Stanaszek Monika, Fortuna Małgorzata. Assessment of adaptive changes under the influence of applied recreational training in men based on cardiorespiratory selected parameters. Journal of Education, Health and Sport. 2020;10(5):102-110. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2020.10.05.009
https://apcz.umk.pl/czasopisma/index.php/JEHS/article/view/JEHS.2020.10.05.009
https://zenodo.org/record/3827911

The journal has had 5 points in Ministry of Science and Higher Education parametric evaluation. § 8. 2) and § 12. 1. 2) 22.02.2019.

Received: 24.04.2020. Revised: 30.04.2020. Accepted: 14.05.2020.

Assessment of adaptive changes under the influence of applied recreational training in men based on cardiorespiratory selected parameters

Monika Stanaszek, Małgorzata Fortuna

Name	Monika Stanaszek
ORCID iD	https://orcid.org/0000-0002-0452-8553
Affiliation	Faculty of Medical and Technical Sciences The Karkonosze University of Applied Sciences in Jelenia Góra
Country	Poland
Bio Statement	—

Name	Małgorzata Fortuna
ORCID iD	https://orcid.org/0000-0002-4545-1847
Affiliation	Faculty of Medical and Technical Sciences The Karkonosze University of Applied Sciences in Jelenia Góra
Country	Poland
Bio Statement	—

Abstract
Introduction: Systematic physical activity contributes to the development of adaptive changes in the human body.
Purpose of the work: The aim of the study was: To assess adaptive changes under the influence of recreational training used in men based on selected parameters.
Material and method: 53 men aged 45 (± 6) years were examined. The tests were performed at the beginning and end of training lasting 18 weeks. Men undertook systematic training three times a week. The training units lasted 1.5 hours, the work performed was continuous, mainly based on oxygen metabolism with elements of anaerobic effort. BMI, HR, RR, VC, TV, IRV, ERV, IC and the difference in chest circumferences between inspiration and exhalation were assessed in the subjects.
Results: Average values were obtained: BMI 26 (± 2), there was no difference in measured chest circumferences before and after the training period. The measured RR values showed a significant statistical difference for diastolic pressure. Diastolic pressure decreased by 4 mmHg at significance level $p = 0.000$. The mean HR measured before and after the training period showed constant values of 68 (± 11) bpm. Similarly, the VC average showed no change. A significant decrease in the ERV parameter was noted for $p = 0.03$. The average value of ERV, IRV, TV measured before and after the training period did not show significant differences. A significant difference was observed during the IC measurement, where this parameter increased its value at the significance level $p = 0.02$.
Conclusions: Adaptive changes and their trends depend on the type of physical training used. Not every type of systematic training used for 18 weeks will cause significant adaptive changes.

Key words: adaptation, vital capacity, physical activity

Among the factors affecting the level of physical performance, systematic physical activity is very important. It leads to the development of adaptive changes of the human body. These changes are visible in various physiological parameters. This is especially evident from the parameters of the circulatory and respiratory systems. These are the most frequently described and studied parameters used to assess adaptation as a result of systematic physical training [1,2]. Physical training causes adaptive changes of the circulatory system visible both at rest and during work. They are due to the influence of nervous regulation on cardiovascular and respiratory functions. Such effects can be expected as a result of physical activity reduction of adrenergic system. These changes are most visible as a result of the aerobic endurance training. People who train in this way develop resting bradycardia in proportion to adaptive changes. The higher the level of training, the greater the bradycardia. Blood pressure has been reported to decrease as a result of systematic oxygen training. In particular is visible, a decrease in more reactive systolic blood pressure [2,3].

Under the influence of any systematically practiced physical activity, including health training, body composition changes favorably by reducing the amount of fat and increasing lean weight [3].

One of the methods of assessing adaptive changes is the assessment of chest circumferences measured on inspiration and expiration. The difference between maximum inhalation and exhalation, indicating that the chest is moving properly, it should be in the range of 3-5cm [4]. The changes cited by many authors that occur as a result of undertaking systematic recreational training in relation to respiratory muscles include an increase in chest mobility and strength of the respiratory muscles, increased vital capacity, ventilation and diffusion capacity during physical effort and at rest [5]. Trained people are usually characterized by greater chest mobility and respiratory muscle strength than untrained ones, and as a result greater lung vital capacity [2]. Some authors question the impact of recreational physical activity on respiratory parameters. An example is research conducted in a group of people regularly undertaking physical activity and in a group of people leading a sedentary lifestyle, which did not show significant differences in the values of vital capacity (VC), forced first-second expiratory volume (FEV1), inspiratory volume (IC) or maximum any ventilation (MVV) [6,7]. On the other hand, the authors of other studies indicated that physical activity affects the change of spirometric parameters, but not depending on the type of training measures taken, but depending on the frequency and intensity of training undertaken, these changes are more or less visible [8]. In general, no influence of physical training on adaptive changes of other static spirometry indicators is found: respiratory volume (TV), increased inspiratory reserve volume (IRV) and increased reserve expiratory volume (ERV) and inspiratory volume (IC) [2]. It seems interesting whether post-workout changes in selected spirometry parameters can be important for increasing the efficiency of oxygen supply during physical exertion and whether there can be significant changes in spirometry parameters after eighteen weeks of recreational training. Can recreational training, lasting more than four months, in men aged 45 (± 6) years, physically active for several years, cause visible adaptive changes based on the measured selected indicators in this work.
The aim of the study was: To assess adaptive changes under the influence of recreational training used in men based on selected parameters.

Material and methods:

The research project was approved by the Senate Committee on Ethics of Scientific Research at the University of Physical Education in Wrocław (No. 24/2017).
53 men aged 45 (± 6) years participated in the study. They declared that they had been physically active in the past few years. This activity was a recreational activity that they still performed, or the declaration was based on the fact of performing typically physical professional work. The first examination was performed from 01 - 06 December 2018, the second was from 09 - 14 April 2019. The period of observation was about 4.5 months during which all the subjects performed systematic recreational physical activity. Men undertook systematic training three times a week. The training units lasted 1.5 hours, the work performed was continuous, mainly based on oxygen metabolism with elements of anaerobic effort. Subjectively, the respondents defined effort as moderate load with elements of hard work. Among the activities, the respondents used various forms: cross-country skiing, downhill skiing, jogging, and cycling. Before and after the observed training period, the subjects were evaluated for selected cardiovascular, respiratory and somatic parameters. The subjects were assessed for heart rate (HR) and resting blood pressure (RR), vital capacity

(VC), tidal volume (TV), increased inspiratory backup volume (IRV), increased expiratory reserve volume (ERV), inspiratory volume (IC) , BMI relative body mass index, and chest circumference difference between inspiration and expiration.
Pressure and heart rate were measured with an Omron M2 Basic. The measurement was taken in a sitting position with the hand resting on the table with the palm facing the inside up. The cuff was placed at the height of the heart, about 1.5 - 2.5 cm above the elbow joint. During the whole measurement, the subject did not move or speak. HR and RR at rest were measured.

BTL - 08 Spiro Pro spirometer was used to evaluate spirometric parameters. This camera is equipped with sensors for measuring ambient temperature, atmospheric pressure and relative humidity. The camera can itself adjust the parameters for BTPS conditions (pressure, temperature, steam saturation). The device has been constructed using the latest knowledge and meets the requirements of ATS / ERS 2005 and contains the European standard for spirometers EN 13826. The device has a built-in table of standard values for a given population including: age, sex, weight, body height, smoking or not smoking. The table used standard values recommended for the European race ECCSERS 1993. Each of the men performed three measurements of the same spirometric parameters during the study, according to the methodology of developed spirometry standardization [9]. The best of the three tests performed was selected for analysis. The tests were performed at the beginning and after the end of the recreational training period.
The tests also included somatic measurements, during which the subjects were dressed in a sports outfit - a T-shirt and shorts, without shoes. The height and weight of the subjects were measured during the tests,. Based on the obtained measurements of somatic features, the following indicators were calculated:
Body Mass Index BMI (Body Mass Index) BMI = body weight [kg] / body height [m^2].
The BMI study uses standards adopted by the WHO- World Health Organization [10].

Table 1. Criteria for BMI value [10].

BMI value in kg / m^2	Interpretation
<18,49	underweight
18,50–24,99	standard range
25,00–29,99	overweight
>30,00	obesity

Chest circumferences were measured with centimeter tape with an accuracy of 0.5 cm. Measurements were carried out in the standing position of the subject. Circuits were measured during the deepest inspiration and largest exhalation
The tests were subjected to statistical analysis, the Statistica program was used for calculations.

Results and discussion:
The following results were obtained (Tab. 2)

Tab. 2 T test for dependent samples. The marked differences are significant from p < 05000

Feature	N	study 1		study 1		Study difference 1-2		Student t-test	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	t	p
age [years]	53	45,17	6,34	45,52	6,37	-0,341	0,093	-26,76	**0,0000**
body height [cm]	53	179,07	5,96	179,08	5,95	-0,009	0,069	-1,00	0,3219
body weight [kg]	53	82,21	9,35	82,10	9,40	0,106	1,745	0,44	0,6612
chest circumference - inspiration [cm]	53	106,99	6,19	106,91	6,07	0,085	0,413	1,50	0,1405
chest circumference - exhalation [cm]	53	100,50	6,17	100,52	6,22	-0,019	0,449	-0,31	0,7609
body mass index BMI [kg/m^2]	53	25,61	2,36	25,58	2,39	0,035	0,536	0,47	0,6380
Resting systolic RR [mm HG]	53	144,74	14,00	142,83	12,10	1,906	11,715	1,18	0,2417
Resting diastolic RR [mmHG]	53	85,02	9,28	81,25	8,27	3,774	7,567	3,63	**0,0006**
resting heart rate [bpm]	53	67,75	11,06	68,02	11,13	-0,264	6,729	-0,29	0,7762
vital capacity of the lungs% due [%]	53	107,78	13,51	107,60	12,28	0,178	6,664	0,20	0,8462
VC [l]	53	5,41	0,81	5,38	0,78	0,033	0,338	0,71	0,4820
ERV [l]	53	2,12	0,73	1,84	0,88	0,274	0,897	2,23	**0,0303**
IRV [l]	53	2,11	0,75	2,25	0,89	-0,134	0,871	-1,12	0,2679
TV [l]	53	1,17	0,64	1,32	0,63	-0,153	0,641	-1,73	0,0888
IC [l]	53	3,28	0,86	3,57	0,92	-0,285	0,837	-2,47	**0,0166**

Analyzing the parameters presented above, it can be stated that the study included men whose average body height was 179 (± 6) cm and body weight 82 (± 9) kg. BMI was calculated from the obtained measurements, the average value of which was 26 (± 2) for the test group, suggesting a slight overweight. The training did not change the measured body mass and BMI.

There are no differences in the measurements of chest circumferences taken before and after the training period. The average value in both measurements before and after the training period was 107 (± 6) cm for the circumference measured during the deepest inspiration. and for the circumference measured during the largest exhalation 101 (± 6) cm. After the measurements of selected circulatory parameters before and after the training period, for the systolic RR the average value measured before training was 145 (± 14) mmHg, for the value measured after the training period was obtained 143 (± 12) mmHg. Despite the downward trend of this value measured after training, no statistically significant differences were found. Similarly, the mean value of diastolic pressure measured before the training period was 85 (± 9) mmHg, measured after training was 81 (± 8) mmHg. These differences are statistically significant at the level of $p = 0.000$. The mean HR measured before and after the training period showed constant values of 68 (± 11) bpm. Similarly, no change was recorded for the average VC, where this value for the two measurements before and after the training period was 5.4 (± 0.8) liters. A significant decrease in the ERV parameter was noted for $p = 0.03$. The mean ERV value measured before the training period was 2 (± 0.7) years, after the training period 1.8 (± 0.9) years. No significant differences were noted for IRV and TV parameters. The average IRV value measured before the training period was 2.1 (± 0.8), after the training period 2.3 (± 0.9) l. The average TV value measured before the training period was 1.2 (± 0.6), after a training period of 1.3 (± 0.6). A significant difference was observed during the IC measurement, where this parameter increased its value at the significance level $p = 0.02$. The mean IC value measured before the training period was 3.3 (± 0.9) measured after the training period 3.6 (± 0.9).

Discussion:

The fastest adaptive changes regarding the regulation of cardiovascular function under the influence of training develop during exercise and at rest. Time of creation and scope of changes may vary depending on the intensity and duration of training. The age of the trainee is also important. Adaptive changes are more visible if the assessed training is started at the level of low cardiovascular fitness [2]. The data obtained from the above studies were obtained by examining a group of middle-aged men active for several years. It could have been assumed that the adaptive changes would be minor or not captured at all. Based on research, there are reports that irrespective of age and sex, as a result of regular physical activity, resting blood pressure, both systolic and diastolic, is reduced [11]

Studies conducted by other authors have shown that aerobic training lasting eight months has already caused a reduction in resting systolic blood pressure by 10 mmHg on average and 5 mmHg diastolic pressure [12,13]. There are also reports of a beneficial effect of resistance training on lowering the resting value of both systolic and diastolic blood pressure [14]. Some sources say that a greater antihypertensive effect can be achieved by using lower intensity workouts. [15]. Based on research conducted by many authors, it is emphasized that the volume of work volume and the length of training used are important. It is suggested that hypotensive changes under the influence of training are visible at a training load of 20-60 minutes a day, where activity should be repeated 3-5 times a week, and its intensity should be in the range of 40-70% of peak oxygen absorption [16]. Based on the average HR measured (68 ± 11), no resting bradycardia was observed in the subjects. Several people had an HR value below 60 bpm. As well as the observed 4, 5-month recreational training did not change the average resting value measured in HR. Probably the prior physical activity prior to the study was not sufficiently intense and systematic. It can be assumed that the set period of recreational training for the subjects did not constitute a sufficient load to evoke the picture of adaptation visible on the basis of resting bradycardia.

Similarly, this can be seen on the basis of assessed blood pressure, where the more reactive systolic pressure did not show visible, significant adaptive changes in the subjects. Although there is a downward trend. The mean value of systolic pressure before the training period was 145 (± 14) mmHg, after the training period 143 (± 12) mmHg The fact of significant decrease ($p = 0.003$) of diastolic pressure in the subjects from 85 (± 9) to 81 (± 8). The mean resting blood pressure value prior to the start of the study in men was 145/85 mmHg. According to generally accepted norms by WHO, this is a high value, which indicates the lack of systematically used physical activity or a large advantage of exercises in the nature of resistance training, which was probably characterized by previous training or the way of professional activity among the respondents. Based on the conducted research, some authors point to a decrease in the BMI index measured after applying a systematic series of recreational trainings. These changes are already recorded at a statistically significant level after recreational training used for three months [17]. However, the body composition method is more accurate than calculating body mass index (BMI). Which has not been examined in this work. BMI assessed in the subjects did not change. And a measured value of 26 (± 2) indicates a slight overweight. The above circulatory indicators already suggested that the previous activity of the studied men was associated with a large contribution of resistance exercises. Also, the BMI index may indicate that they probably had a relatively high percentage of muscle tissue, which resulted in an average BMI value indicating overweight. In many studies, there is a decrease in body weight and BMI after the training cycle used, especially an increase in the percentage of muscle tissue and a decrease in body fat [3]. It can be assumed that the intensity of training and duration was insufficient to achieve a reduction in BMI.

Other studies of the authors indicate no significant differences in the chest circumference measured in recreational practitioners and inactive people [17].

As shown by the results of the difference in chest circumferences measured at maximum inspiration and exhalation in the tested athletes, it can be as high as 9cm, which indicates a positive impact of training on the respiratory system, which is manifested

increased chest mobility [18]. As mentioned in the introduction, this difference should be about 3-5 cm in the chest. In the studied group of men, recreational training did not change the circumferences measured on the chest during maximum inspiration and exhalation. However, probably their earlier lifestyle resulted in a difference in measured circumferences of 6 centimeters. This indicates better than average chest mobility. An analysis of the literature on the impact of training on the functioning of the respiratory system indicates a lot of controversy. Due to the discrepancy of results, a research problem was undertaken, which is the assessment of the impact of 4.5-month recreational physical activity on the functioning of the respiratory system. The impact of physical training on the picture of exercise changes in respiratory function, its adaptation changes in healthy adults is less constant than on the circulatory system. This is due to the fact that the efficiency of respiratory function in healthy people is not a factor limiting the supply of tissues with oxygen either at rest or during physical exertion. The impact of training on the respiratory system is greater in people with limited fitness [2]. Therefore, adaptive changes were more difficult to notice in the study group. Referring to calculations, obtained results of spirometric parameters measured before and after the recreational training period, no significant differences were observed, which probably indicates too short a time span of the conducted training. There is probably a very strong relationship between the VO_2 max level determining physical performance level and FVC [19, 20]. Perhaps if the training were more intense and prolonged in time, adaptive differences based on spirometric parameters would be observable. The average VC value 5.4 (± 0.8) l was obtained among the subjects, which did not change due to the given training. The significant changes in ERV and IC parameters measured before and after the training period seem interesting. However, if VC changes are not registered, they do not bring relevant information related to the adaptation process as a result of the above training. Perhaps these fluctuations occurred due to the RV variable, which was not assessed in this work. The size of VC is shaped depending on the type of training. It depends on the constitutional structure, body weight and height. [21]. For the studied male population, the average VC obtained in relation to the standard values (percentage of due VC) was 108 (± 14)%. This means that probably the earlier lifestyle of the surveyed men resulted in very good results of this parameter against the background of the population, including constitutional structure and age.

Conclusions:
1. Adaptive changes and their size depends on the type of physical training used.
2. Not every type of systematic training used for 18 weeks will cause adaptive changes visible on the basis of BMI, chest circumferences measured during maximum inspiration and expiration, RR, HR, VC and resting spirometry parameters.

Bibliography:

1. Drozdowski S., Prywel J. Wpływ ćwiczeń rekreacyjnych na sprawność fizyczną kobiet aktywnych zawodowo. W: Drozdowski S., Wachowiak E. Wychowanie fizyczne i sport w badaniach naukowych, AWF Poznań, 2000; 53-58.
2. Kozłowski S., Nazar K. Wprowadzenie do fizjologii klinicznej, PZWL Warszawa, 1999.
3. Janiszewska R., Bornikowska A., Gawinek M., Makuch R. Skład ciała i jego zmiany pod wpływem 3-miesięcznego treningu zdrowotnego u dorosłych kobiet. Probl. Hig. Epidemiol. 2013; 94(3): 484-488.
4. Kowalski T. Periodyzacja treningu w triathlonie. Jak ma wyglądać przejście między sezonami? Traithlon. 2014; 3:36-38.
5. Zuzda J., Latosiewicz R. Zasady i komponenty treningu rekreacyjnego- regulacja intensywności rekreacyjnych ćwiczeń systemu Step Reebok Economy and Management 2010; 2: 111-126.
6. Michalak K., Gątkiewicz M., Pawlicka-Lisowska A., Poziomska-Piątkowska E., Wpływ regularnej aktywności pływackiej na wartości wybranych parametrów spirometrycznych wśród młodzieży palącej tytoń i niepalącej. Pol. Merk. Lek. 2012; XXXIII, 193(13): 13-19.
7. Biersteker M.W. Vital capacity in trained and untrained health young adults in Netherlands. Eur. J. Appl. Physiol. 1985; 54: 46-53.

8. Holmen T.L. Physical exercise, sports and lung function in smoking versus non-smoking adolescents. Eur. Respir. J. 2002; 19: 1528-1532.
9. Miller M. R., Hankinson J., Brusasco V. at all Standarisation of spiroometry. Eur. Respir. J. 2005; 26(2): 319-38.
10. Drozdowski Z. Antropometria w wychowaniu fizycznym. AWF Poznań 1998.
11. Kokkinos P. F., Papademetriou V. Exercise and hypertension. Coron. Artery Dis. 2000; 11: 99-102.
12. Ishikawa K., Ohta T., Zhang J. Influence of age and gender on exercise training-induced blood pressure reduction in systemic hypertension. Am J Cardiol. 1999; 84:192-6.
13. Whelton SP, Chin A, Xin X, He J. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. Ann Intern Med. 2002; 136:493-503.
14. Karolewska-Kuszej M, Brodowski L. Kompleksowa rehabilitacja u pacjentów z chorobami układu krążenia. Forum Kardiologów. 2005; 10:112-3.
15. Górski J. Fizjologia Wysiłku i Treningu Fizycznego. Warszawa: Wydawnictwo Lekarskie PZWL 200; 73-91, 103-109, 111-116, 162-163, 220-225.
16. Jałbrzykowska K., Kowalczyk K. Ocena wpływu aktywności ruchowej na ciśnienie tętnicze, w zależności od rodzaju treningu fizycznego u osób z nadciśnieniem tętniczym. Geriatria. 2013; 7: 226-230.
17. Cieśla E. Kształtowanie się poziomu rozwoju fizycznego i sprawności motorycznej a aktywność fizyczna studentów fizjoterapii Wydziału Nauk o Zdrowiu UJK w Kielcach oraz ich wybrane zachowania pro zdrowotne. Studia Medyczne red. Głuszek S. 2009; 16(4): 21-28.
18. Małek O., Witkoś J., Wróbel P. Budziosz J., Sieroń-Stołtny K. Triathlon – wpływ treningów na narząd ruchu sportowca. Ostry Dyżur. 2016; 9(1): 16-22.
19. Collins K. J., Roberts D. F. Capacity for work in the Tropics. 2009; Cambridge University Press, UK: .34.
20. Narvani A., Thomas P., Lynn B . Key Clinical Topics in Sports and Exercise Medicine. J.P. Medical. 2014; Ltd., UK: 106.
21. Zerf M., Houar A., Mime M., Bengoua A. Height versus weight which cassel parameter determine pulmonary functions fitness among the Algerians soccer players. Journal of Pulmonary & Respiratory Medicine. 2016; 6(3): 353-356.