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İDMANÇININ ÜRƏYİNİN XÜSUSİYYƏTİ İLƏ CİNSİYYƏTİNİN VƏ İDMAN FƏALİYYƏTİNİN MÜDDƏTİNİN ƏLAQƏSİ

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Məqalədə idmançıların ürəyinin sol mədəciyinin ölçüsü ilə cinsiyyəti və fiziki məşqlərin müddəti arasındakı əlaqəni öyrənmək məqsədilə aparılmış tədqiqat işi haqqında məlumat verilmişdir. Tədqiqata 29 kişi və 25 qadın olmaqla 54 idmançı cəlb edilmişdir. Fiziki məşqlərin səviyyəsi və uğuru milli dərəcə təsnifatına uyğun olaraq qeydə alınıb. Ürəyin əsas strukturlarının ölçüsünü müəyyən etmək üçün ümumi qəbul edilmiş üsullardan istifadə edilərək exokardioqrafik müayinə aparılmışdır. Göstəricilər bədən səthinin sahəsinə və hündürlüyünə görə uyğunlaşdırılmışdır. Tədqiqat göstərmişdir ki, idmançı kişilərin 24,14 faizində, qadınların isə 32 faizində sol mədəciyin diametri istinad normasından artıqdır. Müayinə olunan 54 subyektdən 52-də sol mədəciyin diametrinin orta normal dəyərə nisbətən artıqlığı aşkar edilmişdir. Sol mədəciyin diametrinin artması ilə idman fəaliyyətinin müddəti arasında mənfi əlaqə aşkarlanmışdır. Sol mədəciyin genişlənməsi idmançıların dördəbirində, kişilərdə və qadınlarda bərabər tezlikdə aşkar edilmişdir. Sol mədəciyin genişlənməsi ehtimalı 5-10 il ərzində məşqlə əlaqədar olaraq artmışdır. Bu artımın sürəti kişilərdə daha aydın təzahür etmiş və 10-illik məşqdən sonra azalmağa meyl etmişdir.

Açar sözlər: idmançının ürəyi, remodeling, exokardioqrafiya

Ключевые слова: сердце спортсмена, ремоделирование, эхокардиография

Key words: athlete's heart, remodeling, echocardiography

THE RELATIONSHIP BETWEEN AN ATHLETE'S HEART CHARACTERISTICS, GENDER, AND THE DURATION OF SPORTS ACTIVITY

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The article presents information on a study conducted to investigate the relationship between the size of the left ventricle of the heart, gender, and the duration of physical exercise in athletes. The study involved 54 athletes, including 29 men and 25 women. The degree of the level of exercise and their success according to the national classification of ranks were recorded. Echocardiography was performed according to standard methods to determine the size of the main structures of the heart, indicators were normalized to body surface area and height. An increase in the diameter of the left ventricle above the reference norm was noted in a quarter of the athletes, in 24.14% of men and 32% of women. The excess of the diameter of the left ventricle relative to the average value of the norm was detected in 52 out of 54 subjects. A negative relationship was found between an increase in the diameter of the left ventricle and the duration of sports activities. Left ventricular dilatation was found in a quarter of athletes, with the same frequency for men and women. The likelihood of left ventricular dilatation increased with physical exercise in the time interval of 5-10 years, was more pronounced for men and decreased after 10 years of sports.

The athlete's heart is the result of remodeling of the heart's structure in response to prolonged exposure to exercise. In a study by J.Mor-

ganroth [1], using echocardiography, two variants of heart changes in athletes were determined, which depended on the type of

load, isotonic or isometric. With isotonic exercise, such as swimming or running, there has been an increase in end-diastolic volume of the heart and its mass due to chronic volume overload. They showed that physical activity with a high level of dynamic component leads to an increase in the left, right ventricles, left atrium, and can also be accompanied by increased wall thickness [2]. However, most disciplines are characterized by varying degrees of expression of both components - dynamic (isotonic) and static (isometric). In the proposed classification of sports, they were distributed depending on the severity of the static and dynamic components [3]. Later, a simplified scale was proposed for Olympic sports, taking into account the severity of isotonic, isometric components and the severity of cardiac remodeling [2].

In addition to the discipline of sports, the size of the heart is influenced by the size of the athlete, their height and weight. Although the features of heart remodeling in women athletes are similar to men, however, the extent of changes is less in absolute terms [2; 4]. In some papers, changes in the right ventricle are indicated as a feature of heart remodeling in women, while in men it is the left ventricle [5]. A number of authors describe the ethnic characteristics of the athlete's heart. In black athletes, Arabic and Asian athletes, the severity of remodeling is higher than in white athletes [6; 7]. In younger athletes, in comparison with the masters, higher indicators of the mass and volume of the left ventricle were noted. Systolic function in both groups does not differ, at the same time, diastolic function can be reduced in masters, which is associated with the physiological process of heart aging [8]. Studies conducted in adolescents have shown large values of the size of the left and right ventricles, as well as left ventricular hypertrophy [4]. At the same time, not all factors influencing the processes of heart remodeling in athletes have been evaluated. There are questions of detailing the dependence of changes in heart parameters on the duration of playing sports, the level of success achieved.

The aim. The aim of the study was to study the associations between gender and duration of participation in sport and the remodeling of the left ventricle of the athlete's heart.

Materials and methods. The study involved 54 athletes, including 29 men and 25 women. To assess the load depending on the sport, Antonio Pelliccia classification was used [2]. The average age did not differ by gender and was 22,21 years, the height, weight, BSA and BMI were significantly higher in men. Among 46 (85,2%) athletes had a dynamic type of load, the duration of training was 10,4 years, 17,79 hours per week, 3,63 hours per day, there was no difference by gender. To determine the degree of the level of exercise and their success, the national classification of ranks was used. It was found that I degree, International Master of Sport of Ukraine, was noted in 7,14% of men and 28% of women ($p=0,037$), II degree, Master of Sport of Ukraine - in 71.43% and 40% ($p=0,023$), III degree, Candidate for Master of Sport of Ukraine - in 14.29% and 24% ($p=0,17$), respectively. No age differences were found between men and women in these categories.

Transthoracic echocardiography was used once in each participant to recognize structural abnormalities of the heart. Ultrasonic measurements were processed by recommendation of the American Society of Echocardiography and European Association of Cardiovascular Imaging [2; 9]. Left ventricle end-diastolic diameter (LVd, mm), Left ventricle diastolic posterior wall thickness (pwLV) were obtained in the parasternal long-axis section of LV, and relative wall thickness (RWT) was computed. Left ventricle end-diastolic diameter (LVd) was normalized to body surface area (LVd/BSA, cm/m²) and to height (LVd/h, cm/m). To assess the frequency of increase in the obtained indicators relative to average values, threshold values of the norm, the recommended data were used [9].

All statistical data were processed using a standard statistical formula. Continuous variables were confirmed for normal distribution by the Kolmogorov-Smirnov test and expressed as mean values $\pm$ standard deviation ($M \pm SD$). Differences between the two groups in continuous variables were analyzed using an independent t-test for normal distribution. The odds ratio (OR) was obtained for pairs with LVd and duration of participation in sport, level of exercise and their success. For statistically significant calculating the criteria χ^2 , Fisher (F), Student test (t) were used. $P\text{-value} < 0.05$ were considered as statistically significant.

All research methods and experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the Declaration of Helsinki.

Results. Since the main results of heart remodeling are the increase heart's chambers, mainly the left ones, and thickening of the myocardial wall, they were taken for further analysis (Table 1). The mean LVd in men was higher than in women. LVd above the upper limit of the norm was noted in 27,78% of the subjects. Exceeding the average value of LVd was noted much more often, in 93% of men and in all women.

The value of the LVd/BSA index was higher in women, which was due to higher BSA values in men. The frequency of LVd/BSA above the norm was more than twice as frequent as for the LVd indicator - 66.67%. The LVd/BSA index

was above the average value of the norm in 94,44% of cases, no gender differences were noted. Exceeding the value of LVd/h above the average value of the norm was noted in 66.67%, lower than for the indicators LVd and LVd/BSA.

The pwLV value was more significant in men than in women. But only in two athletes, the thickening of the posterior wall of the left ventricular myocardium was found above the normative values, in one man and one woman. The percentage of excess of this indicator above the average was more significant for men.

The calculation of the values of the odds ratio indicator was carried out (Table 2).

Table 1. Values of indicators of an echocardiography

<i>Variable</i>	<i>Male</i>	<i>Female</i>	<i>p</i>
LVd, mm	56±3.61	49.72±2.53	0.000
LVd, more than normal range, (n/%)	7/24.14	8/32	0.34
LVd, more than middle value, (n/%)	27/93.1	25/100	-
LVd, % exceed middle value	12.44±6.61	10.49±5.61	0.19
LVd/BSA, cm/m ²	2.99±0.26	3.54±0.32	0.000
LVd/BSA, more than normal range, (n/%)	14/50	23/92	0.000
LVd/BSA, more than middle value, (n/%)	27/93.1	24/96	0.41
LVd/BSA, % exceed value	14.53±7.88	27.55±9.89	0.002
LVd/h, cm/m	3.01±0.23	2.89±0.19	0.06
LVd/h, more than normal range, (n/%)	2/6.89	3/12	0.29
LVd/h, more than middle value, (n/%)	22/75.86	14/56	0.07
LVd/h, % exceed middle value	9.3±6.36	6.09±5	0.04
pwLV, mm,	8.17±0.8	7.12±0.78	0.003
pwLV, mm, more than normal range, (n/%)	1/3.57	1/4	-
pwLV, more than middle value, (n/%)	7/24.14	7/28	0.23
pwLV, % exceed middle value	16.07±9.45	8.57±5.04	0.007
LVd & pwLV more than normal range, (n/%)	1/3.45	0/0	-
pwLV & LVd, more than middle value, (n/%)	7/24.14	7/28	0.23
RWT	0.29±0.03	0.29±0.04	0.409
HR	57.14±9.43	56.92±9.08	0.848

Table 2. Odds ratio values in the risk of developing an increase in the diameter of the left ventricle depending on gender, duration and success in sports

Pair	OR	p	Pair	OR	p
LVd vs Male	0.78	0.2	LVd vs I degree	0.7	0.3
LVd vs < 5y	0.66	0.39	LVd Male vs I degree	3.5	0.38
LVd Male vs <5 yrs	0.69	0.41	LVd Female vs I degree	0.26	0.21
LVd Female vs <5 yrs	2.29	0.45	LVd vs II degree	0.61	0.17
LVd vs 5-10 yrs	3.0	0.05	LVd Male vs II degree	0.5	0.26
LVd Male vs 5-10 yrs	8.67	0.044	LVd Female vs II degree	0.86	0.33
LVd Female vs 5-10 yrs	1.5	0.32	LVd vs III degree	2.47	0.15
LVd vs > 10 yrs	0.35	0.06	LVd Male vs III degree	4.0	0.2
LVd Male > 10 yrs	0.14	0.07	LVd Female vs III degree	1.56	0.36
LVd Female > 10 yrs	0.55	0.26			

The risk of developing left ventricular dilatation was analyzed depending on the duration and success of sports activities. The OR value for the pair LVd vs 5-10 y showed that the risk of dilatation increased 3-fold if the athlete was involved in sports from 5 to 10 years ($p=0.05$). However, there were gender differences - in men, the probability of an increase in LVd increased by 8.67 times ($p=0.044$), while in women by 1.5 times ($p=0.32$). The value of the odds ratio also showed a tendency to increase the risk of developing left ventricular dilatation in athletes with a lower level of success in sports, in particular, at the III degree level. However, these changes were not significant.

Discussion. Signs of left ventricular remodeling were noted in 15 athletes, which amounted to 27.78%. In the vast majority of cases, this was an increase in LVd above the reference value of the norm. This change is most often detected in the presence of an "athlete's heart", according to some authors it is detected in 13-21% and is, as it were, a "common" phenomenon [10; 11]. Most of the athletes with LVd above the reference range of the norms had an Endurance Dynamic prevalent type of Exercise [Yoon HJ, 2021]. Previous studies have reported that an increase in LV size occurs on average among 10% [1; 12], in our study, 11.50%. The absolute values of LVd were higher in men, same with the study of other authors [13]. In our study, the frequency of LVd above the normal range in women did not have significant differences from men, but even tended to higher values in women ($p = 0.34$). The correction of absolute heart size to indicators of physical development cannot always eliminate the identified gender differences [14]. The expected percentage increase in LVd/BSA relative to the mean was greater than LVd. But this was due to increase in this parameter in women, first of all. They had an increase in LVd among 10.49%, while LVd/BSA - among 27.55%. In men it was 12.44 and 14.53%. Thus, the LVd/BSA index was more sensitive to determining the increase in the diameter of the left ventricle, however, gender differences were modulated by differences in physical development indicators, primarily by body weight. In general, in our study, the sensitivity LVd/h was less, both for the level of overcoming the limit of the norm,

and for exceeding the average value of the norm.

The absolute value of pwLV was higher in male athletes ($p=0.003$), but only two athletes, one man and one woman, exceeded the normal limit. This is due to the peculiarities of physical activity [3], with the prevalence in our study of the dynamic type of load. Exceeding the average value of the norm was observed in a quarter of the athletes, without significant gender differences. The deviation from the mean value of the norm was $12.32 \pm 8.25\%$, but it was higher in men ($p=0.007$). Apparently, this can be explained by a large number of athletes - men, performing a static load. None of the athletes had a pwLV value of 12 mm or more, other studies also confirm the rarity of such a change in athletes [15]. In general, the combination of thickening of the left ventricular myocardium and dilatation of the left ventricle is a characteristic feature of the adaptation of the heart [16]. In our study, there were isolated cases of myocardial thickening above the norm, however, all cases of an increase in myocardial thickness above the average for the norm were accompanied by the same increase in the diameter of the left ventricle, which confirmed this feature.

An assessment was made of the influence of the duration of sports activities and the level of success on the severity of left ventricular adaptation. For this, the LVd indicator was taken, which seems to be both sensitive and less dependent on the parameters of physical development and at the same time quite common in the studied group of athletes.

To clarify the period of time when this negative dependence is formed, time intervals were identified in which the presence/absence of an increase in LVd above the norm was determined to calculate the odds ratio. It showed an increase in the chances of developing left ventricular dilatation when playing sports for 5-10 years for the general group with an odds ratio of 3.0, but primarily for men 8.67 ($p=0.044$). For women, the odds ratio was positive, 1.5, but smaller and unreliable. When playing sports for more than 10 years, the probability of developing dilatation decreased by three to eight times, but these values were not significant. Up to 5 years of playing sports, the dependence of the develop-

ment of dilation was also negative for the general group, but positive for female athletes, but the calculations did not give reliable results. These results repeated the assessment of the relationship between the development of LVd and the level of success of an athlete according to the national classification. These changes, apparently, show the peculiarities of the adaptation of the heart to physical activity. Some authors point to an initial increase in pwLV, and 9 months after the start of training, LVd [17]. Others point to primary changes in LVd and then pwLV [18]. Studies conducted in adolescents have shown large values of the ventricle's size, as well as left ventricular hypertrophy [4]. It is indicated that in young athletes the mass and volume of the left ventricle is more significant, which may reflect both the course of adaptation processes and the

processes of physiological aging of the heart [19]. Apparently, our data may indicate the presence of left ventricular remodeling in the form of left ventricular dilatation, mainly in the first years of sports, more pronounced with the duration of these activities of 5-10 years and in athletes with initial levels of the national classification.

Conclusions.

In our study, signs of left ventricular remodeling in the form of its dilatation were found in a quarter of athletes, with the same frequency for men and women, with the absolute value of the diameter of the left ventricle being large in men.

The likelihood of left ventricular dilatation increased with physical exercise in the time interval of 5-10 years, was more pronounced for men, and decreased after 10 years of sports.

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ОСОБЕННОСТИ СЕРДЦА СПОРТСМЕНА, СВЯЗАННЫЕ С ПОЛОМ И ДЛИТЕЛЬНОСТЬЮ ЗАНЯТИЯ СПОРТОМ

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Резюме. В статье представлены результаты исследования, проведенного с целью изучить связи размеров левого желудочка сердца спортсменов с полом и продолжительностью физических упражнений. К исследованию были привлечены 54 спортсмена, в том числе 29 мужчин и 25 женщин. Фиксировалась степень уровня физических упражнений и их успешность согласно национальной классификации рангов. Эхокардиографию проводили по общепринятым методикам с определением размеров основных структур сердца, показатели нормировали по площади поверхности тела и росту. **Полученные результаты.** Увеличение диаметра левого желудочка выше референсной нормы отмечено у четверти спортсменов, у 24,14% мужчин и 32% женщин. Превышение диаметра левого желудочка относительно среднего значения нормы выявлено у 52 из 54 обследованных. Установлена отрицательная связь между увеличением диаметра левого желудочка и продолжительностью занятий спортом. Дилатация левого желудочка выявлена у четверти спортсменов, с одинаковой частотой у мужчин и женщин. Вероятность дилатации левого желудочка увеличивалась при физической нагрузке в интервале 5-10 лет, была более выражена у мужчин и снижалась после 10 лет занятий спортом.

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