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Original Research

Effects of Smoking Habits on Omega-3 Food Intake in Adults

Amelia Lorensia[1*], I Gede Agus Sindhu Aditama[1], Rivan Virlando Suryadinata[2], Dian Natasya Raharjo[1]

[1]Department of Community-Clinical Pharmacy, Faculty of Pharmacy, University of Surabaya, Surabaya
[2]Department Public Health Sciences, Faculty of Medicine, University of Surabaya, Surabaya

***Corresponding Author:** amelia.lorensia@gmail.com

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ABSTRACT

Smoking habits have been shown to impact omega-3 food intake, and cigarette smoke can increase lipid peroxidation through the induction of oxidative stress. Omega-3, an essential fatty acid, can be obtained through the consumption of fish, milk, eggs, and supplements. This cross-sectional research aimed to assess the relationship between omega-3 food intake and smoking habits. The research was conducted from March to June 2022 in Rungkut District, Surabaya, Indonesia. Data collected included the respondents' quantities and frequency of consuming foods containing omega-3, namely fish, milk, and eggs. Additionally, the level of nicotine dependence among smokers was evaluated using the Fagerstrom Test for Nicotine Dependence (FTND). The method for data analysis was the chi-square test. The total respondents in this study were 116 people, consisting of 41 smokers and 75 non-smokers. No significant differences were observed in the consumption patterns of omega-3-rich foods, including eggs, fish, and milk, between smokers and non-smokers ($p > 0.01$ for each food item). However, a significant difference was observed in the consumption of supplements containing omega-3 between the smoker and non-smoker groups ($p < 0.005$). However, the overall omega-3 intake did not exhibit a significant difference between smokers and non-smokers. Notably, a higher proportion of respondents who smoked reported consuming omega-3 supplements compared to the non-smoker group. Consequently, there is a need to conduct further research to identify the underlying factors that influence the habit of smokers toward consuming omega-3.

Keywords: omega-3 intake, omega-3 levels, smoking habit

INTRODUCTION

Smoking is a global health threat, carrying the risk of mortality (1). Indonesia is the sixth-largest producer of tobacco and the largest exporter of cigarettes in the world (2). Additionally, Indonesia is the third largest cigarette consumer in the world (3) and stands among the nations with the highest smoking prevalence (4,5). Despite government initiatives such as the implementation of Government Regulation No. 109, which aims to restrict cigarette advertising and curb smoking rates (6), efforts may be insufficient to deter the rising trend of young smokers. It is crucial to acknowledge that a burning cigarette releases numerous chemical compounds with harmful carcinogenic properties, and there is no safe minimum level of exposure to tobacco smoke (7).

Cigarettes consist of various kinds of chemicals that can harm health and pose significant health risks, with carcinogenic properties that contribute to the development of cancer. Some of the chemicals are nicotine,

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tar, carbon monoxide (CO), and various heavy metals (8). Nicotine, in particular, is very dangerous for health (9,10). Nicotine is addictive and is an indirect cause of decreased lung function as indicated by a gradual decrease in forced expiratory volume in one second (FEV1) values with increasing nicotine dependence (11,12).

Cigarette smoke, a source of exogenous free radicals, significantly contributes to the elevation of free radicals within the body (8). An increase in the number of free radicals in the body will trigger oxidative stress and cause peroxidation in cells, resulting in damage and death of body cells (13,14). Furthermore, the free radicals present in cigarette smoke, particularly reactive oxygen species (ROS), induce oxidative stress within the lungs (8). This oxidative stress triggers an inflammatory response, activating lung macrophages and facilitating neutrophil infiltration. Consequently, this process leads to the inactivation of the antiprotease α-AT1, an inhibitor crucial for regulating pulmonary proteases and preventing the production of pulmonary elastase (15,16,17).

Smoking habits have an impact on omega-3 levels. Cigarette smoke induces lipid peroxidation of polyunsaturated fatty acid (PUFA), which causes decreased PUFA concentrations and triggers oxidative stress (14). Low PUFA concentrations also cause dysfunction in the dopaminergic system associated with smoking dependence and craving (18,19). According to a previous study by Lorensia and Suryadinata (20), the drivers of online motorcycle taxi services or *ojek* were defined as individuals who utilize application technology in partnership with application-based transportation companies. These drivers face a potential risk of exposure to vehicle air pollution, especially considering their smoking habits. The results of the omega-3 intake assessment revealed an average total intake of foods containing omega-3 at 226.47 mg for all respondents, categorizing them into the group with insufficient omega-3 intake (<1,600 mg per day) (21,22). Cigarettes can also reduce appetite. Nicotine in cigarettes will have an effect on reducing appetite. Nicotine, rapidly absorbed into the lungs and bloodstream upon smoking, binds to nicotinic receptors in the brain, influencing ion channels and releasing various neurotransmitters, including catecholamines, dopamine, serotonin, norepinephrine, and GABA. This complex process in the central nervous system is linked to decreased appetite. The level of nicotine in the blood correlates with postsynaptic stimulation of nicotinic receptors, affecting neurotransmitter release. Previous studies have identified hormones such as dopamine, norepinephrine, and leptin as factors influencing appetite due to nicotine's impact (23). Therefore, this study explored the relationship between omega-3 food intake and smoking habits, accounting for the source and quantity of consumed foods. In addition, this study also evaluated the differences between intake of omega-3-rich foods among smokers and nonsmokers.

METHOD

This research used a cross-sectional design and was conducted in the area of Rungkut District, Surabaya, Indonesia from March to June 2022. The dependent variable was smoking habits, and the independent variable was intake of foods and supplements containing omega-3. The assessment of omega-3 intake involved evaluating the quantity and frequency of respondents' consumption of fish, milk, and eggs. The sample was active students from a private university, chosen through total sampling. Inclusion criteria included an age range of 17-30 years, no allergies to fish/milk/egg, and the absence of a special diet (vegetarian). The subjects were enrolled in health-related faculties (medicine and pharmacy) to ensure a homogeneous knowledge and lifestyle background (24). Students willing to participate were interviewed, and those meeting the research criteria became respondents after providing written informed consent.

Data collection involved interviewing respondents about the amount and frequency of fish dishes (regardless of processing method), milk, and eggs. The Fagerstrom Test for Nicotine Dependence (FTND) assessed the level of nicotine addiction in smokers, utilizing a 4-point Likert response sequence (0 = never, 1 = sometimes, 2 = most of the time, 3 = always) across six of the original FTQ

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(Fagerstrom Tolerance Questionnaire) scale items. (25).

The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 24. Descriptive statistics were used to determine frequencies of distribution, percentages, means, and standard deviations. The relationship between omega-3 food intake and smoking habits was examined using the Spearman test, while associations between omega-3-rich food intake among smokers and nonsmokers were assessed using the chi-square test. The significance level was set at $p < 0.05$. The study protocols received approval from the Human Research Ethics Committee at the University of Surabaya, Indonesia through approval No. 016-OL/KE/III/2022.

RESULT

The total respondents in this study were 116 people, consisting of 41 smokers and 75 non-smokers. The respondents had an average age of 23 years (±2.11), and most respondents did not use drugs and did not have a history of illness. Most of the respondents had a normal Body Mass Index (BMI) (Table 1).

Table 1. Characteristics of Respondents

Characteristic	Smoker (*n* = 41)	Non-smoker (*n* = 75)
Gender		
Male	40	28
Female	1	47
Age (years)		
Late adolescence (17-25)	33	60
Early adulthood (26-35)	8	12
Late adulthood (36-45)	0	2
Early seniors (46-55)	0	1
Average age (years)	23.2 4± 2.11	23.99 ± 5.33
Medication history		
Not using drugs	32	30
Vitamin supplements	8	38
Indigestion medicine	0	5
Cardiovascular medicine	0	1
Endocrine medicine	0	1
Respiratory medicine	1	0
Disease history		
None	37	59
GERD (gastroesophageal reflux disease) – Gastritis	1	8
Asthma	1	2
Hypertension	0	2
Liver disease	1	0
Scoliosis	1	0
Sinusitis	0	1
nephrotic syndrome	0	1
PCOS (polycystic ovarian syndrome)	0	1
Anemia	0	1
Body mass index (BMI) (kg/m^2)		
Underweight (BMI ≤ 18.4 kg/m^2)	6	13
Normal (BMI 18.5-25.0 kg/m^2)	24	37
Overweight (BMI 25.1-27.0 kg/m^2)	5	9
Obesity (BMI > 27 kg/m^2)	6	16

kg/m2: BMI calculated by dividing a person's weight in kilograms by the square of height in meters

Source: Primary data, 2022

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Table 2 indicates that there were no significant differences in the consumption of omega-3-rich foods, including eggs, fish, and milk, between smokers and non-smokers ($p>0.05$ for each food item). However, a significant difference was observed in the intake of omega-3 supplements between the two groups ($p<0.005$).

Table 2. Intake of foods containing omega-3

Food containing omega-3	Number of subjects consumed foods containing omega-3 (%)		*p*-value
	Smoker (n = 41)	Non-smoker (n = 75)	
Egg	38 (92.68)	72 (96.00)	0.490
Fish	32 (78.05)	51 (68.00)	0.157
Milk	34 (82.92)	59 (6.67)	0.096
Supplement	11 (26.83)	40 (53.33)	0.000*

*$p < 0.01$

Source: Primary data, 2022

The normality test results on the omega-3 and smoking habit variables obtained p-values of 0.064 and 0.004, respectively. Therefore, the Spearman rank test was employed, revealing a non-significant relationship between omega-3 food intake (eggs, fish, milk, and supplements) and smoking habit, with a correlation coefficient (rs) of 0.05 and a p-value of 0.446.

Regarding smoking habits (Table 3), most smokers initiated smoking between the ages of 15-19 (53.66%), and the majority preferred filtered cigarettes (97.56%). The Fagerstrom Test assessed smoking dependence, as presented in Table 4. A significant percentage of respondents reported smoking their first cigarette within 60 minutes of waking up in the morning (63.41%) and did not find it challenging to smoke in prohibited places, such as churches, libraries, or cinemas (95.12%). Furthermore, the majority smoked ≤10 cigarettes per day (85.37%), with a higher frequency observed in the first hours after waking up (97.56%).

Table 3. Characteristics of smokers (*n* = 41)

Characteristics	Frequency *n* (%)
Age started smoking (years)	
10-14	5 (12.19)
15-19	22 (53.66)
20-24	13 (31.71)
30-34	1 (2.44)
Type of cigarette	
Filter	40 (97.56)
Non-filtered	1 (2.44)

Source: Primary data, 2022

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Table 4. Answer profile of Fagerstrom Test Questionnaire (*n* = 41)

Question of Fagerstrom Test Questionnaire	Frequency *n* (%)
1. How soon after you woke up did you smoke your first cigarette?	
In 5 minutes	4 (9.76)
6-30 minutes	6 (14.63)
31-60 minutes	5 (12.20)
After 60 minutes	26 (63.41)
2. Do you find it difficult to refrain from smoking in prohibited places (e.g., at church, in the library, at the cinema)?	
Yes	2 (4.88)
No	39 (95.12)
3. Which cigarette was the most difficult for you to give up?	
The first in the morning	6 (14.63)
Other	35 (85.37)
4. How many cigarettes per day do you smoke?	
≤10	35 (85.37)
11-20	5 (12.20)
21-30	1 (2.44)
5. Do you smoke more often in the first hours after waking up than at any other time?	
Yes	5 (12.20)
No	36 (87.80)
6. Do you smoke when you are so sick that you are in bed most of the day?	
Yes	1 (2.44)
No	40 (97.56)

Source: Primary data, 2022

Table 5 shows the classification of the Fagerstrom test, revealing that most of the respondents showed low dependence (46.34%) and very low dependence on cigarette addiction (41.46%). In addition, there were no respondents who experienced very high dependence.

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Table 5. Classification of smokers based on Fagerstrom test score

Category (Fagerstrom test score)	Frequency *n* (%)
Very low dependence (0-2)	71 (41.46)
Low dependence (3-4)	19 (46.34)
Medium dependence (5)	4 (9.76)
High dependence (6-7)	1 (2.44)
Very high dependence (8-10)	0

DISCUSSION

Smoking is a problem for those who are addicted to smoking cigarettes (26,27). Nicotine, the primary component in cigarettes, is responsible for causing dependence on cigarettes. Nicotine stimulates acetylcholine receptors on dopamine-containing neurons. This stimulation triggers a surge in dopamine within the brain's reward system. The pattern typically involves reaching peak nicotine levels, a transient activation of the brain reward system, followed by a gradual decline in nicotine levels leading to withdrawal symptoms that can only be alleviated by smoking another cigarette. Efforts to reduce or quit smoking often cause symptoms of anxiety and restlessness. Particularly, the longer nicotine remains in the body, the stronger the smoking behavior becomes, intensifying the challenge of stopping the habit (28).

Omega-3, an essential unsaturated fatty acid needed for the body's tissues, cannot be made by the body and requires external intake, commonly through the consumption of fish such as salmon, lobster, mackerel, herring, and cod (29,130). However, the utilization of omega-3 supplements is still limited due to factors such as cost, fishy odor, and the pill's size (31,32). The dopamine mesocorticolimbic pathway is affected by a deficiency in omega-3, that triggers dopamine withdrawal, leading to nicotine addiction (33). Intake of food and supplements containing omega-3 has an important role in reducing smoking habits, by normalizing the dopaminergic system and reducing the effects of addiction (34). Omega-3 can play a role in smoking termination since omega-3 fatty acids are effective in significantly reducing the desire to smoke.

The brain is vulnerable to oxidative stress due to high metabolic activity and the susceptibility of PUFA to free radical attack, so smoking can also reduce levels of omega-3 (PUFA) in brain tissue (345,356,367,37). In a cross-sectional study conducted by Scaglia *et al.* (35) at a Toronto Hospital, on 50 smokers and 50 non-smokers, it was found that smokers had lower levels of docosahexaenoic acid (DHA) than nonsmokers. Natural fatty acids including omega-3 fatty acids were EPA and DHA (389,39).

Cigarette smoke can increase lipid peroxidation from polyunsaturated fatty acid (PUFA) by triggering oxidative stress and resulting in a decrease in PUFA concentration. This elevation in nicotine levels further impedes efforts toward smoking cessation (34,36). An experimental study on animals has shown that both active smoking and exposure to secondhand smoke are linked to lower PUFA levels in mice and humans; however, an omega-3 index of approximately 8% in mice has vasoprotective and antioxidant properties (40). Previous research conducted by Scaglia *et al.*, which explored the association between omega-3 level in the body and smoking habit, showed that smokers ate less fish rich in omega-3 fatty acids than non-smokers, showing an inverse and significant relationship between omega-3 intake and smoking (35).

Omega-3 and smoking habits have a strong relationship. Considering that smoking habits can impact omega-3 levels and low concentrations of omega-3 polyunsaturated fatty acids (PUFA) may disrupt nerve

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transmission, leading to the hypofunction of the mesocortical system associated with dependency mechanisms, there is a potential for an increased desire to smoke; thus, in turn, hinders efforts to quit smoking (36). So, increasing consumption of omega-3 can be a perspective in the prevention or treatment of smoking. However, there is a lack of research on the role of omega-3 in assisting active smokers in quitting in Indonesia.

CONCLUSION

In short, there was no difference in eating patterns containing omega-3 between smokers and non-smokers, including the consumption of eggs, fish, and milk, with a p-value exceeding 0.05 for each food item. However, there was a difference in the intake of supplements containing omega-3 between the two groups. A higher proportion of smokers reported consuming supplements containing omega-3 compared to the non-smoker group. This causes an increased risk of impaired lung function due to smoking, which still needs further research.

Author contributions

Each author made equal contributions to this paper, including the conception and design of the study, literature review and analysis, drafting, critical revision and editing, and approval of the final version.

Declaration of Conflict of Interest

The authors declare no conflict of interest.

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Data availability

The data that support the findings of this study are available from the corresponding author.

Ethical clearance

The research protocols were approved by the Human Research Ethics Committee, University of Surabaya, Surabaya, Indonesia (approval No. 016-OL/KE/III/2022).

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by Amelia Lorensia

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Original Research

Effects of Smoking Habits on Omega-3 Food Intake in Adults

Amelia Lorensia[1*], I Gede Agus Sindhu Aditama[1], Rivan Virlando Suryadinata[2], Dian Natasya Raharjo[1]

[1]Department of Community-Clinical Pharmacy, Faculty of Pharmacy, University of Surabaya, Surabaya
[2]Department Public Health Sciences, Faculty of Medicine, University of Surabaya, Surabaya

***Corresponding Author:** amelia.lorensia@gmail.com

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ABSTRACT

Smoking habits have been shown to impact omega-3 food intake, and cigarette smoke can increase lipid peroxidation through the induction of oxidative stress. Omega-3, an essential fatty acid, can be obtained through the consumption of fish, milk, eggs, and supplements. This cross-sectional research aimed to assess the relationship between omega-3 food intake and smoking habits. The research was conducted from March to June 2022 in Rungkut District, Surabaya, Indonesia. Data collected included the respondents' quantities and frequency of consuming foods containing omega-3, namely fish, milk, and eggs. Additionally, the level of nicotine dependence among smokers was evaluated using the Fagerstrom Test for Nicotine Dependence (FTND). The method for data analysis was the chi-square test. The total respondents in this study were 116 people, consisting of 41 smokers and 75 non-smokers. No significant differences were observed in the consumption patterns of omega-3-rich foods, including eggs, fish, and milk, between smokers and non-smokers ($p > 0.01$ for each food item). However, a significant difference was observed in the consumption of supplements containing omega-3 between the smoker and non-smoker groups ($p < 0.005$). However, the overall omega-3 intake did not exhibit a significant difference between smokers and non-smokers. Notably, a higher proportion of respondents who smoked reported consuming omega-3 supplements compared to the non-smoker group. Consequently, there is a need to conduct further research to identify the underlying factors that influence the habit of smokers toward consuming omega-3.

Keywords: omega-3 intake, omega-3 levels, smoking habit

INTRODUCTION

Smoking is a global health threat, carrying the risk of mortality (1). Indonesia is the sixth-largest producer of tobacco and the largest exporter of cigarettes in the world (2). Additionally, Indonesia is the third largest cigarette consumer in the world (3) and stands among the nations with the highest smoking prevalence (4,5). Despite government initiatives such as the implementation of Government Regulation No. 109, which aims to restrict cigarette advertising and curb smoking rates (6), efforts may be insufficient to deter the rising trend of young smokers. It is crucial to acknowledge that a burning cigarette releases numerous chemical compounds with harmful carcinogenic properties, and there is no safe minimum level of exposure to tobacco smoke (7).

Cigarettes consist of various kinds of chemicals that can harm health and pose significant health risks, with carcinogenic properties that contribute to the development of cancer. Some of the chemicals are nicotine,

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tar, carbon monoxide (CO), and various heavy metals (8). Nicotine, in particular, is very dangerous for health (9,10). Nicotine is addictive and is an indirect cause of decreased lung function as indicated by a gradual decrease in forced expiratory volume in one second (FEV1) values with increasing nicotine dependence (11,12).

Cigarette smoke, a source of exogenous free radicals, significantly contributes to the elevation of free radicals within the body (8). An increase in the number of free radicals in the body will trigger oxidative stress and cause peroxidation in cells, resulting in damage and death of body cells (13,14). Furthermore, the free radicals present in cigarette smoke, particularly reactive oxygen species (ROS), induce oxidative stress within the lungs (8). This oxidative stress triggers an inflammatory response, activating lung macrophages and facilitating neutrophil infiltration. Consequently, this process leads to the inactivation of the antiprotease α-AT1, an inhibitor crucial for regulating pulmonary proteases and preventing the production of pulmonary elastase (15,16,17).

Smoking habits have an impact on omega-3 levels. Cigarette smoke induces lipid peroxidation of polyunsaturated fatty acid (PUFA), which causes decreased PUFA concentrations and triggers oxidative stress (14). Low PUFA concentrations also cause dysfunction in the dopaminergic system associated with smoking dependence and craving (18,19). According to a previous study by Lorensia and Suryadinata (20), the drivers of online motorcycle taxi services or *ojek* were defined as individuals who utilize application technology in partnership with application-based transportation companies. These drivers face a potential risk of exposure to vehicle air pollution, especially considering their smoking habits. The results of the omega-3 intake assessment revealed an average total intake of foods containing omega-3 at 226.47 mg for all respondents, categorizing them into the group with insufficient omega-3 intake (<1,600 mg per day) (21,22). Cigarettes can also reduce appetite. Nicotine in cigarettes will have an effect on reducing appetite. Nicotine, rapidly absorbed into the lungs and bloodstream upon smoking, binds to nicotinic receptors in the brain, influencing ion channels and releasing various neurotransmitters, including catecholamines, dopamine, serotonin, norepinephrine, and GABA. This complex process in the central nervous system is linked to decreased appetite. The level of nicotine in the blood correlates with postsynaptic stimulation of nicotinic receptors, affecting neurotransmitter release. Previous studies have identified hormones such as dopamine, norepinephrine, and leptin as factors influencing appetite due to nicotine's impact (23). Therefore, this study explored the relationship between omega-3 food intake and smoking habits, accounting for the source and quantity of consumed foods. In addition, this study also evaluated the differences between intake of omega-3-rich foods among smokers and nonsmokers.

METHOD

This research used a cross-sectional design and was conducted in the area of Rungkut District, Surabaya, Indonesia from March to June 2022. The dependent variable was smoking habits, and the independent variable was intake of foods and supplements containing omega-3. The assessment of omega-3 intake involved evaluating the quantity and frequency of respondents' consumption of fish, milk, and eggs. The sample was active students from a private university, chosen through total sampling. Inclusion criteria included an age range of 17-30 years, no allergies to fish/milk/egg, and the absence of a special diet (vegetarian). The subjects were enrolled in health-related faculties (medicine and pharmacy) to ensure a homogeneous knowledge and lifestyle background (24). Students willing to participate were interviewed, and those meeting the research criteria became respondents after providing written informed consent.

Data collection involved interviewing respondents about the amount and frequency of fish dishes (regardless of processing method), milk, and eggs. The Fagerstrom Test for Nicotine Dependence (FTND) assessed the level of nicotine addiction in smokers, utilizing a 4-point Likert response sequence (0 = never, 1 = sometimes, 2 = most of the time, 3 = always) across six of the original FTQ

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(Fagerstrom Tolerance Questionnaire) scale items. (25).

The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 24. Descriptive statistics were used to determine frequencies of distribution, percentages, means, and standard deviations. The relationship between omega-3 food intake and smoking habits was examined using the Spearman test, while associations between omega-3-rich food intake among smokers and nonsmokers were assessed using the chi-square test. The significance level was set at $p < 0.05$. The study protocols received approval from the Human Research Ethics Committee at the University of Surabaya, Indonesia through approval No. 016-OL/KE/III/2022.

RESULT

The total respondents in this study were 116 people, consisting of 41 smokers and 75 non-smokers. The respondents had an average age of 23 years (±2.11), and most respondents did not use drugs and did not have a history of illness. Most of the respondents had a normal Body Mass Index (BMI) (Table 1).

Table 1. Characteristics of Respondents

Characteristic	Smoker (n = 41)	Non-smoker (n = 75)
Gender		
Male	40	28
Female	1	47
Age (years)		
Late adolescence (17-25)	33	60
Early adulthood (26-35)	8	12
Late adulthood (36-45)	0	2
Early seniors (46-55)	0	1
Average age (years)	23.2 4± 2.11	23.99 ± 5.33
Medication history		
Not using drugs	32	30
Vitamin supplements	8	38
Indigestion medicine	0	5
Cardiovascular medicine	0	1
Endocrine medicine	0	1
Respiratory medicine	1	0
Disease history		
None	37	59
GERD (gastroesophageal reflux disease) – Gastritis	1	8
Asthma	1	2
Hypertension	0	2
Liver disease	1	0
Scoliosis	1	0
Sinusitis	0	1
nephrotic syndrome	0	1
PCOS (polycystic ovarian syndrome)	0	1
Anemia	0	1
Body mass index (BMI) (kg/m^2)		
Underweight (BMI ≤ 18.4 kg/m^2)	6	13
Normal (BMI 18.5-25.0 kg/m^2)	24	37
Overweight (BMI 25.1-27.0 kg/m^2)	5	9
Obesity (BMI > 27 kg/m^2)	6	16

kg/m2: BMI calculated by dividing a person's weight in kilograms by the square of height in meters

Source: Primary data, 2022

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Table 2 indicates that there were no significant differences in the consumption of omega-3-rich foods, including eggs, fish, and milk, between smokers and non-smokers ($p>0.05$ for each food item). However, a significant difference was observed in the intake of omega-3 supplements between the two groups ($p<0.005$).

Table 2. Intake of foods containing omega-3

Food containing omega-3	Number of subjects consumed foods containing omega-3 (%)		*p*-value
	Smoker (n = 41)	Non-smoker (n = 75)	
Egg	38 (92.68)	72 (96.00)	0.490
Fish	32 (78.05)	51 (68.00)	0.157
Milk	34 (82.92)	59 (6.67)	0.096
Supplement	11 (26.83)	40 (53.33)	0.000*

*$p < 0.01$

Source: Primary data, 2022

The normality test results on the omega-3 and smoking habit variables obtained p-values of 0.064 and 0.004, respectively. Therefore, the Spearman rank test was employed, revealing a non-significant relationship between omega-3 food intake (eggs, fish, milk, and supplements) and smoking habit, with a correlation coefficient (rs) of 0.05 and a p-value of 0.446.

Regarding smoking habits (Table 3), most smokers initiated smoking between the ages of 15-19 (53.66%), and the majority preferred filtered cigarettes (97.56%). The Fagerstrom Test assessed smoking dependence, as presented in Table 4. A significant percentage of respondents reported smoking their first cigarette within 60 minutes of waking up in the morning (63.41%) and did not find it challenging to smoke in prohibited places, such as churches, libraries, or cinemas (95.12%). Furthermore, the majority smoked ≤10 cigarettes per day (85.37%), with a higher frequency observed in the first hours after waking up (97.56%).

Table 3. Characteristics of smokers (*n* = 41)

Characteristics	Frequency *n* (%)
Age started smoking (years)	
10-14	5 (12.19)
15-19	22 (53.66)
20-24	13 (31.71)
30-34	1 (2.44)
Type of cigarette	
Filter	40 (97.56)
Non-filtered	1 (2.44)

Source: Primary data, 2022

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Table 4. Answer profile of Fagerstrom Test Questionnaire (n = 41)

Question of Fagerstrom Test Questionnaire	Frequency n (%)
1. How soon after you woke up did you smoke your first cigarette?	
In 5 minutes	4 (9.76)
6-30 minutes	6 (14.63)
31-60 minutes	5 (12.20)
After 60 minutes	26 (63.41)
2. Do you find it difficult to refrain from smoking in prohibited places (e.g., at church, in the library, at the cinema)?	
Yes	2 (4.88)
No	39 (95.12)
3. Which cigarette was the most difficult for you to give up?	
The first in the morning	6 (14.63)
Other	35 (85.37)
4. How many cigarettes per day do you smoke?	
≤10	35 (85.37)
11-20	5 (12.20)
21-30	1 (2.44)
5. Do you smoke more often in the first hours after waking up than at any other time?	
Yes	5 (12.20)
No	36 (87.80)
6. Do you smoke when you are so sick that you are in bed most of the day?	
Yes	1 (2.44)
No	40 (97.56)

Source: Primary data, 2022

Table 5 shows the classification of the Fagerstrom test, revealing that most of the respondents showed low dependence (46.34%) and very low dependence on cigarette addiction (41.46%). In addition, there were no respondents who experienced very high dependence.

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Table 5. Classification of smokers based on Fagerstrom test score

Category (Fagerstrom test score)	Frequency *n* (%)
Very low dependence (0-2)	71 (41.46)
Low dependence (3-4)	19 (46.34)
Medium dependence (5)	4 (9.76)
High dependence (6-7)	1 (2.44)
Very high dependence (8-10)	0

DISCUSSION

Smoking is a problem for those who are addicted to smoking cigarettes (26,27). Nicotine, the primary component in cigarettes, is responsible for causing dependence on cigarettes. Nicotine stimulates acetylcholine receptors on dopamine-containing neurons. This stimulation triggers a surge in dopamine within the brain's reward system. The pattern typically involves reaching peak nicotine levels, a transient activation of the brain reward system, followed by a gradual decline in nicotine levels leading to withdrawal symptoms that can only be alleviated by smoking another cigarette. Efforts to reduce or quit smoking often cause symptoms of anxiety and restlessness. Particularly, the longer nicotine remains in the body, the stronger the smoking behavior becomes, intensifying the challenge of stopping the habit (28).

Omega-3, an essential unsaturated fatty acid needed for the body's tissues, cannot be made by the body and requires external intake, commonly through the consumption of fish such as salmon, lobster, mackerel, herring, and cod (29,130). However, the utilization of omega-3 supplements is still limited due to factors such as cost, fishy odor, and the pill's size (31,32). The dopamine mesocorticolimbic pathway is affected by a deficiency in omega-3, that triggers dopamine withdrawal, leading to nicotine addiction (33). Intake of food and supplements containing omega-3 has an important role in reducing smoking habits, by normalizing the dopaminergic system and reducing the effects of addiction (34). Omega-3 can play a role in smoking termination since omega-3 fatty acids are effective in significantly reducing the desire to smoke.

The brain is vulnerable to oxidative stress due to high metabolic activity and the susceptibility of PUFA to free radical attack, so smoking can also reduce levels of omega-3 (PUFA) in brain tissue (345,356,367,37). In a cross-sectional study conducted by Scaglia *et al.* (35) at a Toronto Hospital, on 50 smokers and 50 non-smokers, it was found that smokers had lower levels of docosahexaenoic acid (DHA) than nonsmokers. Natural fatty acids including omega-3 fatty acids were EPA and DHA (389,39).

Cigarette smoke can increase lipid peroxidation from polyunsaturated fatty acid (PUFA) by triggering oxidative stress and resulting in a decrease in PUFA concentration. This elevation in nicotine levels further impedes efforts toward smoking cessation (34,36). An experimental study on animals has shown that both active smoking and exposure to secondhand smoke are linked to lower PUFA levels in mice and humans; however, an omega-3 index of approximately 8% in mice has vasoprotective and antioxidant properties (40). Previous research conducted by Scaglia *et al.*, which explored the association between omega-3 level in the body and smoking habit, showed that smokers ate less fish rich in omega-3 fatty acids than non-smokers, showing an inverse and significant relationship between omega-3 intake and smoking (35).

Omega-3 and smoking habits have a strong relationship. Considering that smoking habits can impact omega-3 levels and low concentrations of omega-3 polyunsaturated fatty acids (PUFA) may disrupt nerve

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transmission, leading to the hypofunction of the mesocortical system associated with dependency mechanisms, there is a potential for an increased desire to smoke; thus, in turn, hinders efforts to quit smoking (36). So, increasing consumption of omega-3 can be a perspective in the prevention or treatment of smoking. However, there is a lack of research on the role of omega-3 in assisting active smokers in quitting in Indonesia.

CONCLUSION

In short, there was no difference in eating patterns containing omega-3 between smokers and non-smokers, including the consumption of eggs, fish, and milk, with a p-value exceeding 0.05 for each food item. However, there was a difference in the intake of supplements containing omega-3 between the two groups. A higher proportion of smokers reported consuming supplements containing omega-3 compared to the non-smoker group. This causes an increased risk of impaired lung function due to smoking, which still needs further research.

Author contributions

Each author made equal contributions to this paper, including the conception and design of the study, literature review and analysis, drafting, critical revision and editing, and approval of the final version.

Declaration of Conflict of Interest

The authors declare no conflict of interest.

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Data availability

The data that support the findings of this study are available from the corresponding author.

Ethical clearance

The research protocols were approved by the Human Research Ethics Committee, University of Surabaya, Surabaya, Indonesia (approval No. 016-OL/KE/III/2022).

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