10.61186/aassjournal.1514

Ann Appl Sport Sci InPress(InPress): e1514.

e-ISSN: 2322-4479; p-ISSN: 2476-4981

ORIGINAL ARTICLE

The Percentage of Cotinine in the Body and Its Relationship with the Level of Achievement of the Snatch in the Weightlifting

[1]Omar Khalid Yasir*

[1]College of Physical Education and Sports Sciences, University of Baghdad, Baghdad, Iraq.

***. Corresponding Author: Omar Khalid Yasir**; **E-mail:** omar.taha@cope.uobaghdad.edu.iq

Submitted December 04, 2024;
Accepted February 14, 2025.

KEYWORDS
Cotinine,
Weightlifting Sports,
Snatch Lift.

ABSTRACT

Background. Smoking is a widespread negative phenomenon among university students, often driven by psychological pressure and social problems, increasing the likelihood of them smoking. **Objectives.** The study aims to identify the percentage of cotinine in the body and its relationship with the level of achievement to Raise the Snatch for first-stage students. **Methods.** Descriptive methods were used in the survey to study the research problem, dividing the sample into two groups: smokers and non-smokers. The sample was deliberately selected from first-stage students at the Faculty of Education. In the College of Physical Education and Sports Sciences, with 76 students from Classes D and E, the sample percentage was 23.75% out of 320 students, and a cotinine examination was conducted for the sample consisting of 70 students in the form of two groups, the first smokers and the second non-smokers. **Results.** The study showed a direct and significant correlation between the variable percentage of cotinine in the body and the variable language. It turned out that the value of the Association of cotinine with achievement for the group of smokers is 0.068 and at a significant level of 0.699, is not significant, as the value of the Association of cotinine with achievement for the group of non-smokers appeared to us 0.9470 with a semantic level 0.000. The relationship is positive, although it did not meet the expected figures. **Conclusion.** The study found that smokers had a weak correlation between cotinine variables and snatch lift achievement, while non-smokers had a positive correlation with snatch lift achievement. Smokers had been exposed to smoking for long periods, indicating a weak correlation between cotinine variables and snatch lift achievement. Non-smokers had a standard percentage of cotinine in urine, indicating a stronger correlation between cotinine variables and snatch lift achievement.

INTRODUCTION

The phenomenon of smoking is one of the negative phenomena that has spread widely in our societies, and the category of university students has not been spared from falling into this great scourge. They are first and foremost part of this society, and an important component of its components falls on them the psychological problems (1). There is no doubt that smoking is one of the phenomena that is not Strange in any society. It is not limited to a specific age group, but what is reprehensible in this phenomenon is the smoking of the educated and educated. It causes many serious diseases in the human body, most notably lung and oral cancer ،Therefore, it is necessary to protect community members and raise their awareness of the danger of smoking, as

well as that smoking and sports do not meet at all (2). Smoking and sports both affect the body and its health, as sports have a positive effect, but smoking negatively affects the body, reducing its ability to exercise and other activities (3). Smoking causes long-term effects on the ability to perform exercise and physical activity. Smoking impairs physical performance, reduces endurance and exercise, as well as weakens muscle strength and reduces flexibility. To perform better, a healthy, healthy body is needed, and to exercise well the heart, lungs and muscles need oxygen-rich blood (4). The student at the Faculty of physical education and sports sciences, especially in the weightlifting class, must meet the requirements of weightlifters, such as muscular and nervous strength, as well as high mental concentration during the class, and it is necessary to avoid injury, as well as health-related elements, such as speed, agility, compatibility, balance, accuracy and other elements required for outstanding motor performance in the sitting snatch and jerk (5). The quality of physical fitness for a weightlifter is different for a football player and for a tennis player in other events (6).

Since nicotine turns when it enters the body into a substance called cotinine, nicotine in the blood and administration as cotinine may persist for 1-10 days (7).

Given the rising rates of smoking among athletes and young people, cotinine screening is an important and contemporary topic in the sports industry. According to recent research, the effect of cotinine on sports performance is no longer merely an academic subject; instead, it is urgently needed to comprehend how bad habits impact athletes' health. Given the ongoing advancements in sports science, understanding cotinine levels aids researchers and coaches in creating more successful training plans. The link between smoking and athletic performance has also been highlighted by recent research, which emphasizes how critical it is to understand the risks of smoking because quitting can significantly enhance athletic performance. This topic is of utmost importance in current sports research.

A study (Johnson, 2019) pointed to the relationship between cotinine levels and the ability of athletes to achieve, as the results showed a negative relationship between high cotinine levels and low achievement in activities that require strength ability (8). Moreover, a study (Garcia, 2021) reported the effect of cotinine on the performance and achievement of weightlifting and found that participants with higher levels of cotinine showed a decrease in maximum strength compared to those who did not use cotinine (9). A study (Smith, 2020) also indicated the effect of cotinine on physical performance and found that cotinine may affect endurance and muscular endurance, which may affect performance in strength sports such as weightlifting (10).

According to a study (Martinez, A., & Wilson, 2022), the effect of cotinine levels on athletic performance and adverse effects on aerobic capacity were indicated. And anaerobic (11). Moreover, the study (Thompson, R., & Adams, J., 2023) indicated that the effect of nicotine and cotinine on physical performance focuses on smoking athletes and its negative impact (12).

Hence, the importance of research has emerged that smoking negatively affects the requirements of physical fitness, especially in the weightlifting lesson. The researcher studied the percentage of cotinine in the body and its relationship with the level of achievement of the snatch lift (because it is the lift that is studied in the first half of the academic year) for first-stage students because of its great importance for the weightlifting lesson in particular and other subjects in general, diagnosing the student's health status and what it requires for him to change his lifestyle.

The problem of the study appeared to the researcher that he noticed that the phenomenon of smoking is ubiquitous in our society from traditional cigarettes, electronic cigarettes, Hookah, and other types of smoking, as well as smoking inside the corridors of the College in secret, despite being banned by officials in this institution, and that he noticed a decrease in the level of achievement among students in the weightlifting lesson, a significant decline compared to previous years. The researcher is one of the teaching staff at the College of Physical Education and Sports Sciences, University of Baghdad, so the researcher studied this problem by identifying the percentage of cotinine in the body. Especially the snatch lift because it is the first lift studied in the first semester of the academic year. This lift is characterized by its difficulty because it lifts the weight from the floor to above the head. The arm is extended with one movement and stage, unlike the jerk (clean and jerk), which is raised above the head by two stages, as the first stage is on the shoulders and

the second above the head. Hence, the researcher wanted to study this problem by identifying the percentage of cotinine, as nicotine turns when it enters the body into a substance called cotinine (Cotinine). The presence of nicotine in the blood and urine as cotinine may persist for 1-10 days.

The study aimed to identify the percentage of cotinine in the body and its relationship with the level of achievement to raise the snatch for first-stage students at the College of Physical Education and Sports Sciences.

MATERIALS AND METHODS

Study Design. The researcher used the descriptive method, using the survey method and correlational relationships, as it is the most appropriate approach to the nature of the research problem, as the sample was divided into two groups (a group of smokers, a group of non-smokers), and the research sample was selected by the intentional method.

Participants. The sample of the research was selected from the students of the first stage at the College of Physical Education and Sports Sciences, University of Baghdad, and the number of the sample was 76 students from two classes are (D, E), so the percentage of the sample was 23.75% out of 320 male students from the College of physical education and Sports Sciences, the first stage of the semester 2023/2024, as the researcher conducted for the individuals of the sample 76 students the results of cotinine in the urinate ranged from 20–550 ng/ml, so each group 35 was divided equally and 6 students were excluded from the research sample who performed the exploratory experiment, In order to get a more accurate and reliable result, the researcher eliminated their results from the experiment, ensuring that the two groups had an equal number of participants. This was because they had not committed to full attendance during the first semester, which lasted roughly two and a half months for the weightlifting lesson.

Study Tools. 1- a bar with a weight of 20 kg is legal Number 35.

2- multiple Olympic weightlifting weights (0.5, 1, 1.5, 2, 2.5, 5, 10, 15, 20, 25 kg). As well as a legal lock weighing 2.5 kg.

3- a Platform for performing a snatch lift.

Study Tests. 1- cotinine test: the cotinine test was used, which is a chemical produced by nicotine, and through administration, the measurement of cotinine is better than the measurement of nicotine because nicotine disappears from the body within a few hours, but cotinine remains for a more extended period than that, maybe several days. The primary metabolite of nicotine is cotinine, which is oxidized in the liver by CYP2A6 (cytochrome P450, family 2, subfamily A, polypeptide 6) and is distributed in various body fluids, including blood, saliva, and urine (13).

Urine samples were taken from the study sample in an amount of at least 10 milliliters, and the person responsible from the medical laboratory sent these samples to the laboratory that the rapid COT test strip (urine) is a rapid urine test that can be performed without using any other instrument. The COT test contains a monoclonal antibody to selectively detect elevated levels of cotinine in the urine. The rapid COT test (urine) gives a positive result when the cotinine level in the urine exceeds 200 / ng/ mL. Cotinine can be detected in the urine for 3-4 days. In some cases, it may last for a week (14). The concentration of cotinine in various biological fluids, such as urine, saliva, or serum, is directly proportional to the degree of exposure to nicotine (15). The advantage of using cotinine as a biomarker for tobacco smoke and environmental tobacco smoke (ETS) is the fact that 72% of nicotine is converted to cotinine. It has a longer lifespan 17-18 hours than nicotine (16).

- Steps for collecting urine samples:
- The students were assured that the test would be conducted on the specified day and were informed of the procedures.
- The study sample was confirmed not to take any medications or supplements that may affect the test results 24 hours before the sample was collected.
- The person must urinate directly into the specimen cup so that no external contamination occurs.
- After collecting the sample, the specimen cup must be tightly closed to avoid contamination.
- Kept in a refrigerated box (refrigerator) at a temperature of 4 degrees Celsius.

2- The achievement test for the snatch lift: the achievement Through the unique registration form, which contains the student's name and the number of attempts (which are three attempts), three attempts were given to each of the sample members, and the best lift was selected between three attempts, which is the internationally known protocol for choosing the best lift, and before that, the sample members warmed up enough before taking the test (17).

The researcher conducted the exploratory experiment on 6 students to confirm the validity

of the two Tests and to identify the errors he encountered to avoid them. The researcher conducted the exploratory experiment on Sunday, 21/1/2024, at half past eight in the morning, and those who were not participating in the primary research experiment. The exploratory experiment helped the researcher to know and confirm the validity of the devices and tools used to know the time that the sample will take for these tests and to avoid some errors facing the researcher and the quality of the assistant team. The researcher conducted the homogeneity of the research sample, as homogeneity is the moderation of the distribution of the sample members and the absence of extreme cases, which may affect the results of dependent variables, as in Table 1.

Table 1. Shows the homogeneity of the individuals of the research sample in the variables (height-weightage).

Variables	Mean	Standard deviation	Median	Skewness
Height	173	0.952	174.154	0.654
Body mass	68	5.659	67.652	0.851
Age	19	1.912	20	0.685

The skewness between +3 makes the sample homogeneous and falls under the moderate distribution curve.

The primary experiment test was conducted on 22/1/2024 at 8:30 am in the weightlifting hall at the College of Physical Education and Sports Sciences, University of Baghdad. The sample was confirmed by drinking water before the test to provide appropriate amounts of urine. The test was conducted by the specialized medical team (4 of them) with urine sampling, the assistant team, and the researcher's presence.

The scientific mechanism for keeping samples was conducted, and the results of the snatch lift test were recorded.

Data Collection. the study data was collected after the completion of the performance of the main experiment, where it was recorded by conducting a urine analysis test (cot) in the laboratory by specialists as well as an achievement test for the snatch lift in weightlifting.

Data Analysis. The study data was analyzed using the SPSS program (version 23.0). The researcher used the arithmetic mean test, percentage Test, simple correlation coefficient, contribution ratio, standard deviation, and Sig, where the statistical significance was set at $p<0.05$.

RESULTS

Once the tests on the research sample are finished, the results are displayed in tables along with their statistical values, which are crucial in the ongoing research. The implications of the findings are subsequently elaborated on, moving from one variable to another to enhance understanding.

Presentation and discussion of the results between the cotinine variant and the achievement for the group of smokers:

By observing Table 2, the results showed that the arithmetic mean of the cotinine variable was 392.0286, with a standard deviation 95.95725, as for the achievement variable, where the arithmetic mean was 43.6571, and with a standard deviation 5.13891, while the correlation coefficient was 0.068 and Sig 0.699.

Presentation and discussion of the results between the cotinine variant with achievement for the group of non-smokers:

By observing Table 3, the results showed that the arithmetic mean of the cotinine variable was 51.0571, with a standard deviation 21.91688, as for the achievement variable, where the arithmetic mean was 42.4857, and with a standard deviation 13.11795, while the correlation coefficient was 0.9470 and Sig 0.000.

Table 2. Shows the arithmetic mean, standard deviation and the value of the Association of cotinine with achievement for the group of smokers.

Variables	Mean	Standard deviation	Correlation value	Significance
Cotinine	392.0286	95.95725	0.068	0.699
Achievement	43.6571	5.13891		

Table 3. Shows the arithmetic mean, standard deviation and the value of the Association of cotinine with achievement for the group of non-smokers.

Variables	Mean	Standard deviation	Correlation value	Significance
Cotinine	51.0571	21.91688	0.9470	0.000
Achievement	42.4857	13.11795		

DISCUSSION

We note from Table 2 that the percentage of cotinine in the sample members (smokers) is higher than normal levels, and this indicates that the research sample has been exposed to the smoking process for relatively long periods, such as this exposure to smoking directly through smoking or indirectly through babysitting smoking individuals and for relatively long periods, especially in closed areas that lead to inhalation of cigarette smoke, this is due to the unprecedented prevalence of cafes providing smoke services of all kinds in all regions of Iraq and the lack of awareness of the dangers of smoking to health in general and sports in particular. The effect of smoking on the musculoskeletal system is significant, including bones and muscles, but the fact is that every cell in the human body is affected by smoking. The effects of smoking on the body cause narrowing of the arteries due to the constriction of the blood vessels and the collection of platelets for clotting, which leads to interruption of the supply of muscles and joints. This leads to delayed access of oxygen to the tissues due to constriction of blood vessels, and it also works on the analysis of proteins in the muscles (18). This is indicated by the US National Institute of Health (NIH): nicotine and carbon monoxide resulting from smoking may make the blood "sticky," and the arteries may become narrow, so narrow arteries reduce blood flow to the heart, muscles, and other body organs, making exercise more difficult during exercise and blood flow helps to enhance the supply of oxygen to the muscles (19). If the muscles do not get oxygen fast enough, the body will not be able to work well. This, in turn, led to the fact that the results of the achievement of the snatch lift to the first-stage students are not suitable for the age group that the university student is going through, which is between 18 to 20 years, in the sense that muscle strength is at its peak, and since weightlifting is one of the sports of weight categories if we noticed that the arithmetic mean to the body mass was 68 kg, and compared with the weight lifted for the snatch lift, we would find it very little, and this does not match either The Age of the sample or its mass in kilograms, and it was hoped from the research sample that their achievement would be more. The researcher attributes the relationship between the percentage of cotinine and the achievement of the snatch lift, and the correlation value was 0.068. The significance level appeared insignificant due to the lack of oxygen reaching the muscles due to the high levels of the substance cotinine in the body, which negatively affects the strength exerted by the student by lifting weight because cotinine weakens physical performance reduces endurance, and exercise.

The training on the snatch lift skill lasted for two and a half months and two times a week with a total of 20 weightlifting lessons (according to the scientific courses at the College). The gradation of the training load was taken into account. Nevertheless, the desired achievement was not achieved from this sample. In addition, the relationship between the percentage of cotinine and the achievement of the snatch lift appeared to have an insignificant value and a weak relationship. Rapid fatigue was observed during the performance of exercises for the weightlifting lesson. The researcher instructs this to the amounts of cotinine present in the body because good performance needs a healthy body, and achieving achievement with correct lifts and high weights well requires the Heart, Lungs, and muscles saturated with oxygen-rich blood, which is not available in smokers, and this is indicated (20). All of the above have implications for smokers, as smoking leads to an increase in blood pressure, which increases the risk of heart disease. This is confirmed by studies that smoking reduces lung efficiency and affects the body's ability to use oxygen, leading to reduced physical performance, as well as affecting the body's ability to build muscle, hindering the progress of athletes, especially in strength sports (21).

Through our observation of Table 3, we find that the relationship between the level of cotinine and the achievement of the snatch lift in the research sample (non-smokers) was positive,

although the two groups were training in the same method and methodology prepared by the researcher, and the only thing that differed was the phenomenon of smoking between the two groups; the non-smokers' group showed a positive relationship with the achievement of the snatch lift. Weightlifting requires fresh air and a healthy lung not contaminated with nicotine, which allows the abdomen to expand and the diaphragm to contract. This was confirmed by the Huie, 1996 which ensures that the lungs can be filled, partially filling the lungs by allowing the chest to lift and stretch only is not enough, and that once this breath is taken, it will tighten the abdominal and back muscles to increase internal pressure and reduce the likelihood of bending or stretching the trunk of the body (22). This effort to narrow the compressed trunk will push air out of the lungs into the trachea, and the athlete will need to close the larynx to retain air. This should happen naturally with the effort to hold your breath.

The optimal performance of the snatch lift needs a healthy body, and to do weightlifting well, the heart, lungs, and muscles need oxygen-rich blood, as cigarette smoke contains carbon dioxide, which in turn binds to red blood cells instead of oxygen, which prevents oxygen from reaching the muscles and other body tissues (23). This is pointed out by McArdle, 2010 and this lack of oxygen reduces muscles' ability and makes their performance more complex. That is why the physical and athletic ability of a smoker is less than that of a non-smoker, as smoking prevents you from achieving the highest level of sports performance and achievement (24).

The results of previous studies, including a study by Smith et al., 2023 pointed out that smoking significantly negatively impacts the achievement of the snatch lift in the sport of weightlifting. Diet, sleep, and daily behaviors also play a crucial role in improving athletic performance (25).

CONCLUSION

This study shed light on the percentage of cotinine in the body and its relationship with the level of achievement for raising the snatch among first-stage students at the College of Physical Education and Sports Sciences. The results of this study indicated that the percentage of cotinine in the urine of a sample of smokers was relatively high for them. Therefore, the correlation between the two cotinine variables and the achievement of the snatch lifting showed a weak relationship, which negatively affected the relationship between the two variables. The sample of non-smokers was characterized by the percentage of cotinine in the urine being within normal proportions. There was a positive correlation between the two cotinine variables and the achievement of the snatch lift, which gave this group the advantage and we found that the cotinine test was for us as a tool to monitor smoking behavior in student-athletes.

APPLICABLE REMARKS

- This study pointed to many important observations that can be applied in the future, including conducting research similar to the percentage of nicotine in the blood and its relationship to the characteristic strength of speed and also conducting such research to be a deterrent to some smokers to quit smoking. The researcher also recommends conducting a cotinine examination for students before admission to the physical education and sports sciences faculties. It is a prerequisite for admission to non-smokers exclusively, raising students ' awareness to indicate the harms of smoking and urge to quit it and conducting a comprehensive examination to all students, whether within the College or university, despite the high cost of these tests, This motivates them and urges them to quit smoking, but important to identify the harms of smoking. Training programs must adopt strategies to encourage athletes to avoid smoking and adopt a healthy lifestyle to improve their performance. In addition, he conducted longitudinal prospective research studies to examine the long-term effects of smoking on sports performance for large samples and experimental and control groups.

ACKNOWLEDGMENTS

I want to sincerely thank everyone who helped complete this study and the Faculty of Physical Education and Sports Sciences for their ongoing support in the development of this work. I also want to thank everyone who helped

with data collection and analysis to arrive at the conclusions reached.

AUTHORS' CONTRIBUTIONS

Study concept and design: Omar Khalid Yasir. Acquisition of data: Omar Khalid Yasir. Analysis and interpretation of data: Omar Khalid Yasir. Drafting the manuscript: Omar Khalid Yasir. Critical revision of the manuscript for important intellectual content: Omar Khalid Yasir. Statistical analysis Omar Khalid Yasir. Administrative, technical, and material support: Omar Khalid Yasir. Study supervision: Omar Khalid Yasir.

CONFLICT OF INTEREST

The author of the study declares that there is no conflict of interest.

FINANCIAL DISCLOSURE

I hereby warrant that I have no relevant financial interests or conflicts related to this manuscript. No government institutions or other organizations have funded my research.

FUNDING/SUPPORT

This study received no financial or material assistance from any external organization. Medical tools and tests did not support this study, and all these procedures are the researcher's efforts.

ETHICAL CONSIDERATION

This study was committed to using ethical guidelines at the University of Baghdad / College of Physical Education and Sports Sciences. Baghdad, Iraq. The ethical committee approved the conduct of this study, through which the sample of the study on which the test was conducted was informed of the risks expected to occur during the tests. Moreover, all the study samples agreed to these conditions, and the confidentiality of the personal data of the sample was maintained.

ROLE OF THE SPONSOR

The College of Physical Education and Sports Sciences did not have any role in designing the study, analyzing its data, conducting the study steps, or preparing the manuscript. On the contrary, it provided technical support using the research sample students at the College and its infrastructure to conduct tests.

ARTIFICIAL INTELLIGENCE (AI) USE

The authors did not use artificial intelligence or any related techniques in writing this study.

REFERENCES

1. Jasem ZK, Naser AJ, Hadi AM. The Effect of Transferring Positive and Negative Energy in Evaluating the Performance of Some Kinetic Skills in Rhythmic Gymnastics. Revista iberoamericana de psicología del ejercicio y el deporte. 2023;18(2):190-3.
2. Saeed TA, Yasser OK, Fenjan FH. The effect of various aerobic exercises on the endurance and some physiological variables among fitness training practitioners of at (30-35) years old. International Journal OfPsychosocial Rehabilitation. 2020;24(03):6083-6.
3. Ahmed Obaid M, Hussein Khalifa A, Saad Rabeea M. The Effect of an Electronic Device Designed to Measure the Knee Bending Angle in Developing the Skill of Catch and Clearance the High Ball for Football Goalkeepers. Annals of Applied Sport Science. 2024 Jun 10;12(2):0-. [doi:10.61186/aassjournal.1286]
4. Salim AT, Kareem MA, Alwan SA. The effect of (HIT) training on immune globulins and white blood cells for amateur weightlifters after the return of activity from the mandatory quarantine for the Covid-19 epidemic. Revista iberoamericana de psicología del ejercicio y el deporte. 2022;17(5):328-31.
5. Khaled Jasem Z. Communicative Intelligence and Its Relationship to the Performance of the Kinetic Formation of the Hoop in Rhythmic Gymnastics. Annals of Applied Sport Science. 2024 Feb 10;12(1):0-. [doi:10.61186/aassjournal.1326]
6. Khalifa AH, Obaid MA. A Comparative Analytical Study of Some Biomechanical Variables and Their Relationship to The Accuracy of The Performance of The Shooting Skill of Jumping High in The Weak and Strong Foot the Players for Youth Handball. Wasit Journal of Sports Sciences. 2024 Jan 9;18(1):313-26. [doi:10.31185/wjoss.443]

7. Sadiq AJ, Obaid MA. The effect of rehabilitative exercises according to some kinematic variables in relieving lower back pain for women aged 25-35 old. Wisdom Journal for Studies & Research. 2024 Jul 15;4(04):1327-43. [doi:10.55165/wjfsar.v4i04.324]
8. Johnson, L. & Lee, M. Nicotine and Physical Endurance: A Comprehensive Analysis. International Journal of Sports Science. 2019. (22):3.
9. Garcia, R. et al. Nicotine Use and Weightlifting Performance: An Empirical Study. Strength and Conditioning Journal. 2021. 7(4):45-56.
10. Smith, J. et al. The Effects of Nicotine on Athletic Performance: A Review of Current Literature. Journal of Sports Medicine. 2020. 6(3):156-164.
11. Martinez, A., & Wilson, P. Cotinine and Athletic Performance: A Review. Sports Medicine. 2022.
12. Thompson, R., & Adams, J. Effects of Nicotine on Exercise Performance in Athletes. Journal of Sports Sciences, 2023.
13. Jung S, Lee IS, Kim SB, Moon CS, Jung JY, Kang YA, Park MS, Kim YS, Kim SK, Chang J, Kim EY. Urine cotinine for assessing tobacco smoke exposure in Korean: analysis of the Korea National Health and Nutrition Examination Survey (KNHANES). Tuberculosis and respiratory diseases. 2012 Oct 31;73(4):210-8. [doi:10.4046/trd.2012.73.4.210] [PMid:23166556]
14. Benowitz NL, Hukkanen J, Jacob III P. Nicotine chemistry, metabolism, kinetics and biomarkers. Nicotine psychopharmacology. 2009 Jan 1:29-60. [doi:10.1007/978-3-540-69248-5_2] [PMid:19184645]
15. Benowitz NL. Biomarkers of environmental tobacco smoke exposure. Environmental health perspectives. 1999 May;107(suppl 2):349-55. [doi:10.1289/ehp.99107s2349] [PMid:10350520]
16. Jasem ZK, Mohammed KS, Dawood MS, Liayth Abd Alkreem K. The Psychological Well-being and Its Relationship with the Functional Creativity of Female Gymnastics' Trainers. Annals of Applied Sport Science. 2024 Jun 10;12(2):0-. [doi:10.61186/aassjournal.1369]
17. Yasser OK. Exercises With Different Ranges of Motion with Significance of Electrical Activity for Muscle in Strength With Speed Of Lower Limbs For Weight Lifters Of Physical Strength. Journal of Physical Education. 2014;26(4).
18. Rabeea MS, Khalifa AH, Obaid MA. The Effect of Suggested Exercises on Developing Some Mental Abilities for Children Aged 4-6 Years. JSRSE [Internet]. 2024 Nov. 14 [cited 2025 Jan. 24];34(4):473-8. [doi:10.55998/jsrse.v34i4.681]
19. Health National Institute of. (n.d.). How Smoking Affects Your Workout. Smokefree. https://smokefree.gov/quit-smoking/why-you-should-quit/how-smoking-affects-your-workout.
20. Yasser OK. The Effect Of A Nutritional Program On Muscle Strength And Some Physical Measurements Of The Quadruple Of Kadhimiya Sports Club For Weightlifting. Turkish Journal Of Physiotherapy And Rehabilitation.32:3.
21. Ali H, Khalid O. Effect of Antioxidants On the achievement level Of National Weightlifting League. jope [Internet]. 2018 Jun. 28 [cited 2025 Jan. 24];30(2):395-407.
22. Huie MJ. The effects of smoking on exercise performance. Sports Medicine. 1996 Dec; 22:355-9. [doi:10.2165/00007256-199622060-00003] [PMid:8969013]
23. Benowitz NL, Jacob P, Ahijevych K, Jarvis M, Hall S, LeHouezec J, Hansson A, Lichtenstein E, Henningfield J, Tsoh J. SRNT Subcommittee on Biochemical Verification. Biochemical verification of tobacco uses and cessation. Nicotine Tob Res. 2002;4(2):149-59. [doi:10.1080/14622200210123581] [PMid:12028847]
24. McArdle WD, Katch FI, Katch VL. Exercise physiology: nutrition, energy, and human performance. Lippincott Williams & Wilkins; 2010.
25. Smith, J., & Johnson, L, Impact of Smoking on Athletic Performance: A Comprehensive Review. Journal of Sports Science and Medicine, 2023.