EVALUATING THE BODY RESPONSE TO A 15-MINUTE WORKOUT PROPOSED AS AN ALTERNATIVE TO GYM TRAINING DURING LOCKDOWN CAUSED BY THE COVID-19 PANDEMIC

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Abstract

The aim of the work was to study the body reaction to high intensity interval training. The study included 92 women aged 18 to -35. People who have been engaged in organised, regular physical activity (at least twice a week) were qualified to Group 1. Group 2 were physically inactive persons. All subjects performed interval training in the Tabata formula - two 4-minute sequences. The exercise carried out in the first part is elevating the legs from the "plank" position, in the second part, the hands were elevated from the same position. The pulse rate, the Borg Scale and the VAS pain rate scale (24, 48, 72 and 96 h after exercise) were used to assess the exercise intensity. The respondents from both groups performed the training at a similar intensity: the average heart rate after workout was 131 beats per minute. The highest pain of all muscle groups (when added together) was recorded 24 hours after training. The highest pain intensity during the four days after the training concerned the back and abdominal muscles in Group 1 and the muscles of the abdomen, back and arms (front and back). The intensity of abdominal and arm muscle pain (front) was significantly higher in Group 2. The proposed 15-minute workout planned in the form of Tabata evoked similar cardiovascular reactions in both groups and a similar subjective evaluation of intensity. Individuals who were physically active before the introduction of restrictions related to the COVID-19 pandemic had less pain in the muscular system after the applied training.

Keywords*: Tabata, plank, COVID-19 lockdown, HIIT, pedometer*

Introduction

In 2020, the SARS-CoV-2 coronavirus started to spread around the world. In order to stop the epidemic, subsequent countries introduced a number of restrictions on public life (such as a ban on leaving home without a clear reason, an order to leave home exclusively alone, limits of people in shops, hours only for seniors, obligatory covering of airways, disinfection of hands and surfaces, etc.). Schools and universities in Poland have been closed since 12 March. Most companies have switched to on-line work. Parks, squares, boulevards, but also sports and rehabilitation facilities such as gyms, swimming pools, physiotherapy practices were closed (https://www.gov.pl/web/koronawirus, 2020). Therefore, pro-health activities such as participating in physical activities (sportive, recreational or rehabilitative) have been significantly impeded. One of the solutions could have been on-line trainings, or exercises prepared by a trainer, performed independently at home. For those who were additionally burdened with remote work at home, it was important to manage time properly. Therefore, a short intensive interval training seems to be a suitable alternative to training in the gym.

High intensity interval training, which was used in this work, entails many changes taking place in the human body. As early as 1996, Japanese scientist Izumi Tabata compared an average 70% VO2max continuous training and HIIT training, in which 8 series were performed, where: the duration of the effort was 20 seconds and its intensity was 170% VO2max, while the duration of the rest break was 10 seconds. As demonstrated in this study, after six weeks, the maximal oxygen uptake for medium intensity continuous training increased by 5 ml/kg

b.w./min. whereas after HIIT training, it changed by 7 ml/kg b.w./min. Besides, HIIT also increased anaerobic capacity by 28% (Tabata et al., 1996). The interval training, which is characterized by the time parameters and intensity used in the above mentioned study is called the Tabata Protocol (Fortner et al., 2014, Obradovic et al., 2016). A greater increase in VO2max compared to continuous medium intensity training and traditional resistance training (with more repetitions and longer rest breaks) is also observed by other researchers (Obradovic et al., 2016; Su et al., 2019; Domaradzki et al., 2020). Thus, this training results in increased aerobic capacity, which increases endurance capacity and reduces the risk of cardiovascular diseases (Tabata, 2019). High intensity interval training should, as a rule, be performed by people who are at least intermediately active, without any health contraindications. It is a powerful stimulus that can cause overload or damage to the locomotive system. Therefore, the aim of the work was to study the body's reaction to high intensity interval training.

Methods

The study included 92 women aged 18 to -35. The group 1 included people who, before the introduction of restrictions related to the COVID-19 pandemic (https://www.gov.pl/web/koronawirus, 2020), had taken part in regular, organised physical activity (at least twice a week). Group 2 are women who do not participate in any form of organised physical activity. On the basis of an initial interview, persons in good current health, without blood and respiratory tract difficulties, capable of intensive exercise were qualified. The study was voluntary and anonymous. Each participant received full information about the interval training and its effects.

Tab. 1. Characteristic of examined people (mean values ±SD)

Groups	Number of people	Age [years]	Body mass [kg]	Body height [cm]	BMI [kg/m^2]
1 (active)	38	21.94 ±4.8	61.69 ±9.1	165.85 ±6.8	22.44 ±3.1
2 (non-active)	54	21.48 ±4.8	65.04 ±10.4	167.13 ±6.4	23.25 ±3.9

The following research tools were used:

1. The Visual Analog Scale (VAS) is the most basic and reproducible scale for assessing pain. The respondent assesses his or her own pain sensations, placing them on a scale from zero to ten, where zero corresponds to a complete lack of pain and ten to unbearable pain, the greatest pain the respondent has experienced. The visual element of the scale is a straight line, with or without graduation, with sometimes suggestive pictograms of emotional expression and a colour variable gradient from green to red (Korzeniowska & Szałek, 2010)

2. The Borg scale for subjective evaluation of effort intensity. The women surveyed determined the weight of the completed effort on a scale of 6 to 20 points. The point value multiplied by 10 is a conventional reflection of the heart rate, i.e. 17 points on the Borg scale is 170 beats/minute (Borg, 1982).

3. The heart rate [number of beats/minute], which was measured on the radial artery near the wrist of the same upper limb. During each examination, the measure was carried out by the same person.

4. Custom questionnaire with basic particulars, covering age, gender, height and weight and education. The main part contains questions about physical activity undertaken in the form of professional or amateur training, now or in the past. In the third part, the respondent is asked to about the contracted injuries, their impact on further training, and ways to improve fitness.

Before starting the exercises, the subjects completed the first part of the questionnaire (concerning biometric data) and took resting heart rate measurements. Then a five-minute warm-up was performed. After that, the proper training started. The training consisted of two series of exercises, according to the Tabata Protocol. The effort duration was 20 seconds and the break time was 10 seconds, which was repeated in eight series. Then, after a two-minute break, the whole set was repeated, obtaining a ten-minute intensive training (Tabata et al., 1996). In the first series, alternating lower limb lifts were made from the support position lying forward on the forearms (the so-called plank position). In the second series, alternating upper limb lifts from the same starting position were performed (Lee et al., 2016; Park & Jeong, 2019; Choi et al., 2019). The heart rate was measured immediately after training. The measurement was repeated one minute after the exercise. Then, on the following days (24, 48, 72 and 96 hours after the training) the subjects determined the level of muscle pain in particular muscle groups: forearms, front arms, back arms, abdomen, back, front thighs, back thighs, lower legs. On the last day, the number of steps taken each day was read out of the pedometers on the participants' mobile phone and entered into the questionnaire.

In order to develop empirical data, standard methods of statistical analysis – arithmetic means together with standard deviations – were used. Significance of differences between pairs of variables was estimated using the Wilcoxon test (differences between individual measurements) and the U-Mann-Whitney test (differences between groups), taking $p<0.05$ as

the minimum level of significance. The calculations were made in MS Excel and Statistica 10 software under license to the Medical University of Warsaw.

Results and discussion

The respondents from both groups performed training at a similar intensity: the average post-workout heart rate was 140 beats per minute in Group 1 and 144 in Group 2. Effort intensity on the Borg scale was also assessed in a similar manner (Table 2).

The highest pain of all muscle groups (when added together) was recorded 24 hours after training (Fig. 1). In Group 2 (inactive), pain intensity was significantly higher in all measurements (24 h: p=0.044, 48 h: p=0.028, 72 h: p=0.041, 96 h: p=0.018). The differences between individual measurements in both groups were statistically significant (p<0.001).

Tab. 2. Heart rate and Borg Scale results

Groups	HR – before the training	HR – after the training	HR – after 1 min	Borg Scale
1	80.95 ±9.1	140.63 ±21.5	103.35 ±16.1	14.65 ±2.7
2	85.17 ±12.4	144.19 ±19.9	107.69 ±15.1	15.11 ±1.6
differences	0.073	0.423	0.239	0.411

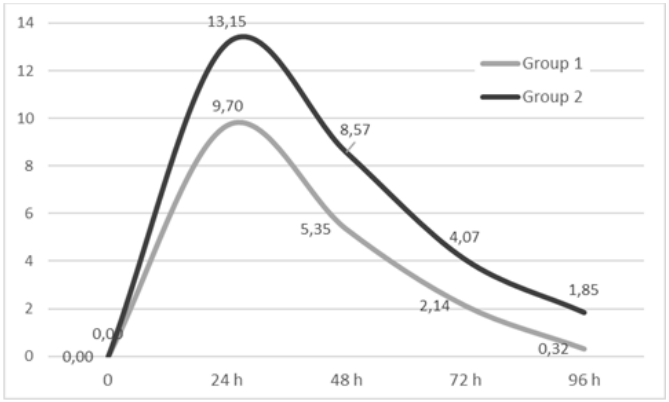

Fig. 1. Average sum of pain intensity in four days after the training

Most people reported post-workout abdominal muscle pain (79%), back (75%) and posterior shoulder muscle group pain (56%). Moreover, in Group 2, as much as 59% of the respondents had pain in the front shoulder muscle group. The smallest number of people declared pain in the calf muscles and in the back thigh muscle group (Table 3).

Tab. 3. Number of people with muscle pain

Groups	Forearms	Arms – front	Arms – back	Back	Abdominal muscles	Gluteal muscles	Thighs – front	Thighs – back	Drumsticks
1	13 (34 %)	15 (39 %)	22 (58 %)	29 (76 %)	30 (78 %)	13 (34 %)	18 (47 %)	11 (29 %)	7 (18 %)
2	16 (30 %)	32 (59 %)	30 (56 %)	40 (74 %)	44 (81 %)	17 (31 %)	22 (41 %)	17 (31 %)	9 (17 %)

The highest intensity of pain during the four days after the training concerned the back and abdominal muscles in Group 1 and the abdomen, back and arms muscles (front and back). The intensity of abdominal and arm muscle pain (front) was significantly higher in Group 2 (Table. 4). Analysing the following days, significantly higher pain intensity in the inactive group was recorded for the abdominal muscles (all four days), the front part of the shoulder muscles (24, 48 and 72 h after training) and the back part of the shoulder muscles (48 h after training). The high level of abdominal muscle pain in Group 2 for four days (Table 5).

Tab. 4. Average sum of pain intensity

Groups	Forearms	Arms – front	Arms – back	Back	Abdominal muscles	Gluteal muscles	Thighs – front	Thighs – back	Drumsticks
1	0.82 ±0.7	1.58 ±1.7	2.58 ±2.3	4.18 ±3.9	4.18 ±3.7	1.89 ±1.9	2.53 ±2.4	1.39 ±1.9	0.79 ±0.6
2	1.91 ±2.3	4.50 ±4.4	4.30 ±4.3	4.50 ±4.2	7.46 ±7.1	1.61 ±1.6	1.85 ±1.9	0.93 ±0.7	0.59 ±0.4
differences	0.100	**0.006**	0.081	0.749	**0.011**	0.726	0.440	0.379	0.730

The spread of the SARS-CoV-2 coronavirus and the COVID-19 pandemic have surprised the entire world. Many countries have started to introduce restrictions on public life. It was a new and unknown situation for everyone. On 12 March, schools and universities in Poland were closed. Most companies have changed to remote mode. Limits have been introduced for people in shops, public transport vehicles and other public places. On April 1, service points, sports

facilities (gyms, fitness clubs) and rehabilitation practices were closed (they started to reopen from May 18). From 1 to 20 April, a total ban on entering parks, forests and sports facilities located in the open air, i.e. a total ban on physical activity in public places, was introduced. On 20 April, some of these restrictions were lifted: running and cycling was allowed with a two-meter distance. Since April 20, it became obligatory to wear protective masks covering the face and mouth (even during physical activity in the open air) (https://www.gov.pl/web/koronawirus, 2020). Restrictions imposed by the government have contributed to the reduction of physical activity among the population in many countries of the world. In April this year, a study was carried out in Italy to demonstrate the impact of quarantine and related restrictions on physical activity. Based on its results, the level of physical activity among the Sicilian population during quarantine was significantly reduced (Giustino et al., 2020).

Reducing the level of physical activity can lead to lower spine pain or increase its intensity. Pain, on the other hand, may lead to abandoning physical activity or reducing physical fitness Thus, the mechanism of the vicious circle of spinal pain is created (Jiménez-Pavón et al., 2020). Lack of appropriate physical activity during quarantine can lead to a reduction in strength and muscle mass, which in turn disrupts the work of these muscles. The weakened muscle may not perform its function as a stabiliser and disturb the spinal mechanics, which in turn leads to pain (McDonough et al., 2013; Moro & Paoli, 2020).

Considering the extraordinary situation, lack of access to sports facilities, often additional workloads due to the change of working mode, a solution can be found in short high intensity training such as HIIT (High Intensity Interval Training). HIIT training brings benefits in terms of the metabolic processes. The fat tissue is reduced due to intensified fat burning, which may last even up to 48 hours after the training; the post-workout surplus in oxygen uptake, EPOC (Excess Post-Exercise Oxygen Consumption), is considered the basis for these processes (Herodek et al., 2014; Franchini et al., 2019).

Tab. 5. Pain intensity in four days after the training

Part of body	Groups	24 h	48 h	72 h	96 h
Forearms	1	0.47 ±0.9	0.24 ±0.5	0.11 ±0.3	0.00
	2	0.93 ±1.8	0.57 ±1.4	0.30 ±0.4	0.11 ±0.2
	differences	0.136	0.114	0.155	0.159
Arms – front	1	0.92 ±1.4	0.39 ±0.8	0.24 ±0.6	0.03 ±0.1
	2	2.02 ±2.1	1.44 ±1.8	0.72 ±1.3	0.31 ±0.6
	differences	**0.012**	**0.002**	**0.043**	0.066
Arms – back	1	1.55 ±1.8	0.63 ±0.8	0.34 ±0.6	0.05 ±0.1
	2	2.04 ±2.4	1.37 ±1.6	0.67 ±1.1	0.22 ±0.3
	differences	0.314	**0.019**	0.149	0.131
Back	1	2.03 ±1.6	1.32 ±1.3	0.63 ±0.8	0.21 ±0.4
	2	2.24 ±2.1	1.39 ±1.5	0.63 ±0.9	0.24 ±0.5
	differences	0.618	0.836	0.994	0.844
Abdominal muscles	1	2.16 ±1.8	1.42 ±1.3	0.55 ±0.6	0.05 ±0.2
	2	3.24 ±2.7	2.28 ±2.2	1.26 ±1.7	0.69 ±0.8
	differences	**0.031**	**0.041**	**0.031**	**0.006**
Gluteal muscles	1	0.97 ±1.5	0.61 ±1.2	0.24 ±0.4	0.08 ±0.2
	2	0.83 ±1.3	0.50 ±0.8	0.19 ±0.2	0.09 ±0.2
	differences	0.698	0.706	0.714	0.887
Thighs – front	1	1.26 ±1.3	0.82 ±1.1	0.39 ±0.7	0.05 ±0.1
	2	0.85 ±0.9	0.57 ±0.7	0.26 ±0.4	0.17 ±0.2
	differences	0.241	0.434	0.555	0.191
Thighs – back	1	0.74 ±1.1	0.45 ±0.6	0.21 ±0.3	0.00
	2	0.61 ±0.9	0.26 ±0.4	0.04 ±0.1	0.02 ±0.1
	differences	0.650	0.343	0.125	0.322
Drumsticks	1	0.29 ±0.4	0.26 ±0.4	0.21 ±0.3	0.03 ±0.1
	2	0.39 ±0.6	0.19 ±0.3	0.02 ±0.1	0.00
	differences	0.669	0.700	0.243	0.324

This type of training is mainly used for experienced exercisers. The exercises proposed in this work were performed in a safe position (plank), without dynamic movements to reduce the risk of possible injury. Even for the untrained, sedentary persons or those only active on a recreational basis, HIIT increases endurance more than continuous, submaximal training. This is thanks to: increased microcirculatory vessel density, increased oxidising enzyme activity and increased expression of type I fibres. HIIT was

also used in the case of ischemic heart disease, due to lowering blood pressure, lowering the fatigue level and economising the heart rate during exercise. Another disease in which the described training is often used is diabetes mellitus type-2, where high intensity interval training causes a decrease in insulin resistance and increased glucose tolerance due to increased number of mitochondria in the skeletal muscles (Laursen & Jenkins, 2020).

Physical activity influences other elements of a healthy lifestyle such as diet or prophylactic behaviours (Boguszewski et al., 2014; 2019). It is also extremely important to reduce the negative effects of quarantine related to the mental sphere, which include low mood and depressive tendencies. They can directly affect the functioning of the body and interfere with various systems: the hormonal, immune, digestive one. Improper work of these systems may translate into further disorders, e.g. muscular system work (Van Kim & Nelson, 2013; Czosnek et al., 2019; Jiménez-Pavón et al., 2020).

Undoubtedly, the weak point of the presented research is the lack of application of advanced technologies and the lack of the trainer's control during the exercises (Dute et al., 2016). However, extraordinary conditions (restrictions imposed by the government) made direct contact with the exercising clients impossible. A simple and short form of activity was therefore proposed, which could contribute to maintaining physical fitness during the national quarantine.

Research on the body's response and effectiveness of various training programmes should be continued, taking into account the multitude of new exercise methods and forms of training used in physioprophylaxis. Further research should be directed towards the use of publicly available tools such as applications in mobile phones or sports watches. They make it possible to obtain more information, which can then verify the effectiveness of applied exercises.

Conclusion

1. The proposed 15-minute workout planned in the form of Tabata evoked similar cardiovascular reactions in both groups (about 140 beats per minute after exercise) and a similar subjective evaluation of intensity, 14-15 points (meaning heavy effort). Therefore, it seems to be an appropriate form of maintaining physical fitness, even for less active people.

2. Individuals who were physically active before the introduction of restrictions related to the COVID-19 pandemic had less pain from the muscular system after applied high intensity interval training. It may have been resulted of higher physical fitness.

3. The obtained results form the basis for continuing research with the participation of a larger group of subjects and using other objective, more technologically advanced research tools.

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