



Comparison of Root Mean Square of Successive Differences (RMSSD) Among Adolescent Smokers and Nonsmokers in Yogyakarta

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Smoking induced the Autonomic Nervous System (ANS) imbalance and hyperactivity. Therefore it influences the level Root Mean Square of Successive Differences (RMSSD). RMSSD interpretation describes parasympathetic activation by variation one beat to beat. Chronic smokers have lower RMSSD than nonsmokers so they have high risk for cardiac sudden death than nonsmokers by lower RMSSD. Adolescent have higher risk of smoking habits. Therefore, they have higher risk for Non Communicable Disease (NCD) in the future. The objective of this study was to know the Comparison of Root Mean Square of Successive Differences (RMSSD) among adolescent smokers and nonsmokers in Yogyakarta. Twenty-nine adolescent whose ages ranged from 18–24 years old, served as the participant for this study, nonsmokers and smokers. They were dividing into 2 groups, twenty nonsmokers and nine smokers. The participant were instructed that the last meal is 2 hours before executed; to abstain from consuming tea, alcohol and caffeine; and no heavy physical activity in the last 2 hours. They must be in relaxing condition. First, they must sit in quite room before executed. Each participant sat with head no more than 15 degree, feet placed on the back. They can close their eyes. After the participant ready, they were recorded for 5 minutes by ECG. Then, RMSSD level was counted by the formula. Result for this study was there are significant differences of the level RMSSD between adolescent nonsmokers and smokers with p value 0.04 ($p < 0.05$). The Mean and Deviation Standard of RMSSD level of adolescent nonsmokers and smokers are 60.89 ± 15.34 and 58.54 ± 4.86 . The levels RMSSD of adolescent smokers lower than nonsmokers.

Keywords: RMSSD, Adolescent Smokers, Adolescent Nonsmoker.

1. INTRODUCTION

Smoking is an unhealthy lifestyle and causes some Non Communicable Diseases (NCD) such as cardiovascular diseases, Diabetes Mellitus (DM) and cancer.¹ Furthermore, smokers have a higher risk for cardiac sudden death than nonsmokers.² World Health Organization (WHO) statistics shows 885×10^6 death by ischemic heart disease, 466×10^6 death by cardiovascular diseases, 154×10^6 death by lower respiratory infection.³ It happened because smoking could make Autonomic Nervous System (ANS) imbalances.⁴ The nervous system divided into peripheral nervous system, autonomic nervous system and central nervous systems.⁵ Sympathetic and parasympathetic nervous system were part of ANS which their systems typically in opposite action⁶ and controlled the body function involuntary.⁵ Although it act in opposite action, however they should act synergy that the ANS act in balance condition.⁵ But, it could be different in ANS imbalance. People with ANS imbalances indicated by hyperactivity of sympathetic nervous system⁴ and poor adaptability.⁷ It was

occurred when ANS damaged. When it was happened, then the ANS couldn't act synergy. As a result it.

Influences the level of Heart Rate Variability (HRV).⁸ HRV is a measuring instrument to know the balance of the ANS.⁴ HRV also could be used to be a marker for ANS adaptability.⁷ Chronic smokers have lower HRV than nonsmokers. It means that they have higher risk for cardiac sudden death than nonsmokers.

A Low HRV caused by chemical substance (nicotine) in cigarette.⁴ Nicotine is psychoactive ingredient from tobacco which have role for addiction⁹ and represent the ANS change. Some studies shows that cigarette smoking increases venous plasma levels which is the principal of sympathetic neurotransmitter, norepinephrine and epinephrine.¹⁰ When nicotine entered the body, it can increase blood pressure, heart rate by increased sympathetic nervous system activation and lowered parasympathetic nervous system.¹¹ Activation of sympathetic nervous system can lowered HRV while activation of parasympathetic nervous system can increased HRV.⁴ Then, chronic smoking

habits will lead the ANS imbalance in the future and make it worst. Therefore, higher HRV shows the good cardiovascular system but lower HRV shows the poor cardiovascular system.¹²

Heart Rate Variability (HRV) is very accessible, non-invasive, no pain, economic and simple measurement. Task Force created a set of gold standards in terms of time measurement durations for 5 min and measured by Electrocardiogram (ECG).^{13,14} Heart Rate Variability (HRV) have 2 domains; they are frequency domain and time domain.¹⁵ Frequency domain consist of Low Frequency (LF) and High Frequency (HF) which shows the balances of sympathetic and parasympathetic nervous system.¹⁶ Time domains consist of Standard Deviation of *N–N* Interval (SDNN) and RMSSD.

RMSSD interpretation answered parasympathetic activity by variation of beat to beat.^{17–19} It is a part of short term variation of HRV.¹⁶ Therefore, it has high correlated with vagal tone mechanism that HRV is able to index vagal tone which contributes in cardiac regulation.²⁰ A part of ANS which contributes in cardiac regulation is parasympathetic nervous system.²¹ The main nerve of the parasympathetic nervous system is vagus nerve.²² Then, the higher vagal tone showed the better emotional and health regulation.²³

A low RMSSD increases the risk of sudden death because of short term variation of HRV.¹⁷ However, high level of HRV decreases the risk for mortality and morbidity.²⁴ Healthy life style may contribute to high level HRV such as good physical activities, no smoking, no alcohol, low stress level, etc. WHO shows the statistic value that adolescent was the higher smoking habits.¹ In Indonesia there are 27,2% smokers in age 20–24 years; 11,2% smokers in age 15–19 years. Therefore, the high level of smoking habit in adolescent increases a risk for NCD. The purpose for this study was to know the level of RMSSD differences in adolescent smokers and nonsmokers in Yogyakarta, Indonesia.

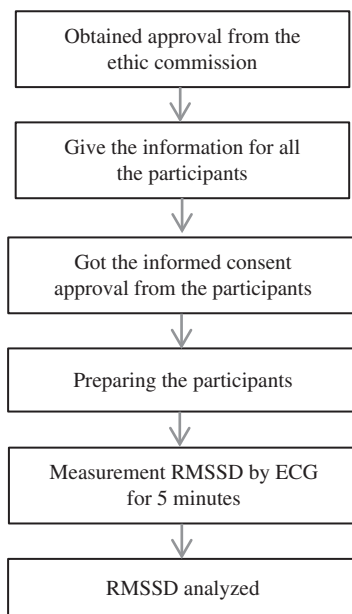


Fig. 1. Research steps.

Table I. Age distribution of adolescence nonsmokers in Yogyakarta, Indonesia (N = 20).

Age	N	Mean ± SD	Percentage (%)
18–20	3	19.33 ± 0.577	15
21–24	17	22.58 ± 0.93	85
Total	20		100

2. EXPERIMENTAL DETAILS

2.1. Participant

Twenty-nine adolescent whose ages ranged from 18–24 years old, served as the participant for this study, nonsmokers and smokers. They were dividing into 2 groups, twenty nonsmokers and nine smokers. In this study, the variables are stable and transient such as age and gender,²⁵ smoking.²⁶

2.2. Procedure

2.2.1. First

Before collect data, this study was conducted the way of with protecting the human rights of all the participants and obtained approval from the Ethic Commission of Faculty of Medicine and Health Sciences Universitas Muhammadiyah Yogyakarta with the number 068/EP-FKIK-UMY/II/2017. All of the participants received about the information and being asked and written consent in the informed consent paper. Then, the participant completed their informed consent before their experiment.

2.2.2. Second

The experiment was executed on 8 am until 12 am on May 2016. The participant were instructed that the last meal is 2 hours before executed; to abstain from consuming tea, alcohol and caffeine²⁷ 2 hours before executed;²⁸ ask if the participant needs to go to bathroom before executed²⁹ and no heavy physical activity in the last 2 hours. They must be in relaxing condition. First, they must sit in quite room before executed.³⁰

2.2.3. Third

HRV measurement is very accessible, non-invasive, no pain, economic and simple measurement. Each participant sat with head no more than 15 degree, feet placed on the back. They can close their eyes. After the participant ready, they were recorded for

Table II. Age distribution of adolescent smokers in Yogyakarta, Indonesia (N = 9).

Age	N	Mean ± SD	Percentage (%)
18–20	2	19.50 ± 0.70	22.22
21–24	7	22.85 ± 0.69	77.77
Total	9		100

Table III. Gender characteristic in adolescent nonsmokers in Yogyakarta, Indonesia (N = 20).

Gender	N	Percentage (%)
Male	18	90
Female	2	10
Total	20	100

Table IV. Gender characteristic in adolescent smokers in Yogyakarta, Indonesia (N = 9).

Gender	N	Percentage (%)
Male	9	100
Female	0	0
Total	9	100

5 minutes by ECG. The results are beat to beat interval, Total Heart Beat (THB), Mean $N-N$.³⁰

2.2.4. Fourth

RMSSD Analysis. After all of the participant being executed, then RMSSD level was counted by the formula. The research steps is described in Figure 1. The result based on this criteria: poor <20 ms, fair 20–40 ms, average 41–60 ms, good 61–80 ms, excellent >80 ms. The data was analyzed by Mann Whitney Test to know the comparison of RMSSD between nonsmokers and smokers in Yogyakarta.

3. RESULTS AND DISCUSSION

Age distribution of adolescent nonsmokers was shown in Table I. The result revealed that almost of the adolescent age is between 21–24 years old (85%).

Age distribution of adolescent smokers was shown in Table II. The result revealed that almost of the adolescent age is between 21–24 years old (77.77%).

Gender distribution of adolescent nonsmokers was shown in Table III. The result revealed that almost of the adolescent nonsmokers’s gender is male (90%).

Gender distribution of adolescent smokers was shown in Table IV. The result revealed that almost the adolescent smokers’s gender is male (100%).

Gender contributed in RMSSD levels in adolescent nonsmokers and smokers was shown in Table V. Mean of RMSSD level in females higher than males. However, there are no significant differences between RMSSD level in females and males.

The level of RMSSD in adolescent nonsmokers was shown in Table VI. The result revealed that almost of adolescent nonsmokers have a good level of RMSSD with mean \pm SD is 68.56 ± 3.75 , and then they have lower risk factor to sudden death and NCD in the future.¹² Most of the adolescent nonsmokers have good levels of RMSSD.

The level of RMSSD in adolescent smokers was shown in Table VII. The results revealed that in adolescent smokers have a good and average level of RMSSD. Most of the adolescent nonsmokers have average levels of RMSSD.

The differences level of RMSSD in adolescent nonsmokers and smokers shown in Table VIII. There was significant a difference the level of RMSSD in adolescent nonsmokers and smokers with p value 0.04 ($p < 0.05$) (Table VIII). The level of

Table V. RMSSD level and gender in adolescent nonsmokers and smokers in Yogyakarta, Indonesia (N = 29).

RMSSD	N	Mean \pm SD (ms)	Percentage (%)	P value
Males	27	59.70 ± 13.31	93.1	0.6
Females	2	66.38 ± 2.1	0.06	
Total	29		100	

Table VI. RMSSD level in adolescent nonsmokers in Yogyakarta, Indonesia (N = 20).

RMSSD	N	Mean \pm SD (ms)	Percentage (%)
Good	15	68.56 ± 3.75	75
Average	2	51.34 ± 7.12	10
Fair	3	28.90 ± 6.66	15
Total	20		100

RMSSD in adolescent nonsmokers was higher than smokers (Fig. 2).

4. DISCUSSION

4.1. RMSSD Level and Age

HRV is a variation of beat to beat in the heart rate which is interpreted of sympathetic and parasympathetic nerve activity in vagus nerve of the heart.³¹ RMSSD is a part of HRV which is reflected vagal tone mechanism. Vagal tone mechanism is the cardiac vagal control that reflected cardiac functioning²⁰ that influences by age. Another study revealed that mean of HRV in adolescent by age are 10–19 years old is 53 ± 17 ms and 20–29 years old is 43 ± 19 ms.²⁵ Cardiac functioning in adolescent is better than adult by the anatomical structure, however in aging process is associated with significant changes of anatomical structure of heart. As a result, in adolescent, they still have a good vagal tone and anatomical structure. Because of that reason, RMSSD score of the adolescent were still in the good levels (Tables VI and VII).

4.2. RMSSD Level and Gender

Gender contributes variation of RMSSD. It is because the hormonal situation which leading the differences between gender. In young age the variation of beat to beat interval between males and females that males have higher sympathetic and lower parasympathetic activity than females.³² There are two females and twenty-seven males participants in this study. Mean of RMSSD in females higher than males (Table V). However, there are no significant differences between RMSSD level in adolescents females and males (Table V).

4.3. RMSSD Level in Adolescent Nonsmokers in Yogyakarta

This study showed almost of nonsmokers RMSSD level was good (Table VI). With the result that they have lower risk factor to sudden death, NCD in the future¹² and lower risk for autonomic dysfunction. Another study showed that participants whose succeed quit smoking had improvement the level of HRV.⁴ From above, smoking could decrease the level of RMSSD.

Table VII. RMSSD level in adolescent smokers in Yogyakarta, Indonesia (N = 9).

RMSSD	N	Mean \pm SD (ms)	Percentage (%)
Good	3	64.54 ± 3.70	33.33
Average	6	55.55 ± 0.00	66.66
Total	9		100

Table VIII. Mann Whitney test for levels of RMSSD between adolescent nonsmokers and smokers in Yogyakarta, Indonesia.

	Mean RMSSD ± SD in adolescent nonsmokers (ms)	Mean RMSSD ± SD in adolescent smokers (ms)	P value
The differences of RMSSD between adolescent smokers and nonsmokers	60.89 ± 15.34	58.54 ± 4.86	0.04

4.4. RMSSD Level in Adolescent Smokers in Yogyakarta

Smoking is an unhealthy lifestyle and causes some NCD such as cardiovascular diseases, Diabetes Mellitus (DM) and cancer.¹ It makes the ANS imbalance and hyperactivity. Nicotine is an ingredient for cigarette which increases venous plasma levels and hyperactivity of sympathetic nervous systems.

The result from this study, we can tell that smoking habits has role to decrease the level of RMSSD. It happened because chemical substances in cigarette.⁴ They could make RMSSD lower by decreased the role of autonomic function.⁴ The chronic of smoking habits will lead to decreasing the level of RMSSD later and ANS imbalance.⁴ Other than that, there is factor that influenced the level of RMSSD such as age.³³ The older of age will decreasing the level of HRV.³³ This study was done in adolescent smokers, so they still has a good and average level of RMSSD (Table VII). Because they are still young, so the ANS was still having a good adaptability.

4.5. Comparison of RMSSD Among Adolescent Smokers and Nonsmokers in Yogyakarta

The level of RMSSD in adolescent nonsmokers and smokers are good and average level (Tables VI and VII) but Mann Whitney Test result that there are differences level between RMSSD in adolescent nonsmokers and smokers (Table VIII and Fig. 2). However, the *p* value of RMSSD between adolescent nonsmokers and smoker still different (Table VIII) with mean levels in adolescent smoker was lower than adolescent nonsmokers (Fig. 2). Smoking would decrease the level of RMSSD by autonomic dysfunction. Another study revealed that nonsmokers have high level of HRV.³⁴ From this above smoking habits has a role to make ANS imbalance than make the lower HRV.⁴ Adolescent smokers have higher risk for NCD than nonsmokers. Therefore, smokers have higher risk for NCD than nonsmokers with lower RMSSD.

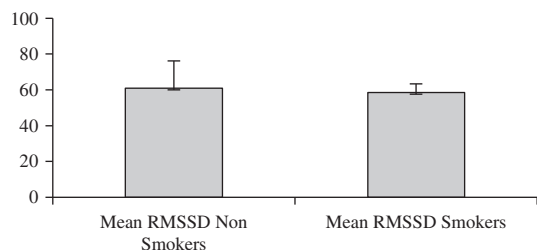


Fig. 2. Mean and standard deviation the level of RMSSD among adolescent nonsmokers and smokers.

5. CONCLUSION

Smoking is unhealthy lifestyle and has a role to make ANS imbalance by decreasing RMSSD. It could happen because of the cigarette substances. They could decrease the level of RMSSD, and then the people with lower RMSSD have higher risk for NCD. Result of this study are smoking decreased the level of RMSSD. Result for this study was there are significant differences of the level RMSSD between adolescent nonsmokers and smokers with *p* value 0.04 (*p* < 0.05). The Mean and Deviation Standard of RMSSD level of adolescent nonsmokers compare with adolescent smokers are 60.89 ± 15.34 and 58.54 ± 4.86. The levels RMSSD of adolescent smokers lower than nonsmokers.

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