



Influence of behavioral risk factors on the state of the cardiorespiratory system of girls living in the arctic region

UDC 612.821.6

Applicant **E.A. Klokotova**¹PhD, Associate Professor **I.A. Varentsova**¹Dr. Biol., Professor **V.N. Pushkin**^{2,3}Dr. Biol., Associate Professor **E.Yu. Fedorova**²¹Northern (Arctic) Federal University named after M.V. Lomonosov, Arkhangelsk²Moscow City University, Moscow³Moscow State University of Sport and Tourism, Moscow

Corresponding author: taiss43@yandex.ru

Received by the editorial office on 03.24.2023

Abstract

Objective of the study was to evaluate the effect of tobacco intoxication on the functional state of the cardiorespiratory system in girls from the Arctic region.

Methods and structure of the study. The experiment involved 51 girls aged 20.54 ± 1.7 years (girls who use smoking tobacco - $n=21$; girls who do not use smoking tobacco - $n=30$). To assess the degree of nicotine addiction, subjects using smoking tobacco filled out the Fagerström test.

Results and conclusions. The results of the experiment show that the hemodynamic and pulmonary systems, regardless of the addiction / disinterest in smoking in girls, are preserved. However, the depth of breathing in people who are fond of smoking, in a state of relative muscle rest, is almost 38% less. Performing physical activity provokes a more significant increase in the values of oxygen consumption (O_2), CO_2 , respiratory volume in smoking girls. Also, in this group, it takes more time to restore the respiratory system after exercise, in contrast to non-smoking respondents. It can be assumed that in smoking girls, tobacco intoxication provokes the accumulation of toxic elements in the body and higher rates of gas exchange are required to remove toxic substances.

Keywords: *students, bad habits, smoking, gas exchange, physical performance, hemodynamics.*

Introduction. Currently, the prevalence of smoking is a significant problem among young people. Modern youth tend to underestimate the danger of developing nicotine addiction; they are characterized by a reckless attitude towards electronic cigarettes and the combined consumption of tobacco and hookah, tobacco and alcohol [5, 8]. Young people also do not realize the dangers of another widespread problem – passive smoking. According to modern research, this problem is observed among 52% of the adult population, and 30% of young people are influenced by second-hand smoke within the walls of educational institutions [3].

The passion for smoking among young people is associated with the fact that in the process of spending time together while using tobacco, it is easier for

young people to adapt to a new environment and assert themselves in a team [6].

Despite the fact that there are more men who smoke both in the world and in our country than women, the number of young girls consuming tobacco is increasing. This trend is extremely dangerous. Since tobacco smoke, including during collateral breathing, has a negative effect on the fetus, provoking deviations in behavioral reactions, elemental homeostasis and morphometric parameters [2].

Nicotine also provokes a significant number of other diseases. One cannot but agree that the external respiratory system is the main organ suffering from the effects of a complex of toxic substances. Under the influence of tobacco smoke, damage to the lung tissue occurs, and negative processes occur that pro-



voke a decrease in the ventilation functions of the pulmonary system [4].

In the northern region, the external respiratory system is already subject to significant stress due to the climatic characteristics of the Arctic region [1, 7]. But, despite having a broad outlook and knowledge of the negative effects of smoking on health, the number of people exposed to this bad habit is not decreasing, but is only growing.

Objective of the study was to evaluate the effect of tobacco intoxication on the functional state of the cardiorespiratory system in girls from the Arctic region.

Methods and structure of the study. The state of the cardiorespiratory system was assessed in practically healthy girls. A total of 51 girls aged 20.54 ± 1.7 years took part in the experiment (girls who use smoking tobacco - $n=21$; girls who do not use smoking tobacco - $n=30$). To assess the degree of nicotine dependence, subjects using smoking tobacco filled out the Fagerström test.

According to the results obtained from the Fagerström test, the smoking girls participating in the study had a “weak” degree of nicotine addiction. To assess the functional state of the cardiorespiratory system, we used stress testing using a bicycle ergometer. The load power was selected taking into account the low physical activity of the girls - 1.5 kgm/min (0.25 W). Pedaling frequency – 60 rpm. To measure pulmonary gas exchange, the MetaMax®3B cardiopulmonary system from CORTEX Biophysik GmbH was used. Data were recorded in a state of relative muscle rest, during load testing (3 min) and during recovery (3 min). The results were processed using the STATISTICA 11.0 software package. The significance level was accepted as $p < 0.05 - 0.001$.

Results of the study and discussion. The study of cardiorespiratory parameters in a state of relative muscle rest did not reveal significant differences in its functional state in smoking and non-smoking girls

(Table 1). Oxygen consumption (O_2) and carbon dioxide emissions (CO_2) in girls from both groups corresponded to normalized indicators. However, the values of respiratory volume (RV) in non-smoking girls are significantly higher than in smokers (0.78 l/min in non-smokers and 0.49 l/min in smokers) ($p < 0.001$). Consequently, the depth of breathing in people who are addicted to smoking in a state of relative muscular rest is almost 38% less. In addition, the respiratory rate (RR) in girls exceeds the normal values for this age (14-18 times/min). Heart rate indicators are also stable relative to the proper values, which are in the range of 84.95-85.67 beats/min.

Thus, an increase in energy expenditure in a state of relative muscular rest to ensure the activity of the cardiorespiratory system in girls living in the northern region can be traced only by the RR indicator, which is 10% higher than the upper values of the appropriate age values.

Analysis of the results obtained during stress testing showed that in smoking girls the increase in heart rate occurs only at the beginning of the 3rd minute of the load, while in non-smokers this process occurs gradually (Table 2). Other studied indicators – O_2 , CO_2 , RV – change similarly in groups. During 3 minutes of physical activity, girls experience an active increase in gas exchange processes, more pronounced in girls who smoke, except for the RR indicator, which increases more actively in non-smoking students. Heart rate values changed slightly during testing dynamics. In the dynamics of the study (resting state-completion of exercise), heart rate values increased in girls from both groups during the entire period of physical activity by 24% ($p < 0.001$). Whereas, relative to the resting state, $O_2/CO_2/RV$ increased, respectively, in smokers by 73% ($p < 0.001$), by 63% ($p < 0.001$) and by 48% ($p < 0.001$), and in non-smoking female students - by 54 % ($p < 0.001$), by 59% ($p < 0.001$).

Table 1. Characteristics of the cardiorespiratory system of girls in a state of relative muscular rest

Indicators	Smoking girls	Non-smoking girls
Indicators of the cardiorespiratory system in a state of relative rest		
Heart rate, beats/min	$84,95 \pm 2,32$	$85,67 \pm 1,7$
O_2 , l/min	$0,28 \pm 0,01$	$0,27 \pm 0,01$
CO_2 , л/мин	$0,21 \pm 0,01$	$0,21 \pm 0,01$
RV, л/мин	$0,49 \pm 0,03$	$0,78 \pm 0,02^{***}$
RR, раз/мин	$20,32 \pm 1,13$	$20,52 \pm 0,49$

Note: hereinafter – * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ – between smoking and non-smoking girls.

**Table 2.** Characteristics of the cardiorespiratory system of girls during physical activity

Indicators	Smoking girls	Non-smoking girls
Indicators of the cardiorespiratory system during 1 minute of exercise		
HR ₁	86,03±0,56	106,25±1,78***
O ₂ , l/min	0,29±0,01	0,47±0,01***
CO ₂ , l/min	0,23±0,008	0,33±0,004***
RV, l/min	0,49±0,01	0,56±0,03**
RR, times/min	21,05±0,13	24,6±0,71**
Indicators of the cardiorespiratory system during 2 minutes of exercise		
HR ₂	110,29±2,87	110,43±1,77
O ₂ , l/min	0,75±0,01	0,59±0,01***
CO ₂ , l/min	0,57±0,04	0,41±0,01***
RV, l/min	0,91±0,06	0,67±0,02***
RR, times/min	21,29±0,62	23,33±0,85***
Indicators of the cardiorespiratory system during 3 minutes of exercise		
HR ₃	111,57±3,28	111,55±1,93
O ₂ , l/min	0,75±0,01	0,65±0,03***
CO ₂ , l/min	0,62±0,04	0,50±0,03***
RV, l/min	0,94±0,06	0,77±0,04***
RR, times/min	21,77±0,70	23,8±0,78*

Анализ показателей гемодинамики и газообмена у девушек, полученный в процессе восстановительного периода, показал, что для студенток, имеющих никотиновую зависимость, требуется более длительное время для восстановления процессов газообмена (табл. 3). После завершения восстановительного периода (3 минуты), в данной группе величины CO₂ и ДО превышают показатели покоя на 20%. Тогда

как в группе некурящих девушек все изученные величины возвращаются к значениям покоя.

Conclusions. Thus, the results of the study indicate that the hemodynamic and pulmonary systems, regardless of whether they are interested in or not interested in smoking, are intact in girls. However, the depth of breathing in people who are addicted to smoking is almost 38% less in a state of relative muscular rest. Performing physical activity provokes a more signifi-

Table 3. Characteristics of the cardiorespiratory system of girls in a state of relative muscular rest and in the process of recovery

Indicators	Smoking girls	Non-smoking girls
Indicators of the cardiorespiratory system during 1 min of recovery		
HR ₁	98,19±3,17	98,88±1,76
O ₂ , l/min	0,53±0,03	0,42±0,01***
CO ₂ , l/min	0,47±0,04	0,34±0,01***
RV, l/min	0,80±0,05	0,62±0,02***
RR, times/min	20,51±0,51	22,00±0,62
Indicators of the cardiorespiratory system during 2 min of recovery		
HR ₂	85,48±2,46	88,56±1,74
O ₂ , l/min	0,32±0,02	0,26±0,01***
CO ₂ , l/min	0,31±0,03	0,23±0,01***
RV, l/min	0,64±0,04	0,51±0,01***
RR, times/min	19,50±0,6	20,79±0,70*
Indicators of the cardiorespiratory system during 3 min of recovery		
HR ₃	85,74±2,20	85,46±1,69
O ₂ , l/min	0,28±0,02	0,24±0,01**
CO ₂ , l/min	0,26±0,02	0,20±0,01***
RV, l/min	0,60±0,04	0,46±0,02***
RR, times/min	18,67±0,61	20,70±0,68*



cant increase in O_2 , CO_2 , and RV values in girls who smoke. Also, this group requires more time to restore the respiratory system after exercise, in contrast to non-smoking respondents. It can be assumed that in girls who smoke, tobacco intoxication provokes the accumulation of toxic elements in the body and higher rates of gas exchange are required to remove toxic substances.

References

1. Andreeva E.A., Pokhaznikova M.A., Kuznetsova O.Yu. Rasprostranennost kureniya sredi zhiteley dvukh gorodov severo-zapadnogo regiona Rossii po dannym mezhdunarodnogo issledovaniya «Respekt» [The prevalence of smoking among residents of two cities in the northwestern region of Russia according to the international study "Respect"]. Kazan: Mnogoprofilnyy meditsinskiy tsentr «Sovremennaya klinicheskaya meditsina» publ., 2017. pp. 45-61.
2. Lizurchik L.V. Vliyaniye tabachnoy intoksikatsii na funktsionalnoye sostoyaniye laboratornykh zhivotnykh i elementnyy gomeostaz v sisteme mat-platsenta-plod [Influence of tobacco intoxication on the functional state of laboratory animals and elemental homeostasis in the mother-placenta-fetus system]. PhD diss. abstract. Peoples' Friendship University of Russia. Moscow, 2022. 26 p.
3. Markova O.L., Kiryanova M.N., Ivanova E.V., Zaritskaya E.V. Puti minimizatsii negativnogo vliyaniya komponentov tabachnogo aerolya pri passivnom kurenii [Ways to minimize the negative impact of tobacco aerosol components in passive smoking]. Gigiyena i sanitariya. 2019. Vol. 98. No. 6. pp. 682-687.
4. Mordyk A.V., Bagisheva N.V., Vershinina M.V. Kureniye, khronicheskaya obstruktivnaya bolezn legkikh i tuberkulez: sostavlyayushchiye problemy [Smoking, chronic obstructive pulmonary disease and tuberculosis: components of the problem]. Omsk, 2018. 126 p.
5. Popova N.M., Korobeinikov M.S., Alekseeva N.A. Rasprostranennost kureniya sigaret, kalyanov i elektronnykh sigaret sredi studentov Izhevskoy meditsinskoy akademii [The prevalence of smoking cigarettes, hookahs and electronic cigarettes among students of the Izhevsk Medical Academy]. Vestnik nauki. 2019. Vol. 2. No. 4 (13). pp. 97-100.
6. Tikhonova N.K., Pleshkova E.M., Pleshkov V.V., Belyaev I.O., Arshansky M.M. Otsenka vliyaniya kureniya na kachestvo zhizni studentov Smolenskogo gosudarstvennogo meditsinskogo universiteta [Assessment of the impact of smoking on the quality of life of students of the Smolensk State Medical University]. Vestnik Smolenskoy gosudarstvennoy meditsinskoy akademii. 2021. Vol. 20. No. 4. pp. 37-43.
7. Pushkina V.N., Gernet I.N., Olyashev N.V., Lubyshchev E.A. Funktsionalnyy sostoyaniye vneshney respirationy molodoy zhenskiy v raznykh regionakh Rossii. Teoriya i praktika fizicheskoy kultury. 2020. No. 2. p. 4.
8. Schneider B., Baumert J., Schneider A., Marter-Mittag B., Meisinger Ch., Erazo N., Hammer G.P., Ladwig K.-H. The effect of risky alcohol use and smoking on suicide risk: findings from the German MONICA/KORA-Augsburg Cohort Study. Soc. Psychiatry and Psychiatr. Epidemiol. 2011. Vol. 46. No. 11. pp. 1127-1132.