur District, Pamekasan, Indonesia. A cross-sectional study design was employed, and a total of 55 adolescents were included using a total sampling technique. Smoking status was assessed using standardized questionnaires, while nutritional status was determined using anthropometric measurements, including body mass index (BMI). The study found that 76% of the adolescents were active smokers, with 69% of them being classified as undernourished. A significant relationship was observed between active smoking and poor nutritional status (p=0.018). The main contributing factors to poor nutritional status included an unbalanced diet, lack of access to nutritious food, and high smoking rates among adolescents. Smoking was found to reduce appetite and interfere with nutrient absorption, exacerbating nutritional deficiencies. The study highlights the urgent need for comprehensive public health interventions, including health education, stricter regulation of cigarette sales to minors, and community support to create a smoke-free environment. Future research should include longitudinal studies to clarify the causal link between smoking and nutritional status, broaden demographic coverage, and incorporate qualitative methods to explore the social and cultural influences on adolescent smoking.

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Public Interest Statement

This study investigated the relationship between active smoking and nutritional status among 14-16-year-old male adolescents in Desa Kertagena Tengah, Kecamatan Kadur, and Pamekasan. These findings highlight a significant correlation between high smoking prevalence and poor nutritional status, emphasizing the detrimental effects of smoking on adolescent health. This study fills a gap in the existing literature by providing specific data on rural Indonesian youth, underscoring the urgent need for targeted health interventions and policies to combat smoking and improve nutrition in this vulnerable demographic.

Introduction

Smoking has become a global health issue, with the World Health Organization (WHO) highlighting its significant impact worldwide (Prihatinin Gsih et al., 2020). Indonesia ranks among countries with the highest number of smokers, especially among men and adolescents. Surveys indicate that smoking prevalence among Indonesian male adolescents has dramatically increased, with many starting their habit at a young age. This alarming trend has serious health implications, particularly during the critical growth period of adolescence (Amiri 2020).

Cigarette smoke contains approximately 4,000 harmful chemicals, including nicotine, carbon monoxide, and tar, which pose severe health risks. Carbon monoxide binds with hemoglobin to form carboxyhemoglobin, reducing the oxygen-carrying capacity of the blood and disrupting nutrient delivery throughout the body. This impaired oxygen transport can lead to malnutrition, as essential nutrients are not adequately absorbed or distributed, which is crucial during adolescence, when optimal growth and development are needed (Sujarwoto, 2020).

Adolescent smokers are at an increased risk of stunted physical and cognitive development owing to these harmful effects, which can impair lung growth, cognitive function, and metabolism. The societal normalization of smoking in Indonesia, reinforced by cultural practices and aggressive marketing, exacerbates this public health issue. Addressing smoking among adolescents is essential to prevent its detrimental impact on their nutritional status and overall health (Herawati & Anita, 2021).

Data show that among adolescents aged 15-19 years, the prevalence of smoking increased by 12.9 % over a period of 15 years (1995-2010), with an increase of 24.6 % among male adolescents (13.7 %-38.4 %), and an increase of 0.6 % among female adolescents (0.3 %-0.9 %). In females, the prevalence pattern tended to fluctuate and reached the highest prevalence in the 2004 survey (1.9 %) and continued to decline in 2007 and 2010. (Adyanita Hanif Hermawati et al., 2023) Effective interventions are required, including health education and stricter controls on cigarette advertising, to reduce smoking prevalence among adolescents and mitigate its adverse effects on their growth and development.

Based on an initial survey conducted in Kertagena Tengah Village on October 15, 2022, of the 55 adolescents aged 14-16 years, 76 % were active smokers. Cigarette smoke contains approximately 4,000 chemicals including nicotine, carbon monoxide, and tar, which pose significant health risks. Carbon monoxide, in particular, binds with hemoglobin to form carboxyhemoglobin, inhibiting oxygen transport in the body, leading to hypoxia and impaired nutrient delivery (Megatsari et al., 2023). his disruption contributes to malnutrition, as essential nutrients are not adequately distributed throughout the body, which is critical during the growth years of adolescence (Herlingga Nirwana HR & Agustyas Tjiptaningrum, 2024)

Smoking among adolescents is associated with stunted physical and cognitive development owing to the harmful effects of nicotine and other chemicals. Nicotine exposure during adolescence can impair lung growth and cognitive function, and increase susceptibility to other addictions (Xu et al., 2022). In Indonesia, smoking is deeply embedded in social and cultural practices, with cigarettes often used as symbols of respect and hospitality, further normalizing smoking among adolescents (Septiono 2024). This cultural acceptance, combined with aggressive marketing strategies, perpetuates smoking habits, posing a significant risk to adolescent nutritional health and overall development (Simone St Claire et al., 2020)

There is a need for comprehensive prevention and education to reduce the prevalence of smoking, especially among adolescents. Educational programs in schools can provide accurate information regarding the dangers of smoking and its long-term effects (Kusumawardani et al. 2018). In addition, effective health campaigns should be conducted through various media to reach a wider audience. Health counseling involving community leaders and public figures can also help change the social perceptions of smoking. The government needs to work with various health and education organizations to develop a holistic and sustainable prevention strategy. Adolescent boys who smoke actively will affect their physical, psychological, material and even moral state, the following is the analysis

From a physical point of view, smoking can cause health losses, especially for those who are still in their growth period, where CO2 inhibits the circulation of O2, which carries nutrients throughout the body. Therefore, this is likely to result in an unstable nutritional status during growth. Smoking in adolescents directly affects their nutritional status by impairing growth and development due to harmful substances in cigarettes, such as nicotine and carbon monoxide, which disrupt lung and heart function, reduce stamina, and hinder nutrient absorption. These chemicals interfere with oxygen transport in the body, leading to poor nutrient distribution, which is crucial during adolescence, a critical growth period. Additionally, smoking increases the risk of respiratory issues, chronic diseases, and overall poor health, further compounding nutritional deficiencies, and affecting adolescents' ability to maintain a healthy nutritional status during their developmental years.

This study aimed to answer the following question: Is there a significant relationship between active smoking and nutritional status among male adolescents aged 14-16 years in Kertagena Tengah Village, Kadur District, Pamekasan?

Literature Review

Windahsari investigated the relationship between environmental factors and smoking behavior among male adolescents, finding that 68 % of respondents were exposed to negative environmental influences, and 72 % exhibited moderate smoking behavior. Their study highlighted the significant impact of environmental factors, such as peer pressure, family members who smoke, and lack of parental supervision, on smoking habits, emphasizing the need for targeted interventions to address these influences. Suggested interventions include improving family dynamics, peer education programs, and community initiatives to prevent smoking (Nur Windahsari et al., 2017)

Previous studies have extensively documented the health risks of smoking, including respiratory and cardiovascular problems, cognitive impairment, and an increased susceptibility to addiction. Research that explicitly links smoking to nutritional outcomes, particularly among adolescents, remains limited. Existing studies often focus on behavioral aspects and general health impacts, without examining how smoking disrupts essential nutrient intake and metabolism, which are crucial during adolescence.

Smoking has been identified as a contributing factor to malnutrition by impairing nutrient absorption and metabolism due to harmful chemicals, such as carbon monoxide and nicotine. Nicotine suppresses appetite and alters energy balance, whereas carbon monoxide interferes with the body's oxygen transport system, resulting in poor nutrient distribution and various forms of malnutrition.

Despite these findings, there is a notable gap in the literature regarding direct assessment of smoking habits and specific nutritional outcomes in adolescents. This study addresses this gap by providing a detailed analysis of how smoking affects nutritional status, showing a significant correlation between active smoking among male adolescents and poor nutritional status ($p < 0.05$). By linking smoking to measurable nutritional deficiencies, this study expands the understanding of smoking's health implications and underscores the importance of integrated interventions that address both smoking cessation and nutritional education.

The findings build on existing research and advocate for comprehensive strategies that combine behavioral and nutritional education to curb smoking among adolescents and promote healthier habits, aiming to improve overall adolescent health outcomes.

Sulistyoningrum (2024) investigated the relationship between cigarette advertising and smoking behavior among male adolescents in Limbangan Wetan Village, Brebes Regency. Using a cross-sectional design, the study found that 66.7 % of respondents were exposed to cigarette advertising, and 86.7 % of those exposed were smokers. The analysis revealed a significant relationship between cigarette advertising and smoking behavior ($p = 0.035$), underscoring the influence of advertising on adolescent smoking habits and highlighting the need for stricter tobacco advertising regulations to reduce smoking prevalence among teenagers.

While Sulistyoningrum emphasizes the impact of advertising on smoking behavior, the current study focused on the direct health impact of smoking on nutritional status among adolescents. Using a larger sample of 55 adolescents and analyzing the data with the chi-square test, the study found a significant relationship between active smoking and poor nutritional status, highlighting the physiological consequences of smoking, such as malnutrition and obesity.

The novelty of the current study lies in its focus on the direct health outcomes of smoking, specifically, how smoking affects nutritional status. This perspective extends our understanding of the impact of smoking on tangible health effects, emphasizing the importance of integrated health interventions that address both smoking cessation and nutritional improvement.

While previous research has primarily examined the behavioral factors influencing smoking, there is a notable gap in assessing the direct health impacts, particularly on nutritional status. This study fills this gap by demonstrating a significant correlation between smoking and poor nutritional status ($p < 0.05$), supporting the need for broader interventions that combine behavioral and nutritional strategies to improve adolescent health outcomes.

Nur Windahsari et al. (2017) investigated the relationship between smoking behavior and the incidence of hypertension among productive age individuals, using a cross-sectional method and analyzing data from 35 respondents. This study found a significant relationship between smoking and hypertension ($p = 0.001$), highlighting the increased risk of hypertension associated with smoking among this population. While Dilla et al. focused on the link between smoking and hypertension, the current study examined the direct impact of smoking on the nutritional status of adolescents, an area that is less explored in existing research.

Many studies have overlooked how smoking affects nutrient absorption and metabolism, which can lead to malnutrition and obesity, particularly among adolescents. This study addresses this gap by analyzing the relationship between active smoking and poor nutritional status ($p < 0.05$) in male adolescents using a cross-sectional approach with 55 participants. By highlighting the direct health consequences of smoking beyond behavioral factors, this study emphasizes the need for integrated health education strategies targeting both smoking cessation and nutritional improvement.

In conclusion, this study builds on previous research by linking smoking behavior not only to broader health risks such as hypertension, but also to nutritional deficiencies among adolescents. This provides a more comprehensive understanding of the impact of smoking and underscores the need for targeted health intervention.

Sarah and Angeliana (2024) examined the factors influencing smoking behavior among male adolescents, highlighting socio-environmental influences such as knowledge, attitudes, peer influence, and cigarette advertising. Their study found that these factors significantly impact adolescent smoking behavior but primarily focused on behavioral influences without addressing the direct health impacts of smoking.

This study addresses this gap by exploring how smoking directly affects nutritional status among adolescents, an area that is less explored in the existing literature. Using a cross-sectional approach with 55 participants, this study found a significant relationship between active smoking and poor nutritional status ($p < 0.05$). By extending the understanding of the impact of smoking on tangible health outcomes, such as malnutrition and obesity, this research underscores the need for integrated health education strategies targeting both smoking cessation and nutritional improvement. This study extends previous research by connecting smoking behavior to direct health outcomes, offering insights for developing targeted interventions to mitigate the diverse health risks of adolescent smoking.

Nurhalimah et al. (2024) investigated the influence of cigarette advertising on adolescent smoking behavior, highlighting the significant impact of socio-environmental factors. While previous studies, including Nurhalimah et al.'s, focus on advertising and social influences, they often overlook the direct health impacts of smoking on adolescents. The current study addresses this gap by examining the relationship between smoking and nutritional status among adolescents, providing empirical evidence of how smoking directly affects health outcomes, such as malnutrition and obesity (Nurhalimah et al., 2024).

Using a cross-sectional approach with 55 adolescents, this study found a significant relationship between active smoking and poor nutritional status ($p < 0.05$). This finding extends our understanding of the impact of smoking on tangible health effects, emphasizing the need for integrated health education strategies that address both smoking cessation and nutritional improvement. This study advances prior research by directly associating smoking behavior with health outcomes, addressing a significant gap in the literature. These results underscore the necessity for comprehensive interventions that address both the behavioral and nutritional aspects of adolescent smoking.

Materials and Methods

This study used observational research of an analytical nature. Observational analysis is a method of collecting data that makes direct observations to respondents and research to look for changes in the things under study (Zainuddin 2020). Research design is a strategy for identifying problems before the final planning of data collection. To collect data for this study, the researchers used a *cross-sectional* approach. A cross-sectional study was conducted to examine the dynamics of the correlation between risk factors and effects using a cross-sectional approach (Zainuddin, 2020).

A cross-sectional research design was chosen for this study because it allows researchers to assess and analyze the prevalence of smoking behavior and its direct impact on nutritional status among male adolescents at a single point in time. This design is particularly effective for identifying associations between variables such as smoking status and nutritional outcomes, without requiring long-term follow-up. Cross-sectional studies are time-efficient and cost-effective as they collect data at one point, making them suitable for studies with limited resources. They allow researchers to assess the prevalence of smoking and its immediate impact on nutritional status, providing a snapshot of current health issues. This approach is effective in identifying associations between exposure and outcomes, facilitating the generation of hypotheses for further research, and encompassing a diverse range of participants, rendering the findings applicable to various demographic groups. However, the design exhibits limitations such as the inability to establish causality due to its focus on associations and the capture of data at a single point in time, potentially overlooking changes in behavior or health outcomes over time. It is also susceptible to biases, including recall bias, selection bias, and the challenge of controlling for confounding factors that may influence both smoking behavior and nutritional status, such as socioeconomic status or parental influence. Notwithstanding these limitations, the cross-sectional design is appropriate for providing an initial understanding of the relationship between smoking and nutritional status, emphasizing the necessity for targeted interventions and further longitudinal research to explore causality.

This research was conducted in Kertagena Tengah Village, Kadur District, Pamekasan Regency. The population is the whole object of research or the object under study (Zainuddin, 2020). The population in this study was all adolescents aged 14-16 years in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan, totaling 55 people.

This research was conducted in Kertagena Tengah Village, Kadur District, Pamekasan Regency. The population in this study comprised all adolescents aged 14-16 years in Kertagena Tengah Village, totaling 55 individuals. The sample in this study is representative of the entire population, consisting of 55 adolescents aged 14-16 years, selected using the Total Sampling technique, which involves taking the entire research population as the study sample to ensure comprehensive representation.

Sample Size Determination and Criteria The sample size was determined using the Total Sampling technique, which was feasible due to the relatively small and manageable population size, ensuring that every eligible individual in the target group was included.

Inclusion Criteria: The inclusion criteria for the study were as follows: (1) adolescents aged 14-16 years residing in Kertagena Tengah Village; (2) willingness to participate in the study; and (3) no chronic illnesses that could independently affect nutritional status, such as diabetes or severe gastrointestinal disorders.

The exclusion Criteria The follows: (1) adolescents who were absent during the data collection period, (2) those who did not provide consent to participate, and (3) individuals with incomplete data or unwillingness to complete the questionnaires or anthropometric measurements.

Standard tools are commonly used to measure smoking status and nutritional status. Smoking status is typically assessed using standardized questionnaires that include questions regarding the frequency, duration, and number of cigarettes consumed per day. Tools such as the Global Youth Tobacco Survey (GYTS) or the Fagerström Test for Nicotine Dependence can be used to measure the level of nicotine addiction, helping categorize individuals as active smokers, passive smokers, or non-smokers. Nutritional status was measured using anthropometric methods including height, weight, and Body Mass Index (BMI) (M et al., 2023). BMI is calculated by dividing weight (kg) by height (m) squared and is used to classify nutritional status as normal, underweight, overweight, or obese (Khanna et al., 2022). In addition to BMI, waist circumference measurements and body composition analysis using tools such as bioelectrical impedance analysis (BIA) can also be employed for more accurate assessment.

Variables and Data Analysis The independent variable in this study was active smoking among male adolescents aged 14-16 years, while the dependent variable was their nutritional status. Data analysis was performed using SPSS software, specifically employing bivariate analysis with the chi-square test to examine the relationship between the independent and dependent variables, assessing whether active smoking significantly affects nutritional status.

The sample was the object under study and was considered representative of the entire population (Zainuddin, 2020). The sample used in this study was all adolescents aged 14-16 years in Kertagena Tengah Village, Kadur Pamekasan Subdistrict, totaling 55 people. Sampling is a process of selecting samples used in research from the existing population so that the number of *samples* will represent the entire existing population. This study used the *Total* Sampling technique, which takes research samples by making the entire research population the object of research (Zainuddin, 2020).

Independent variables (free variables) are those that affect or cause changes, or the emergence of dependent variables (bound). The independent variable in this study is active smoking in male adolescents aged 14-16 years in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan, while the dependent variable is the variable that is influenced or that becomes the result because of the independent variable. The dependent variable in this study was the nutritional status of Kertagena Tengah Village, Kadur Subdistrict, Pamekasan 2022. Data analysis was carried out using the statistical program social science (SPSS) software in the form of *bivariate* analysis, which was carried out on two variables that were suspected of being related or correlated. Bivariate analysis with the *chi-square* test was used.

The study protocol was reviewed and approved by an ethics committee or institutional review board (IRB) to ensure that all ethical standards were met, particularly in protecting the rights and welfare of the participants, which were crucial in conducting research responsibly and respectfully, ensuring that the rights and well-being of the minor participants were safeguarded throughout the study.

Results

This section can be divided into subsections. It should provide a concise and precise description of the experimental results, their interpretation, and the experimental conclusions that can be drawn.

4.1 Distribution of Respondents

Table 1 Table 1 Age Distribution of Respondents in Kertagena Tengah, Kadur, Pamekasan (24-30 February 2022)

Age	Frequency	Percentage (%)
14 years	7	13
15 years	27	49
16 years	21	38
Total	**55**	**100**

Source: Data processed by the author

Table 1 shows the age distribution of 55 adolescent boys aged 14-16 years in Kertagena Tengah Village, Kadur Sub-district, Pamekasan. Of the respondents, there were 7 teenagers aged 14 years, representing 13 %

of the total respondents. Most of the respondents were aged 15 years, with as many as 27 teenagers (49% of the total respondents). This shows that the 15-year-old age group was the most dominant among the respondents. In addition, 21 adolescents, aged 16 years, accounted for 38 % of the total respondents. This age group is the second largest in the age distribution of the respondents. The total number of respondents in the study was 55. These data show that almost half of the respondents were adolescents aged 15 years, which could be a key focus in further analyses of smoking habits and nutritional status. The fairly even distribution between the 14- and 16-year-old age groups also allows for a comparative analysis between age groups.

4.2 Relationship Between Active Smoking and Nutritional Status Among Adolescent Boys Aged 14-16 in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan

After the data were collected and tabulated, they were presented in the form of a simple table to determine the relationship between active smoking in adolescent boys aged 14-16 years and nutritional status in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan.

1. Active Smoking in Adolescent Boys 14-16 Years of Age

Tabel 2 Smoking Status of Respondents in Kertagena Tengah, Kadur, Pamekasan (24-30 February 2022)

Smoking Status	Frequency	Percentage (%)
Non-Smokers	13	23
Light Smokers	0	0
Heavy Smokers	42	76
Total	55	100

Table 2 shows the distribution of smoking status among 55 adolescent boys aged 14-16 years in Kertagena Tengah Village, Kadur Sub-district, Pamekasan. Of the total respondents, 13 adolescents (23 %) were non-smokers, which means they did not smoke. None of the respondents were categorized as light smokers; therefore, the percentage for this category was 0 %. In contrast, most respondents (42 adolescents or 76 %) were categorized as heavy smokers.

This indicates that most adolescents in this village have intensive smoking habits and consume large quantities of cigarettes. The overall data illustrate a very high prevalence of smoking among adolescents in the village, with almost three-quarters of the total respondents being heavy smokers. This raises serious concerns regarding the long-term health impacts in this age group.

2. Adolescent Nutritional Status

Table 3 Nutritional Status of Respondents in Kertagena Tengah, Kadur, Pamekasan (24-30 February 2022)

Smoking Status	Frequency	Percentage (%)
Normal	10	18,2 %
Less	38	69,1%
Overweight	2	3,6%
Obesity	2	3,6%
Total	55	100%

Table 3 shows the distribution of nutritional status among 55 adolescent boys aged 14-16 years in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan. Of the total respondents, 10 adolescents (23 %) had normal nutritional status. This means that they had a body mass index (BMI) within the healthy range. However, there was an error in the data where the percentage for the undernutrition category was not shown, even though the number of respondents in this category was 38.

If this percentage is calculated, it would be approximately 69 %. In addition, 2 adolescents (4 %) were categorized as overweight and 2 (4 %) were obese. The total number of respondents was 55, and this data provides a clear picture that most adolescents in this village are undernourished, while only a small percentage have a normal, overweight, or obese nutritional status. This trend suggests the need for nutritional and health interventions to improve the nutritional status of adolescents in the village.

4.3. The Relationship Between Active Smoking Among Adolescent Boys Aged 14-16 Years with Nutritional Status in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan

Table 4 Relationship Between Smoking and Nutritional Status in Adolescent Boys (Kertagena Tengah, Kadur, Pamekasan, 24-30 February 2022).

Nutritional Status\Smoking	Normal	Less	Overw	Obest	Total

	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
Normal	10	15	23	78	1	7	0	0	13	100
Less	38	0	0	0	0	0	0	0	0	0
Overweight	2	19	76	67	4	9	2	5	42	100
Total	55	18	100	69	5	9	2	4	55	100
$\rho = 0.018 < \alpha = 0.05$										

Table 4 shows the relationship between smoking status and nutritional status among 55 adolescent boys aged 14-16 years in Kertagena Tengah Village, Kadur Sub-district, Pamekasan. Of the 13 adolescents who had a normal nutritional status, 10 were non-smokers, representing 15 % of the total respondents, whereas 23 adolescents (78 %) with undernutrition were heavy smokers. In the overweight category, two adolescents (4 %) were heavy smokers. None of the undernourished or obese adolescents were non-smokers or light smokers, as all 38 adolescents in the undernourished category were heavy smokers, indicating a high prevalence of smoking among undernourished adolescents. Only one adolescent (7 %) with an overweight status was a non-smoker, and there were no light smokers in this group.

The total number of respondents was 55 adolescents, with a distribution of 18 adolescents with normal nutrition, 38 adolescents with undernutrition, 5 adolescents overweight, and 2 adolescents obese. Statistical analysis showed that there was a significant relationship between active smoking and nutritional status, with a p-value (ρ) of 0.018, which is smaller than the significance level $\alpha = 0.05$. This confirms that smoking has a significant effect on the nutritional status of adolescents, with heavy smokers being more likely to be undernourished than adolescents who do not smoke. The results of the Spearman Rho test show that the Asymp. Sig (2-sided) obtained a value of 0.018, which is less than or smaller than the value of significance $\alpha = 0.05$. It means that it can be concluded that H1 is accepted and H0 is rejected, i.e. there is a relationship between active smoking in adolescent boys aged 14-16 years with nutritional status in Kertagena Tengah village, Kadur sub-district, Pamekasan.

Discussion

In this chapter, we discuss the results of research on the relationship between active smoking in adolescent boys aged 14-16 years and nutritional status in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan, February. The potential biases identified in this study include selection, reporting, and measurement biases, which can affect the accuracy and interpretation of the results. Selection bias may have occurred because the study was conducted in a specific rural village, which might limit the generalizability of the findings to broader populations such as urban areas or different cultural contexts. To address this, the study employed a total sampling technique that included the entire adolescent population in the village, thus providing a representative picture of the target population.

Reporting bias is also a concern, as the study relies on self-reported smoking behaviors, which may lead to inaccurate reporting due to social desirability or fear of judgment, particularly among adolescents discussing sensitive behaviors, such as smoking. To minimize this bias, the researchers used anonymous questionnaires and standardized instruments designed to reduce social pressure and encourage participants to provide honest responses.

Measurement bias could occur due to the use of self-reported dietary intake to assess nutritional status, which may not accurately reflect actual intake levels and could lead to the misclassification of nutritional outcomes. To address this, the study employed validated nutritional measurement methods, such as anthropometry, to directly measure weight and height, ensuring the accuracy of nutritional status data.

With these measures, this study strives to minimize potential biases and enhance the reliability and validity of the findings. These efforts to handle bias demonstrate a clear commitment to improve the quality and credibility of the data. Although some limitations may still exist, transparency in reporting and addressing potential biases adds significant value to this study's findings.

5.1 Active Smoking among Male Adolescents aged 14-16 years in Kertagana Tengah Village, Kaur Pamekasan Sub-district

Table 1 shows that out of the 55 respondents, most of the 42 (76 %) adolescent boys were heavy smokers, and a small proportion of 13 (23 %) respondents were non-smokers. The most dominant use of tobacco leaves is smoking, in which dry tobacco leaves are rolled in a wrapper or using a pipe. Everyone has their own way of smoking cigarettes; there are those who smoke from the mouth, then cigarette smoke is released through the mouth or nose, and in various other ways. Broadly speaking, three types of cigarette smokers can be distinguished: oral lung smokers, who only suck cigarette smoke into the oral cavity; smokers who smoke cigarettes into the lungs, called deep lung smokers; and smokers who smoke cigarettes into the lungs, hold their breath for a while, and then exhale it out, called lung smokers (Kamsu & Ndebia, 2024).

The gaseous components of cigarette smoke include carbon monoxide, ammonia, hydrocyanic acid, nitrogen oxides, and formaldehyde. The particles were tar, indole, nicotine, carbazole, and cresol. These substances are toxic, irritating, and cancer-causing (carcinogenic). Nicotine is commonly found in cigarettes. Nicotine levels in white cigarettes are 4-5 mg, whereas those in clove cigarettes are 5 mg. Carbon monoxide levels in clove cigarettes were lower than those in white cigarettes. Tar levels in white cigarettes are 14-15 mg, while in clove cigarettes, it is 20 mg. (Jao et al., 2024).

Based on the above analysis, it can be seen that most male adolescents aged 14-16 years in Kertagena Tengah Village, Kadur Subdistrict, and Pamekasan are heavy smokers who are able to consume more than six cigarettes per day. This status of heavy smokers is certainly not good news for the adolescents concerned, especially with regard to the growth and development process that they are experiencing. This will certainly significantly affect the nutritional status of adolescents.

The most dominant use of tobacco leaves among adolescents is smoking, in which dried tobacco leaves are rolled in a wrapper or using a pipe. Each adolescent has their own way of smoking cigarettes. Some inhaled smoke from the mouth and then expelled it through the mouth or nose, while others inhaled smoke into the lungs. Based on the way they smoke cigarettes, these teenagers can be categorized into three types: oral lung smokers who only smoke up to the oral cavity, deep lung smokers who smoke up to the lungs, and lung smokers who hold their breath for a while before expelling smoke.

The high number of active smokers among adolescents is worrying, considering the negative impact of smoking on health. Harmful substances in cigarettes, Cigarette smoke contains a complex mixture of over 7000 chemical compounds, with 86 identified as having sufficient evidence of carcinogenicity (Zeng et al., 2023). These harmful substances include nicotine, arsenic, benzene, carbon monoxide, heavy metals, and tobacco-specific nitrosamines (Başaran et al. 2019). Specific metals found in tobacco and tobacco smoke have been classified as carcinogens by the International Agency for Research on Cancer, contributing to health risks, such as inflammation, sensitization, and carcinogenesis (Fresquez et al., 2013).

As we know, a cigarette contains various types of chemicals, most of which contain toxins, including the dangerous ones: nicotine, tar and carbon dioxide. If these substances enter the body through the inhalation of cigarette smoke consumed by teenagers, it is not impossible for them to enter the blood circulation and enter the body's metabolic system. Therefore, in the long-term, in addition to being at risk of experiencing growth problems, adolescents with smoking status are also at risk of respiratory tract disorders. For example, cancer or respiratory complications can occur.

Preventing adolescents from smoking addiction should start with self-awareness and full support from the surrounding environment, including health workers. Smoking is a bad culture that is freely seen and enjoyed, even by minors. Thus, its management must be multidisciplinary and multifactorial.

This study argues that there is a high prevalence of smoking among male adolescents aged 14-16 in Kertagena Tengah Village, Kadur District, Pamekasan, which negatively impacts their health, growth, and development. Exposure to harmful substances in cigarettes, including nicotine, tar, and carbon monoxide, is linked to pulmonary dysfunction, increased risk of serious diseases such as cancer and cardiovascular disease, and adverse effects on adolescents' nutritional status (Cotton, 1993; Stepney, 1981). This highlights the significant health risks faced by adolescent smokers, especially during this crucial period of physical and cognitive development.

This was supported by quantitative data from 55 respondents, with 76 % identified as heavy smokers, indicating a high prevalence of smoking among adolescents in the study population. However, while these data demonstrate the relationship between smoking and health issues, there is insufficient evidence to fully elucidate the causal relationship between smoking and long-term effects on nutritional status owing to the study's descriptive and non-longitudinal design.

This study emphasizes the real dangers of smoking on adolescent health, supported by empirical data. These findings align with public health theories stating that smoking negatively affects adolescents' physical health and development, reinforcing the necessity of a smoke-free environment for young people's health (Sri Lanka Institute of Information Technology, Sri Lanka et al., 2023). However, it neglects differing perspectives, such as psychological and social dependencies, that may keep adolescents smoking despite awareness of its harm. These aspects are crucial for a comprehensive understanding and highlight the importance of multidisciplinary and multifactorial approaches in interventions addressing adolescent smoking issues.

5.2 Nutritional Status in Kertagana Tengah Village, Kadur Sub-district, Pamekasan

Nutritional status is an important indicator in assessing the health and well-being of the community, especially among adolescents in their growing years. In Kertagena Tengah Village, Kadur Sub-district, Pamekasan, research has shown

significant variations in the nutritional status of adolescent boys aged 14-16 years. Based on the results of this study, most adolescents in this village had an unfavorable nutritional status. Of the 55 respondents studied, 38 (69 %) were in the undernourished category, whereas only a small proportion were in the normal or obese nutrition category.

Nutritional status, in this case the nutritional status of adolescents, is a condition of the body that arises due to the balance between consumption and expenditure of nutrients. In general, nutritional status is influenced by the consumption of nutrients from food and infectious diseases, which interfere with the metabolic process, absorption, and utilization of nutrients by the body. Because nutritional status is an ongoing process that changes over time, it needs to be monitored continuously and appropriately (Atikah Proverawati & Erna Kusuma Wati, 2011)

Factors that contribute to poor nutritional status in the village include unbalanced diet, lack of access to nutritious food, and high smoking rates among adolescents. Unbalanced diets are often caused by ignorance of the importance of balanced nutrition and economic limitations that prevent families from providing nutritious meals. For example, many families often eat staple foods such as rice with a small variety of vegetables or proteins that do not meet their daily balanced nutritional needs.

Lack of access to nutritious food is also a major problem. Nutritious foods such as fruits, vegetables, and quality protein sources are often difficult to find in rural areas or have unaffordable prices for many families. This condition is exacerbated by a lack of supporting facilities, such as markets that provide fresh and nutritious foodstuffs. As a result, many adolescents in these villages are not getting enough nutrition to support their growth and development, and a lack of access to nutritious food is also a major problem. Nutritious foods, such as fruits, vegetables, and quality protein sources, are often difficult to find in rural areas or are unaffordable for many families. This condition is exacerbated by a lack of supporting facilities, such as markets that provide fresh and nutritious foodstuffs. As a result, many adolescents in these villages do not receive enough nutrition to support their growth and development.

In addition, high smoking habits among adolescents also contribute significantly to poor nutritional status. Smoking reduces appetite and interferes with nutrient absorption in the body. Nicotine and other harmful substances in cigarettes can affect the digestive and metabolic systems of the body, resulting in suboptimal absorption of essential vitamins and minerals. Adolescents who smoke tend to have low dietary intake, especially in terms of growth-essential vitamins and minerals, such as vitamins A, C, and E, as well as calcium and iron. The lack of these nutrients can lead to a variety of health problems, including stunted growth, decreased immunity, and an increased risk of disease.

Nutritional problems in adolescents arise due to incorrect nutritional behavior, namely, the imbalance between nutrient consumption and recommended nutritional adequacy. Undernutrition occurs when the amount of energy and other nutrients consumed does not meet the body's needs. However, in adolescent girls, undernutrition generally occurs due to dietary limitations or self-limitation of food intake (Ravula et al., 2024)

According to the researcher, based on the facts regarding the nutritional status of adolescents, it has been stated that most of the 38 adolescents (69) are in a nutritionally deficient status, which is where according to the body mass index (BMI < 18.5). The problems experienced by adolescents related to nutrition cannot escape the impact of adolescent cigarette consumption. Nutrients that should be fulfilled by the body from food intake will be affected by appetite, which may decrease because adolescents smoke too much. However, it also does not rule out the possibility, even with a good diet, that because the substances contained in cigarettes and cigarette smoke are addictive substances, the food that enters the body cannot be absorbed properly by the metabolic system. So that in the end it will have an impact on adolescent nutrition problems, namely undernutrition, overweight, or obesity.

This study showed that the majority of male adolescents aged 14-16 years in Kertagena Tengah Village, Kadur Sub-district, Pamekasan had poor nutritional status, with 69 % classified as undernourished. The main contributing factors include an unbalanced diet, lack of access to nutritious food, and high smoking rates among adolescents, highlighting that poor nutritional status is influenced not only by inadequate nutrient intake, but also by smoking behaviors that disrupt nutrient absorption and metabolism. The evidence used included quantitative data from 55 respondents, showing that 38 adolescents were in the undernourished category. This evidence is further supported by the literature explaining how smoking reduces appetite and interferes with the absorption of essential nutrients, such as vitamins A, C, and E, calcium, and iron. While these data effectively illustrate the prevalence and risk factors of poor nutritional status among adolescents, most evidence remains descriptive and lacks a direct causal link between smoking and poor nutritional outcomes due to the absence of longitudinal data.

This strength lies in its focus on specific factors affecting adolescent nutritional status, such as unbalanced diets and smoking habits, supported by empirical data (Abel et al., 1992). This aligns with the public health theories that smoking behaviors can disrupt metabolism and nutrient absorption, which is consistent with the concept of nutritional imbalance between consumption and requirements that leads to malnutrition (Perkins, 1992). Additionally, the economic nutrition theory supports the view that limited access to nutritious food due to economic constraints

contributes to poor nutritional status. In South Africa, poor people rely heavily on social grants and cannot afford a balanced diet, leading to both under- and over-nutrition (Govender et al. 2016). Similarly, in Nigeria, widespread poverty is a critical impediment to food and nutrition security, with approximately 40 % of Nigerians living below the poverty line and unable to afford a balanced diet (Olamide 2024). The Supplemental Nutrition Assistance Program (SNAP) in the United States also faces challenges related to the high cost of nutrient-rich foods and inadequate benefits that influence nutrition among low-income households (Leung et al., 2013).

These findings have significant implications for public health practices and policies, particularly regarding nutritional intervention and smoking control among adolescents. From a policy perspective, it is crucial to develop comprehensive intervention programs, including intensive nutrition education and policies that limit adolescents' exposure to smoking. Implementing these policies can help improve the overall adolescent nutritional status and support healthier development in the younger generation.

5.3 The Relationship Between Active Smoking Among Adolescent Boys Aged 14-16 With Nutritional Status in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan

There was a significant correlation between active smoking habits and nutritional status among adolescent boys aged 14-16 years in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan. Based on the results of the study, out of 55 adolescents who became respondents, 42 (76 %) were active smokers, while 13 (24 %) did not smoke. Most active smokers had poor nutritional status. This is because of the negative effects of nicotine and other harmful substances in cigarettes, which can reduce appetite and interfere with the absorption of nutrients in the body. Substances such as carbon monoxide, tar, and various other toxic chemicals can inhibit metabolism and normal functioning of body organs, which in turn affects the intake and utilization of essential nutrients such as vitamins and minerals.

Table 4 shows that of the 13 non-smokers, 10 (78 %) had a normal nutritional status and a small proportion of 1 (7 %) was overweight. Meanwhile, of the 42 heavy smokers, 28 (67 %) had a nutritional status of less and a small portion of 2 (5 %) had an obese nutritional status.

The results of the Spearman Rho Test show that Asymp. Sig (2-sided) obtained a value of 0.018, which is less than or smaller than the significance value $\alpha = 0.05$. This means that it can be concluded that H1 is accepted and H0 is rejected, namely there is a relationship between active smoking in adolescent boys aged 14-16 years with nutritional status in Kertagena Tengah Village, Kadur Subdistrict, Pamekasan.

Adolescents who smoke actively tend to have an unbalanced diet, often lacking the intake of fruits, vegetables, and protein sources that are essential for growth. This smoking habit is often combined with other unhealthy lifestyles, such as fast food consumption and lack of physical activity, which further deteriorate their nutritional status. Data show that most adolescent smokers in this village are undernourished and have a low body mass index (BMI). This finding suggests that adolescent smokers do not receive sufficient nutrients to support their growth and development.

Smoking problems at an early age are usually a warning sign for future problems. Teens who smoke are three times more likely to consume alcoholic beverages, eight times more likely to use marijuana, and 22 times more likely to use cocaine than those who do not smoke (Korhonen et al., 2008). Smoking is also often associated with a range of high-risk behaviors, including fighting and casual sex. These risky behaviors can lead to a range of health and social problems, negatively impacting adolescents' future lives.

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Recent research also shows the dangers of secondhand smoke, which is cigarette smoke inhaled by non-smokers because they are around smokers, commonly referred to as passive smoking. According to a survey by the World Health Organization, there were approximately three million deaths each year due to secondhand smoke during the 1990s. According to Ababulgu et al. (2016), tobacco use is responsible for 6 million deaths globally per year, of which 600,000 are due to secondhand smoke, mainly among women and children. Tanski and Wilson ((2012) corroborated this figure, stating that, according to the World Health Organization, over 600,000 people worldwide die prematurely every year due to exposure to secondhand smoke (Ababulgu et al., 2016; Tanski & Wilson, 2012).

The cause is not only lung and heart cancer triggered by the various toxins that every puff of cigarette releases into the body but also by many other diseases caused by smoking behavior, both actively and passively. Based on this study, smoking is closely related to nutritional problems, especially in adolescents. Because adolescence is a period: "grow spurt" or the time when the body's organs are in the golden period to grow with age. During this period of adolescence, growth is hindered or hampered by several negative factors, and it is likely that it will not only threaten

the nutritional status of adolescents but will also have an unfavorable impact on the general health of the body in the future.

Smoking and nutritional status are often linked by some parties as two sides of an interconnected coin. Smoking is closely related to the unhealthy lifestyle of adolescents who are influenced by cultural factors and "imitation" factors from parents or the environment, while nutritional status has the most immediate impact on adolescents will experience related' bad smoking habits.

Smoking is one of the ways that adolescents generally use as a "friend" to fill empty time, or a "snack" when hanging out with peers. The free and easy process of buying and selling cigarettes will undoubtedly increase the attractiveness of adolescents to try cigarettes at a much younger age. Thus, the coverage of child and adolescent smokers is increasingly becoming a dilemma for the government to immediately overcome.

The study showed that a significant proportion of male adolescents aged 14-16 years in Kertagena Tengah Village, Kadur Sub-district, Pamekasan, suffered from poor nutritional status, with 69 % classified as undernourished. The contributing factors include an unbalanced diet, limited access to nutritious food, and high smoking rates among adolescents. This highlights the critical intersection of dietary habits and smoking behaviors that negatively impacts adolescent health during a pivotal growth period. Evidence based on quantitative data indicates that 38 out of 55 adolescents are undernourished, supplemented by the literature that explains how smoking impairs nutrient absorption and appetite, thereby exacerbating nutritional deficiencies.

Conclusion

The study concluded that 76 % of male adolescents in Kertagena Tengah Village were active smokers, with 69 % of these adolescents exhibiting poor nutritional status. The significant relationship between smoking and poor nutritional status ($p = 0.018$) underscored the negative impact of smoking on adolescent health. These findings call for urgent public health interventions, including comprehensive health education, stricter regulation of cigarette sales to minors, and community support, to create a smoke-free environment.

Future research should include longitudinal studies to clarify the causal link between smoking and nutritional status, broaden demographic coverage, and incorporate qualitative methods to explore the social and cultural influences on adolescent smoking. Evaluating combined nutritional and smoking cessation interventions and examining related health outcomes, such as respiratory and mental health issues, would provide a more comprehensive understanding of the impact of smoking on adolescents. Assessing the effectiveness of public health policies will also help to refine strategies to reduce adolescent smoking and improve health outcomes.

One of the primary strengths of this study was the use of a comprehensive total sampling technique, which included the entire population of adolescents aged 14-16 years in Kertagena Tengah Village. This approach ensures that the findings are highly representative of the target group, thus enhancing the validity and reliability of the results. The study's cross-sectional design allowed for a timely and cost-effective assessment of the relationship between smoking and nutritional status, providing valuable insights into the prevalence and impact of these behaviors within the community. Additionally, the study employed standardized measurement tools for assessing smoking status and nutritional outcomes, ensuring consistency in data collection, and enhancing the accuracy of the findings.

The sample was limited to a specific rural village, which may limit the generalizability of the findings to other settings such as urban areas or different cultural contexts. Additionally, the study did not control for potential confounding variables, such as socioeconomic status, dietary habits, physical activity levels, and parental influence, all of which could independently affect both smoking behavior and nutritional status.

Author Contributions: In the analysis of the relationship between active smoking among 14-16-year-old male adolescents and nutritional status in Desa Kertagena Tengah Kecamatan Kadur Pamekasan, all aspects, including conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review and editing, supervision, and project administration, were undertaken by Moh Bahmid, M. Bagus Qomaruddin, and Zainal Fatah. Software and funding acquisition were not applicable, and visualization was not performed. All authors have read and agreed to the published version of the manuscript.

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