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Original Article

Assessing Intense Physical Activity Among Smokers Via Using Smart Watch an Analytical Cross-Sectional Study

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ABSTRACT

Background: Smoking is a well-known risk factor for various health conditions, particularly affecting cardiovascular and pulmonary systems. Despite extensive research, the impact of smoking on physical performance during intense activity remains inadequately explored. This study aims to bridge this knowledge gap by examining the effects of smoking on physical activity and cardiovascular responses.

Objective: The primary goal of this study was to assess the impact of smoking on intense physical activity, specifically focusing on differences in heart rate (HR) responses and physical endurance between smokers and non-smokers.

Methods: In this analytical cross-sectional study, 30 participants (15 smokers and 15 non-smokers) were recruited. The study employed the Six-Minute Walk Distance (6MWD) test, the Balke treadmill protocol, and the Ekblom-Bak test to evaluate physical performance. Heart rates were monitored using Garmin Vivismar4 smartwatches. Statistical analyses, including T-tests, were performed to compare the results between the two groups.

Results: Smokers demonstrated a significantly lower distance covered in the 6MWD (0.22 ± 0.05 km) compared to non-smokers (0.26 ± 0.06 km). In the Balke treadmill and Ekblom-Bak tests, smokers showed a lower HR (94.8 ± 22.3 bpm and 94.6 ± 28.1 bpm, respectively) compared to non-smokers (143.2 ± 27.0 bpm and 139.9 ± 25.1 bpm). The findings suggest a compromised cardiovascular response and physical endurance in smokers.

Conclusion: The study concludes that smoking adversely affects physical endurance and cardiovascular response during intense physical activity. These findings underscore the importance of considering smoking status in the assessment of physical fitness and highlight the need for further research on the long-term health implications of smoking.

Keywords: Smoking, Physical Activity, Cardiovascular Response, Heart Rate, Endurance, Health Implications.

INTRODUCTION

Physical activity, encompasses a broad range of movements and actions that are deeply embedded within our cultural contexts and influenced by a diverse array of factors including emotions, ideas, and social relationships (1). Engaging in physical activity is not just a matter of moving our bodies; it is an integral part of our societal fabric, impacting our health and well-being. The significance of physical activity lies in its ability to prevent numerous non-communicable diseases. In stark contrast, a sedentary lifestyle is a known contributor to a host of health issues, including diabetes, hypertension, and elevated cholesterol levels (2).

The interplay between physical inactivity and smoking is particularly concerning. Smoking, an independent risk factor for cardiovascular diseases (CVDs) (3, 4), adversely affects cardiovascular health and, consequently, physical performance. Its impact on the cardiovascular system is multifaceted: it affects peripheral vessels, contributes to elevated serum lipid levels, and accelerates atherosclerotic changes in the vascular bed. These factors collectively increase the risk of myocardial infarction, unstable angina, ischemic stroke, and sudden cardiac death (5). A review has highlighted a threefold increase in the risk of sudden cardiac death among current smokers, with a 38% increased relative risk even in former smokers (6). The exact mechanisms linking cigarette smoking to CVDs remain an area of ongoing research, but the adverse effects of smoking extend beyond the cardiovascular system (7).

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Long-term smoking can inflict toxic effects on the pulmonary system, potentially leading to chronic obstructive pulmonary diseases (COPDs). It is hypothesized that the inflammatory processes initiated by smoking not only affect the lungs but also have systemic implications, leading to degeneration and inflammation in other organs and tissues (8-10). Notably, the impact of smoking on skeletal muscle function is significant. Smoking impairs muscle endurance and force generation, irrespective of overt respiratory symptoms. This impairment is attributed to an imbalance in muscle protein dynamics—enhancing breakdown while inhibiting synthesis—mediated by the activation of specific enzymes. Furthermore, the accumulation of carbon monoxide in hemoglobin molecules compromises oxygen delivery to muscles, exacerbating muscle fatigue (11, 12).

Despite the well-documented health hazards of smoking, including its carcinogenic properties, approximately 1.3 billion individuals worldwide continue to use tobacco products (13-15). A significant proportion of these individuals reside in low- and middle-income countries, highlighting a global health challenge. The intersection of physical inactivity, smoking, and health outcomes necessitates a deeper understanding of these relationships to inform effective interventions and public health strategies (1, 16, 17). This study aims to investigate the intricate dynamics between smoking, physical activity, and health, with a particular focus on the use of smartwatches to monitor and assess physical activity levels among smokers. By exploring these connections, It was aimed to contribute to the broader conversation on public health and the role of technology in health promotion.

MATERIAL AND METHODS

In this analytical cross-sectional study, the sample size of 30 was determined using the infinite sample equation, n = p(1-P)(z/e)^2, to ensure statistical robustness. Participants were recruited from the Department of Physical Therapy at Sarhad University. The study utilized a non-probability snowball sampling technique to identify smokers, a method chosen for its efficiency in reaching a specific subset of the population (18). Upon recruitment, candidates underwent a thorough screening process to assess their eligibility based on predefined inclusion and exclusion criteria. The objectives and procedures of the study were clearly explained to all eligible participants. Additionally, comprehensive demographic data, alongside detailed smoking histories, were obtained from each participant (19).

The primary assessment tools employed in this study included the Six-Minute Walk Distance (6MWD) test, the Balke treadmill protocol, and the Ekblom-Bak test (20). The 6MWD test was conducted in a spacious, open corridor to facilitate unrestricted movement (21). In contrast, the Balke and Ekblom-Bak tests were administered on a treadmill and a cycle ergometer, respectively. These tests were chosen for their proven effectiveness in evaluating cardiovascular and pulmonary endurance (22).

To gauge perceived respiratory exertion, the Borg CR 10 scale was utilized. This scale is a recognized tool in assessing the level of exertion experienced by individuals during physical activity. Participants were instructed to exert themselves to a submaximal level, quantified as a Borg score of 7. This level was chosen to ensure participant safety while still providing a rigorous assessment of their physical capabilities (23).

Heart rate measurements were accurately captured using a Garmin Vivismar4 smartwatch, a device selected for its precision and ease of use. The functionality of this smartwatch allowed for continuous monitoring of heart rate, an essential parameter in evaluating the physiological responses to physical activity (24).

Before the commencement of the tests, all participants were thoroughly briefed about the procedures involved in both the Balke treadmill and Ekblom-Bak protocols. The Borg scale was not only explained in detail but also provided in printed form for easy reference during the tests. To maintain consistency, all data collection occurred between the hours of 2 to 4 pm, a time frame chosen to control for potential diurnal variations in physical performance. The data was analysed in SPSS 24.0.

RESULTS

The findings have been detailed in tables. Table 1 shows the demographic details of the research participants in terms of age, height, weight and BMI among smokers and non-smokers. The mean age of the smokers were 24 years ± 1.2 and that of the non-smokers was 23 years ± 1.0. height was smoker was 171 ± 9.1 cm and 171 ± 9.2 of non-smokers. Mean BMI of smokers and non-smokers was 22.7 ± 3.7 and 25.0 ± 3.1 respectively.

Table 1 demographic details of smokers and non-smokers

Variables	Smokers n=15	Non-Smokers n=15
Age	24 ±1.2	23 ± 1.0

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Height	171.6 ± 9.1	171 ± 9.2
Weight	68.8 ± 12.3	73.2 ± 8.8
BMI	22.7 ± 3.7	25.0 ± 3.1

Table 2 shows the comparison of different variables of smokers and non-smokers by mean values and ± SD. According to results of this study, the mean and ± SD of resting heart rates of non-smokers is higher i.e., 85.1 ± 7.8 bpm and 82.4 ± 10.6 bpm for non-smokers and smokers respectively. and so is HR at the end of six MWD, non-smokers had means HR of 90.7 ± 10.9 bpm while smokers had 82.0 ± 18.0 bmp. Non-smokers were able to cover the highest Distance in six MWD which was 0.26 ± .06 (in Km) as compare to smokers which was 0.22 ± .05 (in Km). However, there wasn't significant difference in distance covered during Balke treadmill test. Mean distance covered by both the groups in Balke treadmill was 1.09 ±.23 (in Km) by smokers and 1.1 ± 1.6 (in Km) by non-smokers. The difference of mean and ± SD of HR at the end of Balke treadmill test of both the groups is significantly high i.e., 94.8 ± 22.3 bpm and 139.9 ± 25.1 bmp. Similarly, in the Ekblom-bak test, the non-smoker group had higher heart rate as compare to smokers i.e., 139.9 ± 25.1 bpm and 94.6 ± 28.1 bpm respectively. Moreover, the non-smoker group was able to perform the Ekblom-bak test for longer duration of time to reach PRE 7 on BORG scale in comparison to smoker group i.e., 14 ± 1.5 ± 13.1 ± 1.6 minutes respectively. Similar pattern was seen in the Balke treadmill activity as well i.e., 14.1 ± 2.7 min and 15.0 ± 1.3 min by smokers and non-smokers respectively. Furthermore, the final intensities of both, the Balke treadmill and Ekblom-bak protocol is seem to be less in smokers' group in contrast to non-smokers. The final speed that participants of smokers group could reach was 6.5 ± 1.1 (Km/hr.) while non-smokers reached 6.7 ± .49 (Km/hr.). On the other hand, the final work rate of smokers during the Ekblom-bak test was 111.6 ± 25.5 watt/kg while the non-smokers had 123.2 ± 31.4 watt/kg in which again, non-smoker group outweigh the smokers' group. Non-smokers took more time to reach PRE 7 on BORG scale in Ekblom-bak test as compare to smokers. The mean and SD time of non-smokers and smokers in this activity was 14 ± 1.5 min and 13.1 ± 1.6 min respectively.

Table 2 mean and standard deviations of different variables.

Variables	Smokers	Non-Smokers
Resting HR	82.4 ± 10.6	85.1 ± 7.8
HR at end of 6MWD	82.0 ± 18.0	90.7 ± 10.9
Distance cover at 6MWD	0.22 ± .05 (in Km)	0.26 ± .06 (in Km)
HR at end of Balke protocol	94.8 ± 22.3	143.2 ± 27.0
Total distance cover in Balke test	1.09 ±.23 (in Km)	1.1 ± 1.6 (in Km)
Final Speed in Balke Protocol	6.5 ± 1.1 (Km/hr.)	6.7 ± .49 (Km/hr.)
Total time of Balke test	14.1 ± 2.7 min	15.0 ± 1.3 min
HR at end of Ekblom-bak test	94.6 ± 28.1	139.9 ± 25.1
Work Rate of Ekblom-bak test	111.6 ± 25.5 watt/kg	123.2 ± 31.4 watt/kg
Final resistance of Ekblom-bak test	13.6 ± 2.5	14.7 ± 3.4
Total time of Ekblom-bak Test	13.1 ± 1.6 min	14 ± 1.5 min

Table 3 Sample t-test of 6MWD Balke treadmill and Ekblom-bak test

T-test for equality of means			
	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed*	0.124	8.66667	5.46498

Equal variances not assumed*	0.126	8.66667	5.46498
Equal variances assumed**	0.002	34.53333	9.99378
Equal variances not assumed**	0.002	34.53333	9.99378
Equal variances assumed***	0.000	45.333	9.739
Equal variances not assumed***	0.000	45.333	9.739

Table 3 shows sample t-test of heart rates during 6MWD, Balke treadmill and Ekblom-bak test. 2-tailed significance value for 6MWD is 0.124 which is above the significance levels of 5%. Therefore, we failed to reject null hypothesis for 6MWD however, Balke treadmill and ekblom-bak tests shows different analysis. The significance values of independent t test for Balke treadmill test are equal to 0.02 which is lesser than the level of significance 0.05 and shows that homogeneity of variance of two groups is violated therefore rejecting the null hypothesis. Similarly, Sample t-test for Ekblom-bak protocol is equal to 0.00 which indicates that difference of variances thus, rejecting the null hypothesis.

DISCUSSION

In this study, the effects of smoking on intense physical activity and cardiovascular response were investigated among 30 participants, equally divided into smokers and non-smokers. The demographic characteristics of the groups included average ages of 24 ± 1.2 for smokers and 23 ± 1.0 for non-smokers, with weights and heights being 68.8 ± 12.3 kg and 171.6 ± 9.1 cm for smokers, and 73.2 ± 8.8 kg and 171 ± 9.2 cm for non-smokers, respectively.

During the Six-Minute Walk Distance (6MWD) test, it was observed that smokers covered a shorter distance (0.22 ± 0.05 km) compared to non-smokers (0.26 ± 0.06 km). This disparity in performance could be attributed to the onset of fatigue and reduced exercise tolerance in smokers, a phenomenon that is supported by previous studies. However, the heart rate (HR) during the 6MWD test did not show significant differences between the groups, with smokers at 82.4 ± 10.6 bpm and non-smokers at 90.7 ± 10.9 bpm. This finding contradicts other research that reported a higher HR in smokers during a similar test, possibly due to differences in participant age and athletic background (4, 13, 21, 24).

The Balke treadmill protocol, which is designed to challenge the cardiovascular system through increasing speed and inclination, revealed more pronounced differences. The mean HR values for smokers (94.8 ± 22.3 bpm) were significantly lower than those of non-smokers (143.2 ± 27.0 bpm), indicating a phenomenon of chronotropic incompetence among smokers. This finding aligns with other research, which noted a decreased maximum HR in smokers compared to non-smokers, although HR differences were not evident at submaximal levels (15, 19, 22, 23).

During the Ekblom-Bak test, the statistical significance (p-value = 0.00) confirmed the impact of smoking on HR, with smokers exhibiting a mean HR of 94.6 ± 28.1 bpm, in contrast to 139.9 ± 25.1 bpm in non-smokers. Additionally, the final resistance at the end of the Ekblom-Bak test was lower for smokers (13.6 ± 2.5 watt/kg) compared to non-smokers (14.7 ± 3.4 watt/kg), potentially due to increased fatigue. This finding is in line with studies suggesting that impaired oxygen supply to muscles in smokers leads to oxidative stress and muscle wasting during physical activity (22).

These findings highlight the complex influence of smoking on physiological responses during intense physical activity. Smoking not only affects cardiovascular function, but also impacts muscular oxidative mechanisms. The variation in HR responses between smokers and non-smokers during different physical tests underscores the need for further research to explore potential long-term risks associated with smoking.

CONCLUSION

In conclusion, while the 6MWD test showed no significant HR differences between smokers and non-smokers, the Balke and Ekblom-Bak protocols revealed a noticeable decrease in HR among smokers. The observed fatigability in smokers suggests compromised physical performance, raising questions about the broader health implications of smoking. Future research should focus on the long-term risks posed by smoking and its impact on various physiological systems, considering the limitations of the current study such as sample size and demographic homogeneity. This research contributes to a growing body of evidence on the adverse effects of smoking and underscores the importance of targeted interventions to mitigate these risks.

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