

CIGARETTE DEPENDENCE AND CARDIOVASCULAR ENDURANCE IN YOUNG ADULT CIGARETTE SMOKERS: A CORRELATION STUDY

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ABSTRACT

Background and Aim: Cigarette smoking is associated with a high mortality rate and smokers tend to have significantly lower cardiovascular endurance. There is a lack of literature investigating the relationship between cigarette dependence and endurance. Thus, the aim of this study is to identify the correlation between cigarette dependence and cardiovascular endurance in young adult cigarette smokers. **Methods:** This correlation study involved 20 smokers aged between 18-30 years old, which were recruited via purposive sampling. Cigarette Dependence Scale (CDS-12) and 20-Meter Multi-Stage Shuttle Run Test (20-m MST) were used to determine their cigarette dependence and cardiovascular endurance, respectively. Pearson's test and simple linear regression were applied to analyse the data. **Results:** The mean of cigarette dependence was 31.25 (\pm 6.81). For cardiovascular endurance, the mean was 36.4 (\pm 6.22). The endurance of all participants was under the poor category. Pearson's test revealed a significant negative correlation between cigarette dependence and cardiovascular endurance ($r = -.68, p < .05$). Simple linear regression showed that each one-unit increase in cigarette dependence was associated with a 0.62 decrease in cardiovascular endurance. **Conclusion:** A statistically significant and moderate negative linear correlation was found between cigarette dependence and cardiovascular endurance. The cardiovascular endurance of all studied participants was under the poor category. These urge the need for effective measures for improving endurance and promoting smoking cessation in the smoker population. These findings also could be used by educators to educate smokers to quit smoking and to educate those who are at risk of initiating cigarette smoking.

Keywords: *Cigarette dependence; Cardiovascular endurance; cigarette smoking; young adult smoker*

INTRODUCTION

Globally, it is estimated that there are 1.3 billion smokers and the number is expected to climb to 1.6 billion by 2025 (Mathers and Loncar, 2006). Cigarette smoking harms almost every body system and the major causes of higher mortality in cigarette smokers are smoking-related diseases including cancer, chronic obstructive pulmonary disease and coronary heart disease. Smoking-related diseases contributed to about 4.8 million deaths in 2006 and the number is expected to reach 8.3 million by 2030. The life expectancy of smokers in Australia and Japan was found to be reduced by 10 years on average (Banks et al., 2015; Sakata et al., 2012). Despite studies showing that early smoking cessation helps in reducing almost all the hazards and mortality associated with smoking, smoking cessation remained a rare occurrence (Doll et al., 2004).

Previous studies have found that when compared to a non-smoker, cigarette smokers have poorer cardiovascular endurance (Kobayashi et al., 2004 and Miyatake et al., 2011). In those studies, however, the authors merely compared the endurance of the smoker group to the non-smoker group, no consideration was given to the cigarette dependence or smoking characteristics. Studies showed that with high cigarette dependence, the smokers are typically associated with higher usage of cigarettes, higher sedentary behaviour and lower physical activity levels (Fagerström and Furberg, 2008; Azagba and Asbridge, 2013; Audrain-McGovern et al., 2013; Loprinzi and Walker, 2015). All of these would either directly or indirectly affect cardiovascular endurance. Furthermore, the withdrawal symptoms associated with high cigarette dependence such as stress, anxiety, irritability and anger could also have affected the endurance. Hendricks et al. (2006) found that when smokers were not allowed to smoke, the withdrawal symptoms emerged in as less as 30 minutes. A significant negative correlation was also found between anxiety intensity and cardiovascular fitness (Williams et al., 2016).

In the study done by Lauria et al. (2017) which investigated the dose-response relationship between smoking and endurance, despite that the authors found a significant negative correlation between cigarette smoking and endurance level by correlating pack*year value of smoking with the result of cardiopulmonary exercise testing, consideration only has been given to the dosage of smoking. According to the substance dependence criteria by ICD-10 (World Health Organization, 1992), aside from dosage, several other aspects should also be considered including (a) *desire or compulsion to take the substance*, (b) *withdrawal when*

substance use has ceased or reduced, (c) neglect alternative interest due to the use of substance, (d) spend extra time for obtaining or taking the substance, and (e) persist with substance use although aware of harmful consequences. Even though from previous studies we may draw the conclusion that cigarette smoking is associated with lower endurance when compared to a non-smoker, the relationship between cigarette dependence and cardiovascular endurance remains unclear.

Therefore, the aim of this current study is to identify the correlation between cigarette dependence and cardiovascular endurance in young adult cigarette smokers. This will help in providing a more complete understanding with regard to cigarette smoking and cardiovascular endurance. In addition, it will also provide insights into designing smoking cessation programme and also to guide in intervention for improving the cardiovascular endurance among cigarette smokers.

METHODOLOGY

Study Design

This study was designed as a correlation study and it has been approved by MAHSA Research Review Committee. The sample size was calculated based on the formula by Hulley et al. (2007), by using the effect size of $r = .8$ from the study by Wier et al. (2008) with type I error rate, $\alpha = .05$ and type II error rate, $\beta = .2$ using 95% confidence interval. A total of 20 participants were recruited. The eligibility criteria were manufactured cigarette smoker; age 18-30 years; and normal body mass index (18.5-24.9 kg/m²). The participants were excluded if they were involved with other sources of tobacco or nicotine uptake except for manufactured cigarettes. The participants were also excluded if having any medical history that may have affected their cardiorespiratory function or ability to participate in 20-m MST.

Measurement Tools

Cigarette Dependence Scale (CDS-12)

CDS-12 is a 12-items questionnaire that can be self-administered for identifying cigarette dependence. CDS-12 covered all the ICD-10 criteria for substance dependence (Etter, 2008). Each item scored from 1 to 5 with a total score of 60. The higher the score, the higher the cigarette dependence. With reference to the nicotine module of MINI which reflected the criteria of dependence by ICD-10 and DSM-IV, the CDS-12 total score of 43/60 was found

to be the cut-off point for the classification of a dependent smoker. The validity and reliability of CDS-12 have been proven in several studies (Etter, 2005; Etter, Le Houezec and Perneger, 2003; Rohsenow et al., 2013).

20-Meter Multi-Stage Shuttle-Run Test (20-m MST)

20-m MST is a field test commonly used for identifying cardiovascular endurance. During the test, the assessor ticked the corresponding column in the recording sheet when the participant completed a shuttle. The total number of shuttles covered by the participant was used for data analysis. The 20-m MST is a valid and reliable test for identifying cardiovascular endurance and it is significantly correlated to VO₂max (Paradisis et al., 2014; Chatterjee et al., 2008; Chatterjee et al., 2010; Cetin et al., 2005).

Study Procedures

Eligible participants received written and oral information about the study. After obtaining the written informed consent, the participants first answered the CDS-12, a self-administered questionnaire. The participants then proceeded with 20-m MST.

Procedure for 20-m MST

A running pathway of 20 meters with a two-meter line from each end of the pathway was marked on a smooth concrete surface. The participants were required to run back and forth between the 20-meters pathway with the running speed dictated by audio “beeps”. The test begins with a speed of 8.5 km/h and increases by .5 km/h for every subsequent level. A practice session with five minutes of rest was given. If the participants reached another end of the pathway before the next “beep”, the participants were required to form the next “beep” before continuing running. If the participants failed to reach the two-meter line before the “beep”, a warning was given but the participant can still continue running and try to catch up. The test was completed when the participant failed to reach the two-meter line for two consecutive runs or when the participant felt he/she was unable to continue. The total number of shuttles covered was then calculated. The test protocol is similar to the study by Aandstad et al. (2011).

Statistical Analysis

Values are expressed as means (\pm standard deviation) for continuous variables and *n* (%) for categorical variables. Pearson’s test was used to correlate the CDS-12 total score and the

number of shuttles covered in 20-m MST to examine the correlation between cigarette dependence and cardiovascular endurance. Pearson's test revealed that there is a significant linear correlation between the two variables. Simple linear regression was further administered to identify the extent of the linear relationship between cigarette dependence and cardiovascular endurance. SPSS version 24 was used to perform all the statistical analyses and the statistical significance was set at $p < .05$.

RESULTS

Twenty smoker participants were recruited for this study. No adverse event was reported during the data collection process.

Table 1: Characteristics of participants (N=20)

Variables	Mean (\pm SD) or n (%)
Age (year)	22.35 (\pm 2.28)
Gender	
Male	20 (100)
Race	
Malay	7 (35)
Chinese	11 (55)
Other	2 (10)
Height (m)	1.72 (\pm .05)
Weight (kg)	66.10 (\pm 7.39)
BMI (kg/m ²)	22.23 (\pm 1.93)
Smoking duration (year)	4.80 (\pm 3.05)
Cigarette dependence (CDS-12 score)	31.25 (\pm 6.81)
Cardiovascular endurance (number of shuttles covered in 20-m MST)	36.40 (\pm 6.22)

The characteristics of the participants were tabulated in Table 1. The participants were averaged 22.35 (\pm 2.28) years old and ranged from 18 to 26 years old. All of them were male with 7 (35%) of them being Malay, 11 (55%) Chinese and 2 (10%) of other races. The mean smoking duration was 4.8 (\pm 3.05) years. For cigarette dependence, the mean CDS-12 total score was 31.25 (\pm 6.81), with the lowest score of 21/60 and the highest score of 43/60. For

cardiovascular endurance which is expressed by the number of shuttles covered in 20-m MST, the mean was 36.4 (\pm 6.22). The number of shuttles covered ranged from 26 to 48. According to the non-athlete male normative value for 20-m MST (Bizley, Chalk and Halliday, 2010), all the participants' endurance was under the poor category.

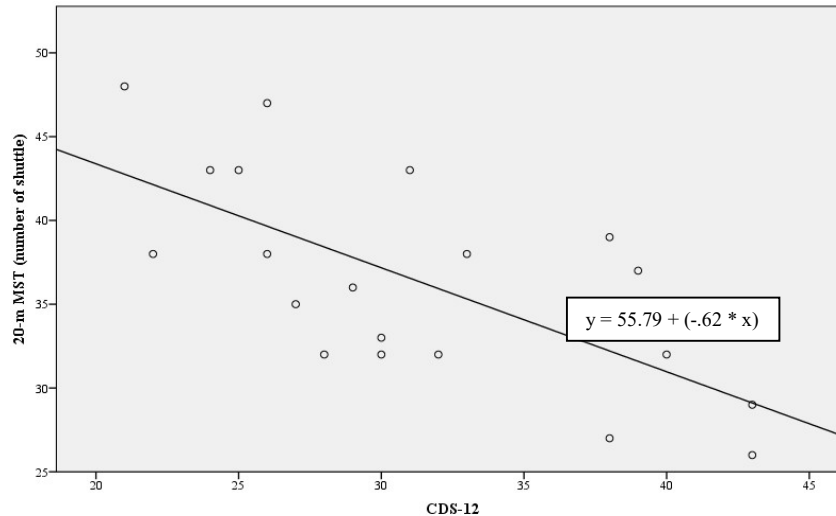


Figure 1: Scatter plot with regression line of CDS-12 against 20-m MST

Pearson's test was performed for correlating the participants' CDS-12 total score with the number of shuttles covered in 20-m MST to find out the relationship between cigarette dependence and cardiovascular endurance. A significant moderate negative linear correlation was found between the two variables ($r = -.68, p = .001$). The increase in cigarette dependence will be accompanied by a reduction in cardiovascular endurance. Simple linear regression was conducted to construct the prediction model so that the extent of the correlation could be identified. The scatter plot with regression line of CDS-12 against 20-m MST was shown in Figure 1. The y-intercept value, β_0 was 55.79 with the slope value, β_1 of $-.62$. Therefore, the cardiovascular endurance expressed by a number of shuttles covered in 20-m MST was expected to decrease by $.62$ for each one-unit increase in cigarette dependence expressed by the CDS-12 total score. The regression analysis also illustrated that even when cigarette dependence was at its lowest, cigarette smokers will have poor cardiovascular endurance.

DISCUSSION

In this study, a statistically significant and moderate negative linear correlation was found between cigarette dependence and cardiovascular endurance ($r = -.68, p < .05$). This finding was in a similar trend to the study done by Packa-Tchissambou et al. (2001) and Packa-

Tchissambou et al. (2004). The studies found that with higher cigarette dependence, the lower the cardiovascular endurance. In both studies, the authors divided the smokers into different groups based on their dependency level by using FTND and compared their VO₂max, rather than finding the correlation. However, between groups analysis did reveal that there was a significant difference in the VO₂max for all group comparisons, implying there is an inverse correlation between cigarette dependence and cardiovascular endurance.

Cigarette smoking has been proved that it was associated with carbon monoxide inhalation and carbon monoxide has an affinity of 245 times greater than oxygen in binding with haemoglobin, forming carboxyhaemoglobin which will reduce the oxygen-carrying capacity of the haemoglobin (Rudra et al., 2010). Dierker et al. (2007) also pointed out that with higher cigarette dependence, the smokers are typically associated with greater urge and quantity of smoking, thereby, the dose-dependent effect of greater cigarette usage may explain the inverse correlation found between cigarette dependence and cardiovascular endurance. Despite previous studies showing that smokers exhibited higher serum haemoglobin levels when compared to non-smokers, it was believed that it is due to carbon monoxide-induced hypoxaemia associated with cigarette smoking, subsequently resulting in greater erythropoietic response for compensating the detrimental effect of smoking on oxygen uptake (Milman and Pedersen, 2009). As a result, the breathing efficiency and alveolar gaseous exchange will be negatively affected, resulting in poorer cardiovascular endurance.

This was further supported by the study done by Lauria et al. (2017) which found that cardiovascular endurance was inversely correlated with cigarette smoking ($r = -.32, p < .05$). The discrepancy in the r value with this current study is possibly due to different variables being used to correlate with cardiovascular endurance. The present study used cigarette dependence expressed by CDS-12 while Lauria et al. (2017) used smoking-load expressed by pack*year of smoking. Lauria et al. (2017) also found that all smokers' endurance determined by cardiopulmonary exercise testing was below normal which was similar to the finding of this present study. Moreover, the simple linear regression further showed that even when cigarette dependence was at its lowest, the predicted cardiovascular endurance is also clearly below normal.

Cigarette smokers with greater dependency were significantly 30% less likely to be physically active than non-smokers (Azagba and Asbridge, 2013). Pesta et al. (2013) reported that high

doses of nicotine are able to enhance serotonin and opiate activity, thereby producing a calming and pleasurable sensation. If the smokers enjoy deriving pleasure from cigarette smoking, it is possible that they are less likely to seek an alternative source of subjective rewards, such as physical activity. Therefore, the inverse association between cigarette dependence and cardiovascular endurance found in the current study may be due to the direct negative effects of smoking on cardiorespiratory fitness causing the smokers unable to endure the physical activity as well as due to the indirect effects associated with high cigarette dependence. Furthermore, from item 10 of CDS-12 “Sometimes I drop everything to go out and buy cigarette”, only 25% of the studied participants responded with “totally disagree”. This suggested that the majority of them might spend an increased amount of time obtaining cigarettes or smoking, therefore, displacing the time being spent on being physically active which subsequently reduces their endurance level.

CONCLUSION AND RECOMMENDATIONS

The present study revealed a significant negative linear correlation between cigarette dependence and cardiovascular endurance. The regression analysis showed that even when cigarette dependence was at its lowest, the predicted cardiovascular endurance was also under the poor category. This urges the need for an effective exercise programme targeted at improving the cardiovascular endurance of cigarette smokers. On the other hand, the use of CDS-12 in this study also allowed the identification of the smokers’ characteristics and smoking behaviours, which could be used by health care professionals or educators in planning a smoking cessation programme. However, this study has only investigated the young adult smoker population and did not consider their physical activity level in the data analysis, which may have confounded the result. Future studies could focus on the smoker population of different age ranges with consideration to their physical activity level.

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