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Knee Proprioception and Quadriceps strength and endurance between King Abdulaziz university Smokers and Non-Smokers students

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Smoking is one of the primary avoidable causes of death and diseases. Investigating the endurance capacity, knee proprioception, and quadriceps muscle strength between smokers and non-smokers. Forty male subjects were participated in this study, 20 Smokers and 20 Non-Smoker subjects with age between 19-25 years old and the smoking duration was between one and 3 years and smoking about half box per day. Active knee repositioning precision for measuring knee proprioception and isokinetic quadriceps strength were tested for all students by Biodex multi-joint system pro Isokinetic dynamometer, and endurance was measured by Six-Minute Walk Test. Results: There was no significant difference for knee joint repositioning accuracy and quadriceps strength and endurance between smokers and non-smokers, where P-value was 0.672, 0.162 and 0.079 respectively. knee joint repositioning accuracy and quadriceps strength and endurance are not significantly affected by smoking in young age for a period less than three years. Hence, upon the results we can advise the students in the 1st stages of smoking to quit smoking to avoid its deleterious effects and complications in the long run.

Keywords: smoking, knee proprioception, quadriceps strength, Isokinetic dynamometer

INTRODUCTION

Tobacco is one of the causes that leads to death and disease, agreeing with World Health Organization (WHO) and Center for Disease Control and Prevention. Smoking is an avoidable risk factor for disease and death (Duman et al. 2017). The smoker numbers in the world could be about 1.3 billion, and over 80% of them live in low- and middle-income nations (WHO, 2015) .

A worldwide decrease in the number of smokers between 1980 and 2012, were observed in some North Americans and Scandinavians. Whereas, in the same time it has increased significantly in high-income nations including Saudi Arabia (Ng et al. 2014). Consistent with available evidence between 2007 and 2018, the dominance of tobacco smoking between Saudi youths with a range of 2.4% to 39.6% (Alasqah et al. 2019)

The smoking rate between adult Saudis was 23.7% for men and 1.5% for women. Regrettably, the WHO statistics displayed ongoing increasing rate of smokers between Saudi teenagers from 12.45% in 2000 to 15.1% in 2010. WHO reports estimating that by 2025, 38% of men and 2% of women in the age of 15-24 will be cigarette smoker (WHO, 2017).

Smoking habit habitually begins in puberty, and subjects starting to smoke earlier in their teens are unlikely to give up smoking (So and Yeo, 2015). There is an estimate of nearly 90% new cigarette smokers will be under the age of 18, underlining the urge to initiate strategies for prevention and/or controlling this habit among teenagers (Park, 2011).

WHO shared reports of experiments involving scholars from 35 nations in North America and Europe, with results that any young subject from lower-income family or with bad parental and any family member relations was more probably be a smoker (Moor et al. 2015). Smoking has effects on the smoker and nearby subjects (passive smoker). The main reasons of smoking-related death include lung cancer, circulatory disorder, atherosclerosis, and prolonged obstructive alveolar diseases (Centers for Disease Control and Prevention (CDC) 2008, Dube et al. 2009).

In Jeddah, Saudi Arabia, in 2013 the smoking

prevalence reached 37% (Fida and Abdelmoneim, 2013). While in Hail, a cigarette smoking investigation reported that 19.5% of adolescents were currently cigarette smokers (Algorinees et al. 2016). Tobacco is not permitted to be grown or manufactured in Saudi Arabia, however, approximately $ 150 million (SAR 600 million) is spent annually on tobacco (Jarallah et al. 1999).

Smoking is prevalent among the Saudi population of various age groups, and it is much higher among males than among females. The current smoking prevalence rate between Saudis is ranging between 2.4-52.9% with a rate of 17.5%. Tobacco is the only utmost avoided reason for early passing and the greatest significant community health matter now. Continuous upsurge is noted in the prevalence of smoking among teenagers all over the world, especially Saudis (Bassiony, 2009).

The musculoskeletal system is one of the major systems in the human body, and it includes bones, joints, cartilage, tendons, ligaments, muscles, and other connecting soft tissue (AL-Bashaireh et al.2018). Cigarette smoking has deleterious effects on the musculoskeletal system. Studies have reported lower maximum force generation capacity of the quadriceps muscle of smokers than of non-smokers (Abate et al. 2013). Cardiopulmonary endurance is one of the vital constituents of good health (Gibson et al. 2018).

Nicotine in tobacco is a factor causing harmful health effects of smoking, it raises pulse rate and arterial blood pressure, reduces pulmonary functions, and narrows pulmonary and blood vessel walls (Özgür Bostanci et al. 2019). Cardiopulmonary endurance is the capacity to complete active exercises comprising big muscles with medium to high intensities for a prolonged time (Song et al. 1998). Smoker persons might suffer from reduced strength and endurance of muscles of inspiration (Özgür Bostanci et al. 2019).

Proprioception is vital for voluntary control, smoothing and coordination of movements, learning of movement, correcting errors during movements, providing postural stability and controlling balance (Kaya et al. 2018). This study aimed to investigate the knee proprioception, quadriceps strength and endurance between King Abdulaziz university smokers and non-smoker students.

MATERIALS AND METHODS

The present study was carried out in the outpatient clinic of the Physical Therapy Department, Faculty of Medical Rehabilitation Sciences, King Abdulaziz University from January 2020 till April 2020 to investigate the knee proprioception, quadriceps strength and endurance between King Abdulaziz university smokers and non-smoker students.

Subjects:

Forty male students participated in this study, 20 smokers and 20 non-smokers subjects.

The inclusive criteria:

Age from 19 to 25 years old, a smoking duration from 1 to 3 years and consuming about half box per day.

The exclusive criteria:

Any disease in the knee joint. Previous knee surgeries. Knee deformities. Patient with polyneuropathy. Athletic subjects, and chronic disease as diabetes and hypertension.

Design of study:

This was an observational cross sectional study. Forty students participated, and were randomly distributed to two equal groups. Group (A) as a control group including 20 healthy non-smoker students and group (B) as a study group and included 20 smoker students. Active knee reposition accuracy as a measurement of knee proprioceptive function, isokinetic quadriceps strength and six minutes' walk test were performed for both groups.

Instrumentation:

Biodex Multijoint System, pro Isokinetic Dynamometer (Biodex Medical INC., Shirley, New York, USA), was used for measuring knee proprioception and quadriceps strength.

PROCEDURES:

Knee Proprioception Assessment:

The procedure of joint position sense (JPS) evaluation includes active relocation of the prevailing lower limb. JPS evaluation was achieved via the Biodex. Drouin et al., verified that the Biodex System 3 isokinetic dynamometer is a mechanical consistent device for measuring angular positions, isometric torque, and slow: moderate velocity, with higher intra-class correlation coefficients *(*Pranjali and Khushboo, 2017).

The students' abdomen and thigh must be firmly secure via belts for ensuring vertical positioning at 90° alongside the knee joint and the dynamometer tube axis. The range of motion was at this time evaluated. Alteration of proprioception of the knee at 45° were measured. With the students' eyes closed, the assessor asks him to recognize the calculated angles and to recall them; these angles must be preserved along 10 seconds. Next, the students were requested to assume the same angle *(*Torres et al. 2010*).*

Lateral femoral epicondyles were considered as bony landmarks for corresponding the knee axis of rotation with that of the dynamometer resistance adapter (Cho et al.2013). Three trials were done and the means were taken, target angle positions and student perceived final range positions (absolute error) were noted in degrees as the discrepancy in repositioning accurateness and

were used for statistical study (Pincivero et al. 1997, Ribeiro and Oliveira 2010).

Quadriceps strength:

All students were instructed to sit on the Biodex chair. Keeping trunk, thigh, and tibia stabilized with velcro straping for preventing other joint movements. Dominant limb knee was placed in 90 flexion (zero = full extension) (Bandy and Sanders, 2007). Lateral femoral epicondyles were considered bony landmarks for comparing the knee axis of rotation with that of the dynamometer resistance adapter (Siatras et al. 2008).

Quadriceps muscle peak torque (PT) was tested at an angular velocity of 60◦ /second. Students were asked to extend the leg as firm and fast as potential. Isokinetic tests consist of three trials. Verbal encouragement was added. The greatest scorings of the three trials (PT) of every test were taken for additional statistical analysis (O'Connell et al. 2011).

Six-Minute Walk Test (6MWT):

was used to assess aerobic endurance. 6MWT has shown good reliability and validity (Kaya 2018). The subject should walk as far as possible in 6 minutes. Subject may slow down, stop, rest, and restart as needed during the test. 6MWT was used to explain to the students just how to walk the path, as well as turns. Measuring resting arterial blood pressure, pulse rate, oxygen saturation. Recording laps, marking stop points, walked distance through the testing, and careful observation of active recovery. 6MWT spots the predicted performance regressions among age groups, as well as distinguishing between subjects with low and high physical activity level and functional ability testing scores. Test-retest reliability was r = 0.94 (Gibson, A.L., 2018).

Statistical analysis

Gathered data from both groups undergo statistical analysis. Descriptive statistics in form of mean and standard deviation and analytic statistics in form of unpaired t test to compare between groups were used. P value was set at $p \leq 0.05$.

RESULTS

General Characteristics of the Students: Forty male students were enrolled in the study. 20 non-smokers and 20 smokers were allotted into two groups, control (A) and study (B).

Group (A):

Twenty non-smoker male students were involved in this group. Table (1) is representing mean age (21.95 ± 1.276) in years, mean weight (73.975 ±16.273) kg and their mean height (171.8± 4.6399) cm.

Group (B):

Twenty smoker male students were enrolled in this group. Table (1) is presenting mean age (21.800 ± 0.9514) in years, mean weight (68.925 ± 12.773) kg and their mean height (171.35 ± 5.6779) cm.

Unpaired t-test between both groups displayed non-significant difference for age (P=0.676), weight (P=0.282) and height (p= 0.762) as seen in table (1).

Knee joint repositioning error:

Table (2) displays the knee repositioning error for both groups. There was non-significant difference in the unpaired t-test results among knee joint repositioning errors for both groups, with a mean value of group (A) (6.0050) and for group (B) (5.4500) and a t-value of (0.426) and P-value of (0.672).

Table 1: Physical characteristics of students in both groups

Variable	Group (A) Non-smokers		Group (B) Smokers		Comparison		Sig.
	Mean	±SD	Mean	±SD	t-value	P-value	
Age (years)	21.95	±1.276	21.80	±.951	.421	.676	NS
Weight (Kg)	73.97	16.273	68.92	12.77	1.092	.282	NS
Height (cm)	171.8	4.6399	171.35	5.6779	.305	.762	NS

SD: standard deviation, P: probability, Sig: significance, NS: non-significant.

Table 2: Mean, SD, t and P values of Knee joint repositioning errors between groups

Unpaired t-test	Knee joint repositioning error	
	Control group(A) Non-smokers	Study group(B) Smokers
Mean	6.0050	5.4500
±SD	±4.55937	±3.62252
Mean difference	0.555	
DF	38	
t-value	0.426	
P-value	0.672	
Sig.	NS	

*SD: standard deviation, DF: degree of freedom, P: probability, Sig: significant.

Quadriceps strength:

Table (3) displays the peak torque of the quadriceps muscle for both groups. Non-significant difference was seen in the unpaired t-test results among PT of the quadriceps for both groups as the mean of group (A) was (74.5450) and for group (B) was (91.3900), with a t-value of (1.425) and P-value of (0.162).

Table 3: Mean, SD, t and P values of Quadriceps Peak Torque between groups

Unpaired t-test	Quadriceps Peak Torque	
	Control group(A) Non-smokers	Study group(B) Smokers
Mean	74.5450	91.3900
±SD	±31.87040	±42.16569
Mean difference	16.84500	
DF	38	
t-value	1.425	
P-value	0.162	
Sig.	NS	

*SD: standard deviation, DF: degree of freedom, P: probability, Sig: significant.

Six-Minute Walk Test Distance:

Table (4) demonstrated the 6MWT distance for both groups. Non-significant difference was noted in the unpaired t-test between 6MWT distances for both groups as the mean of group (A) was (579) and for group (B) was (555.10), t-value of (1.803), and P-value of (0.079).

Table 4: Mean, SD, t and P values of Six-Minute Walk Test distance between groups

Unpaired t-test	Six-minute Walk Test distance	
	Control group (A) Non-smokers	Study group (B) Smokers
Mean	579	555.10
±SD	±43.18016	±40.60321
Mean difference	23.90	
DF	38	
t-value	1.803	
P-value	.079	
Sig.	NS	

*SD: standard deviation, DF: degree of freedom, P: probability, Sig.: significant.

DISCUSSION

The present experiment was directed for investigating the knee proprioception, quadriceps strength and endurance between smokers and non-smokers students. forty male students aging between 19 to 25 years old participated in this study and were allocated into two groups (A and B), where A as a control including 20 normal students and B as a study group including 20 smokers. In this study Biodex multijoint system, pro isokinetic dynamometer was used to measure active angle reproduction as a quota of proprioception precision of the knee and also to measure the peak torque of the quadriceps muscle, while six minute walk test was used to measure general endurance.

The study results showed no statistically significant difference between knee repositioning errors and quadriceps peak torque of both groups, where P-values were (0.672) and (0.162) correspondingly.

Regarding the six minute walk test distance, although there was a mean difference between both groups as the distance walked by the non-smokers was more than that for smokers, this difference was statistically non-significant as the P-value was (.079). These results may be explained with respect to the age range of young smoker students and the duration of smoking which was a little bit short duration and also the small sample size, in addition to the amount of smoking per day.

In contrast, a study done by Pooja et al., for comparing functional capability between smokers and non-smokers via 6MWT showed a significant difference, as non-smokers walked additional distance in comparison to smokers. Accordingly, the conclusion was that non-smoker students have a superior functional capacity than smokers (Pooja et al. 2017).

The results were in disagreement with Marjeta et al., who reported a significant difference between smokers and non-smokers on aerobic endurance. 350 subjects participated in this study, 175 smokers and 175 non-smokers. Smokers were divided into 3 groups according to the duration of smoking. Aerobic test was applied using direct spiroergometry. The results showed a decrease in endurance in smokers (Misigoj-Durakovic et al. 2012).

A study conducted by Maarten et al., reported an inverse relationship between smoking and the strength of knee flexors and extensors by using an isokinetic strength test. Participants' ages were 21 to 36 years and were divided into 4 groups, at age 21 (n = 181), 27 (n = 141), 32 (n = 426) and 36 years (n = 373). The disagreement between our study and this study may be due to the sample size and the age factor (Kok et al. 2012).

Rob et al., studied the knee extension torque on the right foot using a cybex norm dynamometer. The study included 40 smokers both men and women (19 men and 21 women). Maximal torque capacity was lower in women than men smokers. Also, in this study, voluntary activation was determined on the quadriceps muscle using the interpolated twitch technique, and the results showed an increase in the degree of smokers compared to non-smokers. Also, in this study, the torque-frequency relationship and contractile speed was assessed by stimulating in random order. There was no difference in torque-frequency relationship among smoker and non-

smoker subjects (Wüst et al. 2008).

Michele Abate et al., reported that smoke affects the musclo-skeletal system, and reduces bone mineral content and muscle strength and muscle mass. Quadriceps muscle strength was measured in men and women at age 21, 27, 32 and 36. An inverse relationship was found between thigh muscle strength and tobacco (Abate 2013).

This study was in agreement with Morse et al., who reported that there was no significant effect of smoke on quadriceps muscle. The number of participants was 9 men smokers whose average age was (22.2) years, and 10 non-smokers whose average age was (25.4) years. Maximal voluntary contraction (MVC) of the quadriceps muscle, contractile properties by stimulating the quadriceps muscle and fatigue were measured. The results showed that no significant difference was noted in MVC and contractile properties among smoker and non-smoker subjects. The results showed more possibility of quadriceps muscle fatigue in smokers than non-smokers *(*Morse et al. 2007).

Parker et al., studied the influence of cigarette smoking on endurance. Nineteen male college students participated in this study, 12 regular smokers and 7 non-smokers with mean age 22.2 years. The results showed no significant difference between either group *(Parker, P.A. 1954).*

CONCLUSIONS

It can be concluded that the knee joint repositioning accuracy and quadriceps strength and endurance are not significantly affected by smoking in young age for a period less than three years. Hence, upon the results we can advise the students in the 1st stages of smoking to quit smoking to avoid its deleterious effects and complications in the long run.

Supplementary materials

The supplementary material / supporting for this article can be found online and downloaded at: https://www.isisn.org/article/10.3390/antiox12081524/s1,

Author contributions

Conceptualization, A.M. and S.R.; methodology, M.F., A.M., S.R. and H.M.; software, A.M.; validation, A.M. and S.R.; formal analysis, A.M. and M.F.; investigation, A.M. and S.R.; resources, H.M.; data curation, A.M.; writing-original draft preparation, A.M.; writing-review and editing, A.M. and S.R.; visualization, M.F.; supervision, M.F. and H.M.; project administration, S.R.; funding acquisition, all authors. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was approved by the Bioethical Committee of the Faculty of Medical Rehabilitation Sciences.

Informed Consent Statement

Not applicable.

Data Availability Statement

All of the data is included in the article/Supplementary Material.

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Conflict of interest

The authors declared that present study was performed in absence of any conflict of interest.

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