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Possible Approaches to Increasing Fitness in the Military in the Context of the Current Level of Fitness in the Population

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Abstract

Army environment is specific in the variability of stimuli arriving during different time periods throughout the year and their nature. The physical preparation and readiness of the soldier, which is influenced by climatic conditions, equipment and armament as well as limited regeneration time must lead to the ability to use capabilities under difficult conditions and immediately when needed. Currently, there is a trend towards decreased physical activity throughout the day, which also affects professional soldiers. We want to draw attention to both health aspects in the context of body composition and fitness components, namely aerobic and anaerobic capacity and their sustainable development. For these purposes, we present exercise programs based on long term systematic work with load and rest intervals, while the High Intensity Interval Training (HIIT) method is used and workout is based on basic multi-joint exercises that serve not only to increase fitness, but also to prevent injuries.

KEY WORDS: *physical fitness, High Intensity Interval Training – HIIT, anaerobic and aerobic capacity, body composition*

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1. Introduction

The subject of this article is physical fitness and the possibilities of influencing it within the army through various training methods, which can be fundamentally divided into continuous and interval training. When assessing and designing, we draw from the findings of the global scientific community and our own research experience in the field of sports training. We aim to base our work on general relationships and phenomenon that occur in society, which necessarily reflect on various components, including the army environment.

We highlight certain shortcomings in efforts to develop fitness, which we also view as opportunities for improving the motor skills of future professional soldiers, and we explore possible solution proposals. To understand deeper connections, we present the basic principles of general fitness preparation focused on developing fitness.

In the context mentioned, we point out the HIIT method, belonging to the interval training form, as one of the possible means in systematic fitness development. We delve into this method not only with its general characteristics but also highlight the advantages of its application, relevant results published by global authors, and personal experiences with implementing the method in our own research activities. However, for an objective perspective, we also address potential risks associated with the method and other limitations.

In conclusion, we attempt to outline how the physical readiness process for soldiers could proceed in a way that respects not only performance but also health and sustainability.

2. Purpose

Physical readiness and a high level of fitness are key elements for the performance of a soldier's duties. Within the preparation for future service, the importance of this component cannot be overlooked; it needs to be developed and given due attention. Physical training in a military environment is fundamentally divided into nonspecific (general physical preparation) and specific (specialized physical preparation).

This division is somewhat simplifying, as in practice, exercises of varying degrees of specificity are included. While specific physical training focuses on developing motor skills related to specific performance requirements (such as climbing, combat training, swimming, etc.) and is also a decisive condition for technical preparation, the content of nonspecific physical training encompasses a broader spectrum of exercises that form the basis for various types of activities (as mentioned above). The goal of nonspecific physical preparation, which we focus on in this article, is primarily the development of functional and bioenergetic capacities, necessarily accompanied by morphological adaptations. This preparation is characterized by efforts to engage as many muscle groups as possible in multiple planes of movement simultaneously, which relates to the selection of basic multi-joint exercises. The main objective is to establish a stable foundation for specific motor learning and achieve a high level of resilience, which is a fundamental prerequisite for subsequent activities [1,2].

Physical fitness is not only related to physical manifestations but also to abilities in the psychosocial domain (coping with emotions, stress, and cognitive functions). The level of these abilities is largely determined by the results of physical activity because higher physical fitness implies a greater ability to cope with higher demands, especially in the social or emotional areas. The specificity of the army environment is reflected in the diversity of stimuli encountered throughout the year and their nature.

The physical preparation and readiness of the soldier, influenced by climatic conditions, equipment, and armament, as well as limited regeneration time, must lead to the ability to utilize capabilities under challenging conditions and immediately when needed. The aim of physical fitness is to be prepared for potential operational deployment [3].

Given the versatility and diversity of a soldier's work, the development of fitness should be:

• Comprehensive: stimulating the main components of fitness, both aerobic and anaerobic capacity (endurance and strength, terms which we will further develop in the text), affecting body composition parameters (reducing fat tissue, maintaining or increasing muscle tissue), and developing a wide range of motor skills. This should also correspond to the selection of exercises, which should be multi-joint and performed in multiple planes of movement. It is crucial to create a training program from actions that occur in the given activity [4,5].

• Systematic: aimed at gradual load increase and education in the field of physical education for long-term maintenance of health, fitness, and vitality. Periodization over a longer timeframe (weeks-months-years) is important, as well as systematization within a training unit, which can be composed of load and rest intervals.

• Efficient: maximizing lesson time allocation and student potential, as time is perceived as a valuable commodity in today's fast-paced world. This necessitates pressure on its effective use and the search for the most efficient ways for versatile development.

3. Problem

1.1. Social Perspective and Its Refleciton in the Army

In the field of physical education and the level of movement abilities and skills, society is facing a decline in performance, which can be described as an undesirable phenomenon. One of the reasons for the decline in fitness in society may be the increase in physical inactivity combined with a sedentary lifestyle. Authors state that the rate of physical inactivity has increased, especially among young girls and boys aged 15 to 21 [6]. This fact manifests itself in many areas and at various levels, so it is not surprising that we have encountered this negative phenomenon in the military environment as well. Physical preparation in the army should aim at the ability of a professional soldier to apply their fitness when performing duties under pressure. The goal of physical fitness is to be prepared for potential operational deployment. Currently, previously stated decline in daily physical activity is beginning to manifest, affecting professional soldiers as well. Alarmingly, a significant portion of work activities do not directly demand fitness. As a result, there is a decline in performance and an increased incidence of injuries during training of movement abilities and skills. The cause appears to be the absence of comprehensive exercises, which are replaced by one-sided physical activity, and a lack of adherence to principles of organism adaptation to stress over longer periods. One reason for the decline in fitness is the increase in body weight associated with a significant decrease in aerobic fitness and muscle strength, as pointed out in article focusing on the physical fitness of young men entering military service between 1973 – 2015 [7].

Military training primarily consists of long-term physical activities performed at low intensities, which may disrupt optimal muscle strength development with regard to the development of maximal strength and aerobic capacity of the organism [8]. Training programs to increase fitness in professional soldiers should focus on gradual load increase considering various training periods. Some authors lean towards combined endurance and strength training as a recommended training approach to enhance the physical fitness of soldiers [7]. Their studies have shown that military training requires greater variation in training stimuli to induce more effective training adaptations, especially concerning the development of maximal or explosive strength and maximal aerobic capacity. They also highlight the fact that it is essential not only to optimize the training process but also to consider often neglected external negative factors such as lack of sleep, carrying burdens, and equipment. The combination of these stress factors can lead to worsened training adaptation, overtraining, and an increased rate of musculoskeletal injuries.

3.2. Development and Management at the Workplace Level Perspective

To properly grasp the problem and propose solutions, it is essential to consider the specific environment in which the processes occur. As an example, we take the Centre of Physical Education and Sport at the University of Defence, where we work. However, similar issues in preparation, methodology, other procedures, and challenges can also be found at foreign universities and centres of a similar nature. One of the key problems we identify is the inconsistent structure in the content of activities managed by individual assistants and specialized assistants in physical education. This prevents objective assessment of the effectiveness of training methods within scientific research activities and the full utilization of students' conditioning potential. The importance of optimizing the training process can be found on several levels. At the individual level, there is a fundamental effort to maximize physical potential in line with adopted techniques and methods of physical fitness development. At the workplace level, the goal is to create a conducive environment for this development and transform the centre into a globally competitive workplace offering top-notch services in physical education, science, and research. In terms of physical preparation, students attend two training sessions per week with a time allocation of 90 minutes. The content of these units is individually managed in line with credit requirements and falls fully under the competence of assistants and specialized assistants of the Physical Education and Sport Centre. Currently, lessons are often guided intuitively, which can lead to inefficiency and incomparable results. Insufficient systemization is also evident in the training of basic exercise techniques, and there is a lack of detailed instruction necessary for an effective training process and maintaining health and fitness. The following table displays the credit requirements for first-year students for men and women (see Table 1).

Table 1.
Overview of Physical Education Assessment Tests for First-Year Students

Men´s Disciplines	Women´s Disciplines
1000 m Run	1000 m Run
Pull-ups	Pull-ups endurance
10 x 10 m Shuttle Run	10 x 10 m Shuttle Run
SAC (Jumping and Acrobatic Exercise)	SAC (Jump and Acrobatic Exercise)

From the table, it is evident that the development of anaerobic capabilities and strength endurance is crucial for meeting the requirements. Strength and anaerobic capabilities appear as a key component of comprehensive fitness [27]. A soldier should be universally physically prepared, but we are facing a declining trend in fitness levels. In physical education classes, there is a lack of systemization and periodization of fitness preparation. All these aspects need to be considered when seeking an optimal solution.

3.3. The approach to the problem

Given the above, this section will focus on approaches related to the development of fitness prerequisites. Through analysis, synthesis, and deduction methods, potential solutions to the problem and the selection of potentially applicable methods will be outlined.

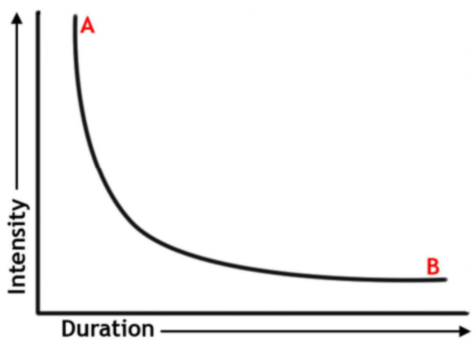

Fig. 1. Curve of Intensity-to-Duration Ratio (https://cerin.files.wordpress.com/2011/08/intensity_duration_curve.gif.).

Conditioning training

Conditioning training is part of the training process primarily aimed at developing bioenergetic, functional, and movement potential in line with the demands of the given performance. Secondarily, it targets the prevention of functional disorders and damage to the organism due to its stress. The desired effect of the training, from the perspective of metabolic, morphological, and physiological changes, is to increase the organism's ability to work more intensively in a shorter time or maintain work intensity over a longer period and resist fatigue (e.g., Fig. 1). The key is the strength of the stimulus, which should reach an optimal level to achieve a positive adaptive effect of "overload," meaning a level between sub and supra-threshold stimulation. Training primarily focuses on developing strength, speed, endurance, and flexibility (motor skills). The development of individual components often complements each other [9].

The fundamental categorization of conditioning training relates to the mode of energetic supply and the development of energetic capacity. Energetic supply occurs either aerobically, utilizing oxygen, or anaerobically, without its utilization, corresponding to the types of conditioning (aerobic and anaerobic) and developmental methods. In the training process, methods are predominantly employed, based on specific requirements, either for the development of aerobic fitness or anaerobic fitness [1]. However, this classification is somewhat oversimplified, and in practice, the characteristics of both methods often synergize or can hinder each other. An example of the interplay between these components could be a soldier prepared for long-distance movement (conditioned by aerobic capacity) but also ready for short-distance runs, combat, carrying heavy loads, throwing, or climbing (conditioned by anaerobic capacity). In conditioning preparation, methods are divided based on the desired outcome into continuous and intermittent loading. The variability in method application is primarily determined by exercise volume and intensity, or the characteristics of loading and rest intervals between specific sets (in interval training, the term "programming" is used). The fundamental difference between methods lies in the mode of energy release, determined by biochemical processes. Essentially, the character of energetic supply is categorized as predominantly aerobic, anaerobic, or mixed [1,9,10].

Aerobic capacity, or aerobic performance, is defined as the maximal oxygen consumption expressed by metabolic indicators of $VO_2Max.kg^{-1}$ and stands as one of the primary indicators of physical fitness. Maximal oxygen consumption is represented by the maximum amount of oxygen delivered to tissues during exertion, which does not increase further despite continued strain. It is primarily determined by the functional capacity of the O_2 transport system and oxidative energetic source levels [11,12].

Anaerobic capacity can be characterized as the organism's ability to sustain high-intensity physical performance even with significant acidosis caused by anaerobic glycolysis energetic supply. The duration of high-intensity muscle activity is approximately up to 60 seconds and typically involves various forms of interval loading. The level of anaerobic capabilities can be measured through anaerobic tests, with the Wingate test being the most commonly used laboratory examination [13].

The development of both energy supply components is exemplified by the HIIT method, which we will detail further in the subsequent text. Primarily, the method focuses on anaerobic fitness development; however, it also enhances aerobic fitness comparably, sometimes even more effectively than methods exclusively aimed at aerobic capacity development. This attribute was confirmed by research from Tabata and numerous other authors in the 1990s, as evidenced by Milanovic's 2015 meta-analysis [1,9,14,15].

The method significantly impacts changes in body composition parameters. At the hormonal level, HIIT stimulates growth hormone, adrenaline, and insulin. At the enzymatic level, it manifests through increased levels of enzymes such as phosphofructokinase, dehydrogenase, and sensitive lipase. By combining these substances with complex exercises, anabolism is supported, with one kilogram of Fat-Free Mass (FFM) representing an energy demand of up to 40 kcal/kg/day compared to approximately 5 kcal/kg/day of Fat Mass (FM). Lastly, HIIT induces substantial energy expenditure, reflecting in the overall energy balance. All these factors influence the change in body composition parameters; however, significant importance is attributed to Excess Post-Oxygen Consumption (EPOC) and the creation of an oxygen deficit, leading to additional calorie consumption and an increase in basal metabolism to levels matching pre-exertional demands [16]. The distinct energy supply processes during aerobic and anaerobic activities are illustrated below (e.g. Fig. 2).

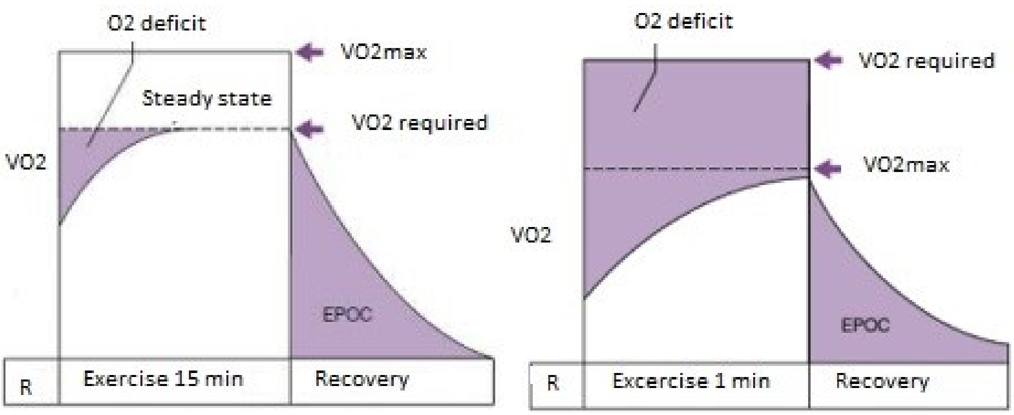

Fig. 2. Difference between aerobic - at low intensity (left) and anaerobic - at high intensity (right) energy supply [1].

HIIT

HIIT is a training method targeted at developing muscular endurance falling into the category of workouts with short to ultra-short intervals [3]. In general terms, HIIT can be defined as a combination of periods where high-intensity exercise alternates with low-intensity exercise or passive rest, known as an inactive phase. The effectiveness of the method is conditioned by the composition of individual variables, known as programming. Authors defined a total of 12 variables, of which intensity of load, duration of load, form of rest, duration of rest, and form of load are considered key [17]. The complete scheme of variables (+ environmental cond., nutrition status, total volume of work) in the HIIT method. (e.g. Fig. 3).

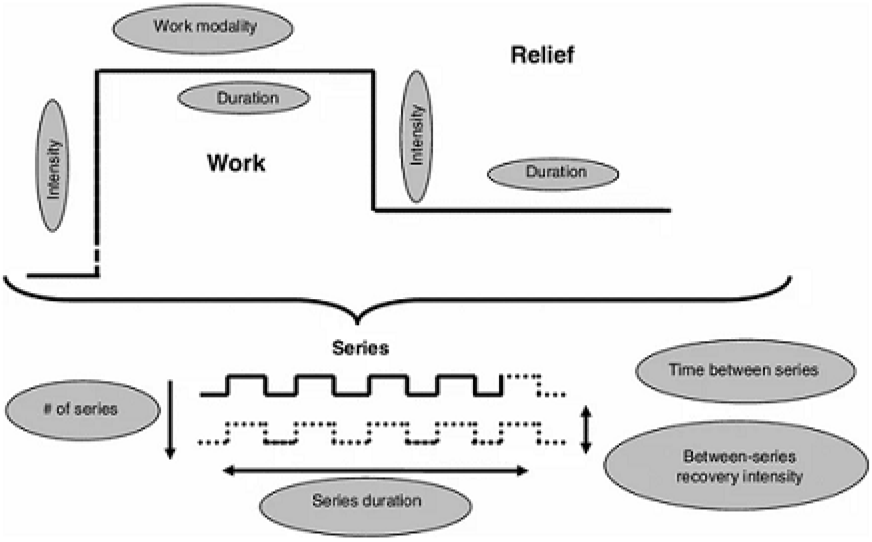

Fig. 3. Scheme of variables HIIT [23].

Based on the above, it is evident that intensity is a key factor for eliciting the desired response. To achieve this, it is essential to select exercises that challenge the entire musculoskeletal system and bodily systems. This need corresponds with the requirements for selecting exercises considering the diversity of a soldier's work and the development of their fitness, as mentioned earlier. From the perspective of developing bioenergetic potential (aerobic and anaerobic capacities – simplistically, strength and endurance), the HIIT method appears to be potentially very effective for a soldier's performance. It is also worth noting that for maintaining health, it is crucial to maintain an optimal ratio of muscle and fat components, on which the method has a proven effect. The most significant effects of HIIT are summarized below in five points:

- Significant stimulation of anaerobic capacity and strength (glycolytic energy cover).
- The method demonstrably increases aerobic capacity [14].
- The method significantly influences body composition parameters (growth of muscle mass and reduction of fat component due to EPOC).
- Additional effects are demonstrated at the hormonal, metabolic, and enzymatic levels; the method also considerably reduces the time individuals spend exercising.
- Efficiency considering time utilization (e.g. Fig. 1).

Effects of HIIT in Selected Research

In this section, we present the results of conducted research confirming the hypotheses from the previous section, which we expand upon in some aspects. Attention is paid to the effects, particularly concerning aerobic and anaerobic capacity and body composition. We also provide insights from our own research using the method and highlight various body development systems applied worldwide in connection with HIIT.

HIIT significantly affects the function of the anaerobic energy system (energy cover primarily occurs in anaerobic glycolysis mode), the ability to maintain homeostasis due to increased resistance to hydrogen ions causing a decrease in pH, and the utilization of non-carbohydrate sources (lactate, amino acids, glycerol) in the gluconeogenesis process. All these reactions lead to higher efficiency in ATP production during glycolysis. Through HIIT, strength capabilities are also stimulated, especially muscular endurance and contractile abilities [18].

Consequently, the increase in anaerobic capacity, or performance, is not particularly surprising given the aforementioned, especially with studies confirming this, where an increase of 18 % was observed after completing an eight-week cycle [19] or with an increase of 12.4 % [20] or demonstrating an improvement of 16.5 % [21]. From the perspective of increasing overall bioenergetic capacity, it is undoubtedly worth mentioning studies documenting the intervention's impact on the aerobic capacity component, which may not be entirely evident a priori.

Studies [22,23,24] confirm significant improvements in both aerobic and anaerobic components. Similarly, shifts in AT (anaerobic threshold), VT (ventilation threshold), PPO (peak power output) – peak performance, and the ability for its longer duration, along with overall higher values in the anaerobic area, are noted. Siahkouhian's research [22] measured active (12 respondents) and inactive athletes (12 respondents) and the effect of HIIT training on the aforementioned indexes. Measurements were conducted over eight weeks after 3 sessions each (e.g. Fig. 4). The basis of the study was a 3000*m* run and its measurement due to the influence before and after training values (e.g. Fig. 5).

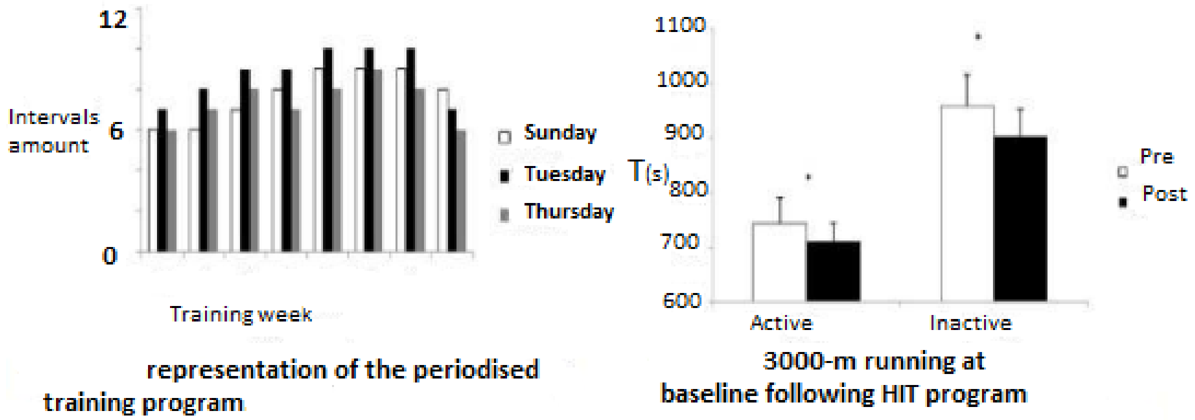

Fig. 4. and Fig. 5. Graphs illustrating training volume (6-10 sets of 30*s* load with a 4*min* passive rest) and a 3000*m* run before and after the study [22,23,24].

As evident from the table below (e.g. Tab. 2), both groups experienced an increase in VO_2max (±7.6 % and ±13.7 %) and a shift in the ventilatory threshold (±4.5 % and ±3.8 %). The first VT1 was automatically generated by the computer upon an increase in O_2 ventilation, irrespective of the equivalent rise in CO_2 ventilation. Conversely, the second VT2 was detected as the point where there was a rapid increase in CO_2 ventilation and an associated observed decrease in partial CO_2 pressure. Participants ran on a treadmill to subjective exhaustion to determine aerobic capacity. For anaerobic capacity and peak power output (PPO – peak power output – e.g., Table 3), the 30*s* Wingate Power test was used on a mechanically braked cycle ergometer at the maximum possible speed. The study saw an increase in both PPO (±8.3 % and ±14.6 %) and MPO (±10.9 % and ±19.0 %) [22,23,24].

Table.2. Table displaying improvements in ventilatory threshold and VO_2Max

Variable	PRE (AG)	POST	PRE (IG)	POST	p
VO_2Max	53.5±4.6	54.4±3.9	41±2.6	46.7±4.9	.005
AVT_1 (%VO_2Max)	63.9±4.2	66.7±3.9	56.3±4.3	58.5±4.3	.005
AVT_2 (%VO_2Max)	78.1±3.5	81.3±3.8	72.3±2.6	75.1±4.3	.005

Values are ± SD
P < 0.05 between the two groups
AC..Active group, IG..Inactive group

Table.3
Table shows an increase in performance both at maximal and average levels, where PPO represents the 5*s* peak power output during the test, and MPO is the average work for the 30*s* segment [22,23,24].

Variable	PRE (AG)	POST	PRE (IG)	POST	p
PPO (w/kg)	11.4±0.9	12.3±0.5	10.4±1.1	11.9±0.8	.005
MPO (w/kg)	7.2±0.8	8±0.6	6.3±0.6	7.4±0.4	.001

Values are ± SD
P < 0.05 between the two groups
P < 0.001 from the corresponding pre-training value

From the tables, it can be inferred that HIIT training leads to an increase in VO_2Max, ventilatory threshold, and consequently, greater maximal performance. One of the most well-known studies associated with HIIT and the development of both anaerobic and aerobic capacities is the six-week Tabata study conducted in the 1990s [15]. The study compared HIIT composed of 8 super-intense 20*s* intervals at 170 % VO_2Max separated by 10*s* passive rest intervals to 60 minutes of continuous exercise at 70 % VO_2Max. Tabata's training protocol demonstrated higher efficiency of HIIT (IT) compared to continuous training (ET) in developing anaerobic performance. After the six-week cycle, there was a 28 % increase (77.9 ml/kg/min) in anaerobic capacity with HIIT compared to continuous training, which did not show improvements in anaerobic capacity (e.g., Fig. 8 – on the left maximum anaerobic capacity on the y-axis versus time on the x-axis). An interesting finding may also be the relatively greater increase in aerobic capacity using HIIT (an increase of 5 ml/kg/min) compared to continuous training (an increase of 4.5 ml/kg/min), as shown in Fig. 6 on the right (VO_2Max displayed on the y-axis versus time on the x-axis).

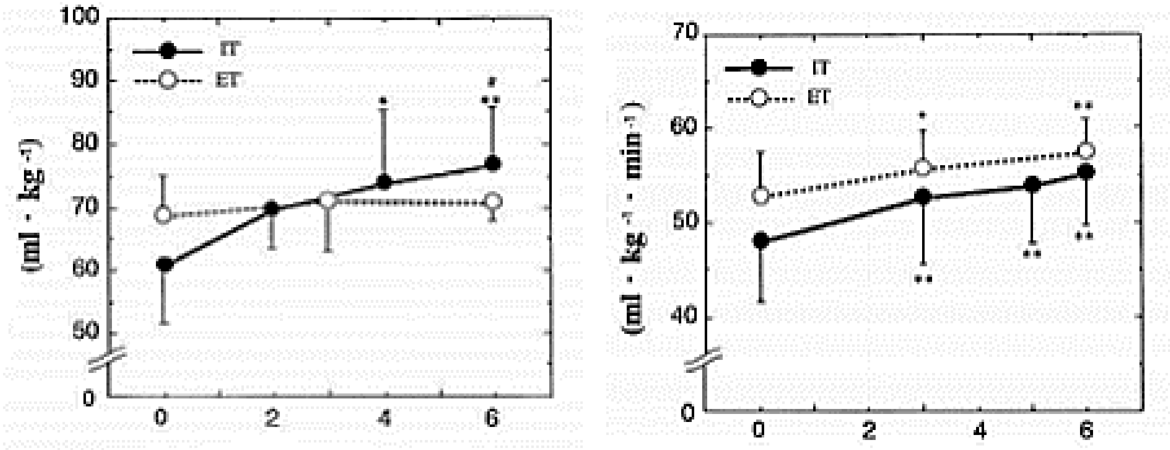

Fig. 6. Comparison of the effectiveness of IT and ET on indicators of aerobic and anaerobic capacity within weekly training load [15].

As a part of the research for the dissertation, we subjected the Tabata system to further examination, by observing the effect on both aerobic and anaerobic capacity parameters and body composition. Considering the issues of programming and the scheme presented in Figure 2, we compared the traditional Tabata, consisting of 20s/10s intervals (2:1 ratio) in eight exercise sets, with a modified version of 20*s*/20*s* intervals (1:1 ratio). Participants (n=46) were divided into two intervention groups and one control group. Within two weekly training sessions, male recreational athletes performed two exercise sets. The selected exercises, chosen for their complexity, were squats with jumps and burpees.

Significant effects on anaerobic capacity performance, as demonstrated by the Wingate test (p=0.0228 for the 2:1 protocol and p=0.0098 for the 1:1 protocol), were observed. Additionally, significant effects on changes in body composition parameters, particularly a reduction in fat mass for the 2:1 protocol (p=0.0001), were confirmed. Interestingly, effects on aerobic capacity, tested using load spirometry for both protocols, were also verified. The monitored parameters included VO$_2$Max, minute ventilation, and performance converted to kilograms. For the key variable VO$_2$Max, the value was p=0.015 for the 2:1 protocol and p=0.0819 for the 1:1 protocol. However, the substantive significance expressed by Cohen's d for the 1:1 system indicated a moderate level of effectiveness (d=0.654). The differences (pretest x posttest) for the mentioned values are represented in the figure below (e.g., Fig. 7).

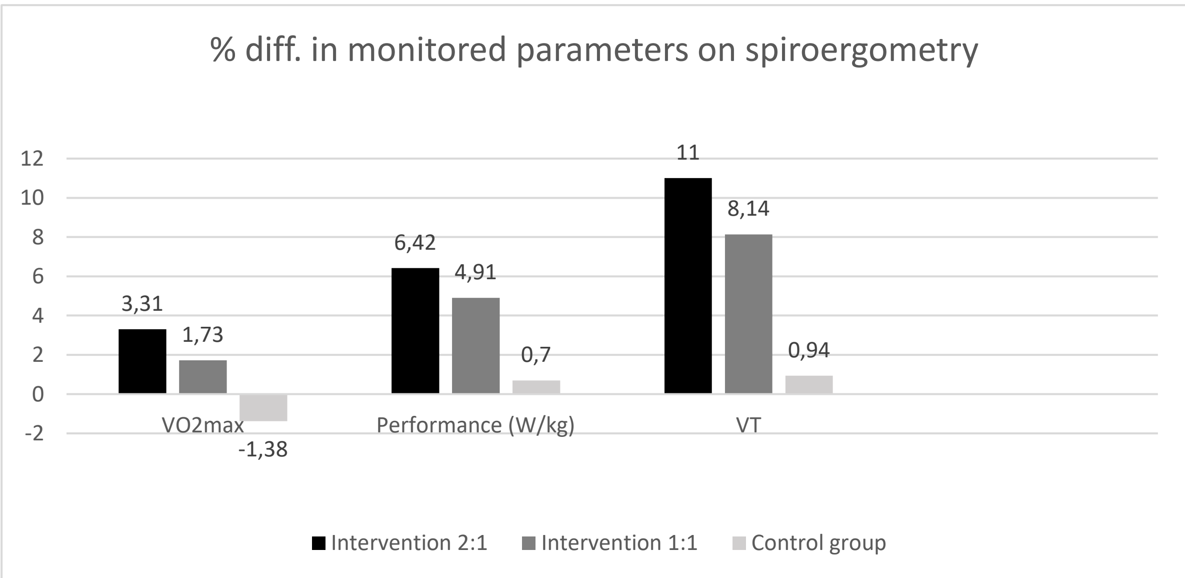

Fig. 7. Percentage differences (pretest/posttest) in the median of the observed parameters on the Spiroergometry [25].

The relationship between HIIT and the development of VO$_2$Max and other fitness parameters has been explored since the beginning of the millennium [26]. The results, showing the effect, can be seen in the example of twelve studies listed below (e.g. Tab. 4).

Table.4

Analysis of Research on VO_2Max at Various Intensities

Reference	n	Mode	Freq. (d/w)	Weeks	Reps	Intensity (VO_2Max)	W/R duration (min)	Results
Hickson	8 M	R/C	6	10	6	100 %	5/2	↑VO_2Max
Green	10 M	C	1	1	16	90 %	6/54	↑PCr
Keith	7 M	C	2-4	8	2	Th + 30 %	7.5/0.5	↑VO_2Max
Burke	21 F	C	2-4	7	-	85-98 %	0.5-2	↑VO_2Max
Simoneau	10M/14F	C	4-5	15	4-15	60-90 %	0.25-1.5	↑Type1
Rodas	5 M	C	7	2	4-7	All-out	0.25/0.75	↑PCr
Parra	5 M	C	2	6	4-7	All-out	0.5/12	↑PFK
Macdougal	12 M	C	3	7	4-10	All-out	0.5/4	↑PFK
Henritze	23 F	R	5	12	1	Th	NA	↑Th
Nevill	4M/4F	C	3-4	8	2-10	All-out	0.5/10	↑Lac
Tabata	7 M	C	5	6	7-8	170 %	20/10 s	↑VO_2Max
Hamer	7 M	C	3	7	4-10	All-out	0.5/4	↑Th

C..Cycle training, F..Female, Lac.. Lactate, M..Male n..number of probands, R..run training, PCr..Phosphocreatine, PFK..Phosphofructokinase aktivity, Th..Threshold, Type 1.. Muscle fibre type, ↑.. improvement.

The interconnection between both energetic systems (aerobic and anaerobic) and the mutual influence of their respective capacities can be explained through the following principles. When high intensity is used, energetic demands are met anaerobically in the glycolysis process. Glycogen is broken down into pyruvate, which is subsequently metabolized into lactate and hydrogen ions, leading to a decrease in the internal pH. This is the main factor slowing down ATP production — the primary energy source. The term "buffer capacity" is synonymous with anaerobic capacity. The term "buffering" refers to buffers, especially phosphates, hemoglobin, histidine, and carboxylic acids, and it is the readiness of the aerobic system that conditions the ability of the buffering capacity. Maintaining pH stability (striving for homeostasis) also significantly influences the function of the cardiorespiratory system due to the exhalation of CO_2. The ability of the aerobic system for this purpose is stimulated by an increase in maximal cardiac output, increased capillary density, mitochondrial oxidative capacity of skeletal muscle, and ventilation [28,29].

Fitness Programs in Military Environments

In designing an intervention training program and synthesizing the research problem, we were convinced that such programs are not commonly used in military sports environments worldwide. To competently discuss the global uniqueness/specificity of our training program, it was necessary to determine how various countries approach physical fitness development in the context of military conditioning (e.g., Tab. 5). Detailed research revealed information about training programs in European countries (most prevalent), Asia, North and South America, and Australia. These programs focused on measuring different parameters during diverse physical activities, with training periods ranging from 2 to 34 weeks and involving subjects ranging from 17 to 423 participants.

In Greece, the impact of a series of physical tests on army cadet performance was studied. A 12-week intervention training period resulted in improved performance in both specific military physical activities and general movement skills [30]. Cardiovascular performance and maximum strength were evaluated in a control group of 72 tested individuals in the Finnish military environment after an 8-week military training program. The result was an increase in VO_2Max capacity by over 12 % and leg extensor strength by nearly 13 % [31]. Norwegian military cadets (n=107) were examined during a 10-month period of mandatory military service [32]. The objective was to evaluate physical fitness using parameters such as VO_2Max, maximum sit-ups, push-ups, chin-ups, and 3-km running time. Significant improvements were found in sit-ups and push-ups. Other activities did not show significant improvement but also no deterioration. In Brazil, the effect of a 7-month military training program on changes in body composition variables was studied. A sample of 270 Brazilian cadets was divided into two training groups: military physical training routine and specific sport training. The resulting effect was similar for both groups [33]. The Spanish army tested a sample of 21 professional soldiers to determine performance differences after Resisted High Intensity Interval Training (RHIIT) and Endurance High Intensity Interval Training (EHIIT) programs compared to conventional and classic approaches. Significant improvements in cardiovascular parameters were observed after RHIIT and EHIIT interventions [34]. The effect of High Intensity Interval Training was also tested in Israel. Test subjects were divided into two groups – control and intervention. The intervention group underwent high-intensity training, while the control group underwent classic training. The training program lasted 5 weeks. The results showed a significant change in the observed parameters in favor of the intervention group [35]. Changes in the physical performance of Australian army personnel after a 5-week specific physical training program were the subject of a pilot study focused on physical, occupational, and technological assessments. The result showed no significant difference in variables characterizing performance between the control group and the experimental group [36]. A comparative system of results was also used in Iran. The study aimed to determine the effect of Crossfit on cardiovascular parameters and body composition. Soldiers from the Crossfit group showed significant positive reductions in BMI index and heart rate compared to soldiers from the control group [37].

Table.5.

Military Training Programs in Different Countries.

Country	Measured Parametres/Variables	Training Period	Physical Activities	Subjects	Results
Greece	Just performance	12 weeks	Pull-ups, 50m swim, Mile Run, Obstacle Course	423	Improvements
Finland	Cardiovascular (VO2 max), Maximal Strength, BodyMass	8 weeks	Combat training, Marching, Running, Walking, Cycling, Strength Training, Ball games, Shooting	72	Improvements
Norway	VO2 max, TTE (time to exhaustion), Body weight	10 weeks	Running, Strength Training, Ball play	107	Improvements, except pull-ups
Brazil	DXA, spBIVA	34 weeks (5 days/week, 90min/day)	Running, Calisthenics, Resistance, Swimming, Sports training	270	Improvements
Spain	Rate of perceived extertion, heart rate, skin temperature, explosive strength, bodyweight	2 weeks	Resisted high intensity interval training (RHIIT), endurance intensity interval training (EHIIT)	21	Improvements
Australia	Cardiorespiratory fitness, Muscular strength, Occupational capacity	5 weeks	Puhs-ups, Multistage fitness test, squat, strict press, deadlift, floor press, one-leg balance, one-arm plank	17	Depends on group (Control vs. Experimental)
Israel	Maximal oxygen consumption	6 weeks	Running (5-8km 3x times/week), agility and strength training, Army Fitness Test (3km running, pull-ups, squats, dips)	60	Depends on group (Control vs. Experimental)
Iran	BodyMass, heart rate, systolic and distolic blood pressure, VO2 max, maximal power to weight	4 weeks (3 times/week)	Weight-lifting, gymnastics, metabolic conditioning	24	Depends on group (Control vs. CrossFit)
Croatia	Variables in Tests: 20 yard shuttle run, Medicine ball sitting throw, Continuous JumP, 20m dash, Push-ups, Sit-ups, Pull-ups, Squats, Max. bench press, 3200m stuttle run	5 weeks	Continuous running session, calisthenics, exercises in pairs. bench press, 300 yard shuttle run, 3200m stuttle run	124	Improvements in BMPR group, in CERS group except horizontal jump, pull-ups and sit and reach test
USA	Variables in Tests: Push-ups, Sit-ups, 2 mile run, Deadlift, Pull-ups, Flexed arm hang, Standing long	6 months	Self-report aerobic activity, muscle-strenghtening activities	123	Depends on group (Physical activity standards)

Two 5-week training programs formed the basis of research focusing on the physical readiness of Croatian military cadets. They were divided into continuous endurance, relative strength training, and basic military physical readiness training groups. Both groups achieved statistically significant positive changes in various physical activities compared to their pre-training program state [38]. In the USA, a comparison was made between the impact of the standardized older physical test, the Army Physical Fitness Test (APFT), and the new test, the Army Combat Fitness Test (ACFT), on the physical performance of army personnel. They found that APFT is more suitable for increasing muscle strength, whereas aerobic capabilities increase due to ACFT [39].

4. Conclusions

Although the topic of fitness, both in society and in the military environment, is quite complex, and oversimplification could be counterproductive, we will attempt to summarize based on the above information what approaches could be effective in developing the fitness of future soldiers to best meet the specific requirements of the army. Contemporary society is generally struggling with decreasing fitness levels, which is associated with an increase in lifestyle diseases, overweight, and other undesirable aspects. Therefore, it is necessary to find ways to effectively counteract this emerging phenomenon. In the military environment, good physical readiness is not only associated with health aspects but primarily with the defence of the country, and the demands on the physical and mental resilience of soldiers are enormous. One method that comprehensively develops physical fitness and aligns with today's fast-paced trends and demands for efficient methods is the HIIT method. Based on numerous studies which we refer to in this work and based on our own research activities, we know that this method can effectively develop both essential components of fitness: aerobic and anaerobic capacity. Moreover, it is possible to achieve a positive effect on changing body composition parameters, which various authors consider an integral part of fitness. The method has been used with satisfactory results in the armies of Spain and Israel (e.g., Fig. 11). However, due to the complexity of programming, it will undoubtedly be necessary to subject the planned interventions to thorough scrutiny. It should be noted that high intensity is not only associated with physical development but also carries certain risks related to musculoskeletal damage (particularly the occurrence of micro and macro traumas) or the internal environment (mainly involving RO(N)S – reactive oxygen (and nitrogen) species) and local to systemic acute inflammation in connection with cumulative microtraumas. Another question remains at what level will the achieved fitness be maintained after the intervention is completed during the transitional period, or how to maintain the achieved level. All these factors need to be taken into consideration when designing interventions and long-term fitness development planning and subjected to further research. At the same time, we see the lack of clarification of all these causes as certain **limits** of this article. Nevertheless, HIIT can be an effective method for developing motor skills, which, on the one hand, respects the needs of military readiness and, on the other hand, aligns with the demands of society and the trend of the current fast-paced era.

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