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ТЕМАТИЧНИЙ НАПРЯМОК «ФІТОТЕРАПІЯ ТА БІОМЕДИЧНІ ДОСЛІДЖЕННЯ В СИСТЕМІ ФІЗИЧНОЇ РЕАБІЛІТАЦІЇ»

Running rehabilitation in the United States is a professional sports medicine system that combines diagnosis, treatment, and prevention; it's not just treatment, but an investment in long-term health. Thanks to advanced technologies (video analysis, 3D gait scanning) and personalized programs, runners quickly return to training and reduce the risk of recurring injuries.

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A REVIEW OF SCIENTIFIC RESEARCH IN MODERN SPORTS MEDICINE

The young field of Ukrainian sports medicine continues to develop, necessitating significant refinements, particularly in its terminology. Currently, numerous inconsistencies exist in the conceptualization of terms within pedagogical, didactic, medical, and sports-related formulations found in Ukrainian scientific literature on sports medicine. These inconsistencies often confuse researchers when discussing and processing the results of their studies.

Historically, in the early stages of medical supervision for individuals engaged in physical culture and sports (what sports medicine was called before the early 1970s), physicians and scientists conducted physical examinations of participants and athletes. They compared athletes' results "in general", often without considering specialization, and then determined their eligibility for physical culture or sports activities. These comparisons sometimes included individuals not involved in sports, whom certain authors later termed "untrained individuals", despite athletes consistently demonstrating superior performance [1].

It is now evident that such comparisons, with predictable outcomes, are methodologically flawed. Comparing parameters from athletes, whose motor regimens and high physical and psychological demands significantly differ from those leading sedentary lifestyles, demonstrates physiological economization and a high functional state in athletes.

When selecting individuals not engaged in sports as control groups, considering them as relatively healthy and defining them as the "norm", implicitly categorizes elite athletes as "supernormal – leaders who have advanced humanity's potential. The extraordinary achievements in sports, such as a 100-meter sprint in 9.58 seconds, a high jump of 245 cm, or lifting approximately 270 kg, are beyond the capabilities of the average person. This underscores the necessity of establishing a concept of "sport-specific norm" with specific indicators that may deviate from average statistical values. This approach highlights the lack of logic in comparing data from athletes with that of non-athletes [1].

The distinction between sports medicine and other medical specialties lies in sports medicine's focus on specific athletic activities as the "norm" for human physiological functioning, contrasting with "general medicine", where typical human existence is the norm. Therefore, comparing indicators among athletes with different training regimens, or between athletes and non-athletes, appears inappropriate.

Beyond the term "untrained individuals", there are also degrees of training such as "less trained", "insufficiently trained", "poorly trained", "more trained", and "well-trained" [2]. Such terminology is perplexing as it disregards established sports terminology, with authors often forgetting that only athletes can be considered trained or untrained. The concept of "trained athletes" refers to an athlete in good competitive form (often during the competitive period), while "untrained" describes an athlete at the beginning of a preparatory period or after a period of rest due to injury or illness, not individuals who do not participate in sports. Consequently, it is advisable to replace the term "untrained" with "individuals not engaged in sports". This aligns with definitions from prominent sports pedagogy experts, who define "trainability" as the state of an organism determining an athlete's physical preparedness, resulting from training. It is a condition developed through systematic training, enabling the most effective execution of specific muscular activities and readiness for achieving sports results. Trainability is a complex, multifaceted concept encompassing technical, tactical, physical, psychological, and functional preparedness, determining an athlete's overall and specific work capacity and readiness for peak performance.

Therefore, trainability is primarily the coach's domain, requiring them to integrate data on all its components, with assistance from various sports specialists. The physician's role is to assess one of the most crucial components of trainability: the athlete's functional state and level of functional preparedness. As these definitions indicate, the focus is exclusively on athletes, with no relevance to individuals not participating in sports.

These formulations reveal a subjectivity in defining trainability criteria and who determines this state – coach, athlete, physician, or scientist. To discuss the degree of trainability, one must know the athlete's competitive result for comparison, particularly in individual sports where results are quantifiable in units of measurement (meters, centimeters, seconds, minutes, kilograms, etc.). The situation becomes more complex in team sports, where a team might win despite individual players performing below par.

Considering that the degree of trainability falls under the coach's purview, sports physicians, in their research, should collaborate closely with the athlete's or team's coach, in addition to their laboratory findings.

Following the proposed classification of sports based on training process orientation and physiological principles, scientific works have emerged that incorporate these recommendations when comparing data. Some studies compare results between "successful" and "unsuccessful" athletes. Researchers should primarily analyze competitive outcomes. To assess an athlete's success, one must record initial results, conduct functional state assessments during a training period (e.g., preparatory), and then re-evaluate performance data during the competitive period. It is understood that initial preparatory period results are typically lower for most athletes. Training loads often lead to improvements in physical and other qualities, functional state, and technical proficiency, ideally resulting in better sports performance. This is contingent upon the absence of injuries, illnesses, regimen violations, overtraining, and physical overexertion. Occasionally, an athlete may perform poorly in competition despite being in good "sporting form" due to psychological burnout. A pertinent question arises: into which category – successful or unsuccessful – should an athlete be placed if they achieve the same or worse results as in the preparatory period but win a prestigious competition? However, the fact that a well-structured training process leads to improved functional status and, consequently, better sports results during the competitive period cannot be denied. The categorization of athletes into those who improve their results ("successful") and those who do not ("unsuccessful") appears contrived.

Scientific works increasingly address the determination of athlete qualification based on sports classification, particularly for publication in foreign journals. Abroad, qualification standards often differ, while Ukrainian classifications (e.g., Candidate Master of Sports, Master of Sports, Master of Sports of International Class) denote high-level athletes. Consequently, some propose characterizing athletes from the 1st class athlete to Master of Sports of International Class as "qualified", and athletes at the Master of Sports of Ukraine and Master of Sports of International Class levels as "high-level", "elite", or "world-record-capable".

Our study involved 741 coccer players classified into three groups: high-class players (Master of Sports to Master of Sports of International Class), advanced players (1st class athlete to Candidate Master of Sports), and intermediate players (3rd class to 2nd class athlete). This classification system is more understandable to specialists in Western Europe and the USA unfamiliar with Ukraine's grading system. While international authors acknowledge some inconsistencies in defining skill levels, elite athletes – Olympic participants and medalists – are generally categorized as "elite". National-level participants and medalists are considered "advanced", and regional competitors are "intermediate".

According to D.S. Lorenz et al., the distinction between elite and non-elite athletes remains debated, although traditionally, elite athletes participate in top-tier competitions. However, defining "elitism" involves various variables, including anthropometric and physiological characteristics, balance, role in the team, training duration and type, talent development, and physical fitness levels. Thus, differentiating athletes into "elite" categories is a complex, multi-component process, reflecting the multifaceted nature of "elite-class athlete" [3].

With the growing popularity of "MASTERS" competitions, research into the functional status of veteran athletes – individuals who continue practicing their sport after retiring from competitive athletics, some even competing – is advancing. The study of functional status in individuals who have ceased active sports careers becomes more relevant when examining specific sports (athletics, swimming, wrestling, etc.) and specific disciplines within them (e.g., race distances, weight classes) rather than general "sports veterans." Our findings in elite throwing athletes indicate that hemodynamic peculiarities persist after active training, not only in those who continue physical activity but also in sedentary veterans, albeit to a lesser extent.

Our research on 40 male veteran runners (100-400m, 85% high-level, medalists of World, European, and Ukrainian Championships) explored the impact of lifestyle on health indicators. Veterans leading active lives exhibited significantly more bradycardia, predominantly parasympathetic autonomic nervous system (ANS) influence, a more physiologically economical hypokinetic circulatory type (CT) with no hyperkinetic CT, greater physical capacity, and lower body mass index (BMI) compared to those with sedentary lifestyles. Similar research on 24 female sprinters (75% high-level, Olympic, World, European, Universiade, and Ukrainian medalists) revealed a tendency towards increased parasympathetic ANS influence and a prevalence of hypokinetic CT, with no significant differences in BMI during and after their sports careers [4].

We conducted a novel study in Ukraine (and possibly globally) on two groups of veteran athletes with significant youth achievements in 100-200m (Group 1) and 400-800m (Group 2) running, who continued to compete in "MASTERS" events. Despite regular training, albeit at reduced volume and intensity compared to their younger years (without health impairments), veterans experience a decline in sports results and physical capacity over time, a regression attributed to cumulative age-related processes. This regression appears more pronounced in middle-distance runners than sprinters, requiring further investigation.

We propose that valid research on veteran athletes should involve comparisons with their non-athletic peers to elucidate the positive or negative effects of specific sports on the human body. Such interpretations of stable functional changes in veterans can aid in the clinical assessment of similar changes in currently training athletes. Comparisons can also be made between veterans of the same sport and gender who have ceased active participation but maintain a supportive exercise regimen, versus those leading sedentary lifestyles. These comparisons are most informative when conducted in sports with quantifiable results (e.g., athletics, swimming, weightlifting).

Therefore, in scientific works, comparisons of performance indicators in athletes can be based on age, duration of sport participation, sports qualification, sex, body length (for team sports), body mass (for combat sports, weightlifting, certain rowing disciplines), training period (preparatory or competitive), and for team sports, playing position (forward, goalkeeper, etc.). An important approach involves comparing athletes who develop similar physical qualities, such as endurance in marathon runners and road cyclists, or speed in track sprinters and swim sprinters. However, caution is needed regarding the term "sprinter".

According to most scientists (sports physicians, physiologists, educators), endurance athletes ("stayers") have lower resting heart rates (HR) than sprinters, who develop speed or speed-strength qualities. Sprinting encompasses distances from 60 to 400 meters, and swimming from 50 to 200 meters. This category also includes cycling (track 200m flying start), kayaking and canoeing (200m), and speed skating (500m). Given the comparable times to cover these distances across genders and qualifications, comparing rowers with skaters and 400m runners is permissible, as they perform maximal cyclic physical work emphasizing speed and strength with very similar completion times. Sprint distances also exist in biathlon, cross-country skiing, and some triathlon events, though this terminology is less precise and relates to shorter competitive distances not aligning with the classic definition of sprint.

To verify the general hypothesis that athletes in speed-focused sports have higher HR than endurance athletes, we compared data from female sprinters (track and swimming) of comparable qualifications with female triathletes. Our findings indicated that female track sprinters (1^{st} class-CMS and MS-MSIC) had statistically higher mean HR over 100 meters than triathletes of similar qualification ($p<0.001$, $p<0.001$). For female swim sprinters, comparisons with triathletes showed no significant differences. Similar results were observed in men.

These data reliably support the assertion of statistically lower HR in endurance athletes (triathlon) compared to track sprinters. However, comparisons between triathletes and swim sprinters of both genders revealed no significant differences. This implies that track sprinters (100m in 14.0-10.70s, depending on sex and qualification) and swim sprinters (100m in 84.0-53.0s, depending on stroke and qualification) differ significantly in energy provision for muscular work, leading to swim sprinters exhibiting HR values comparable to triathletes, despite the latter focusing on endurance.

The HR data from elite endurance athletes compared to elite track sprinters are noteworthy. Mo Farah, a four-time Olympic champion in 5000m and 10000m, had a resting HR of 33 bpm. Similarly, Usain Bolt, an eight-time Olympic champion in 100m and 200m, also recorded a resting HR of 33 bpm. This pronounced bradycardia, indicative of physiological economization characteristic of highly qualified athletes in good form, can be observed not only in endurance athletes but also in those developing speed and other physical qualities.

Regardless of the specific HR value, it moderately decreases with increasing trainability and increases with detraining. Therefore, dynamic monitoring and comparisons of HR and other indicators within the same athlete across different training periods are crucial. Ensuring standardized measurement conditions – the same time of day, preferably after a rest day, avoiding the influence of prior training and meals, maintaining consistent room temperature – is paramount. Only under such conditions can data be obtained that is significant for both the athlete and the physician in interpreting functional status.

We reiterate that such research benefits sports physicians and scientists in comparing the functional status of athletes developing similar physical qualities in different environments and body positions. It also aids coaches by expanding their repertoire of training exercises and understanding HR response during specific activities.

Significant questions arise when comparing the functional status of athletes who perform training and competitive loads in different physiological planes – vertical (runners) versus horizontal (swimmers) – yet engage in similar muscular energy expenditure. We believe it is important to focus on justifying comparisons between runners and swimmers not only due to their comparable competitive results but also because both sports involve maximal power cyclic work emphasizing speed and strength, with energy provision primarily from anaerobic lactic sources. This energy pathway, involving glycolysis and lactate production, typically lasts around 30 seconds, aligning with their competitive distances.

The horizontal position favored by swimmers offers a physiological advantage over runners, allowing for greater training volume due to reduced exertion in the aquatic environment.

Equally important are issues concerning the physical development of individuals engaged in physical culture and sports, as some anthropometric indices and overall assessments remain controversial. For a rapid, albeit approximate, evaluation of physical development, certain indices are proposed, requiring careful consideration.

The mass-to-height indicator – Quetelet's BMI (Body Mass Index) – is calculated using the formula: body mass (g) / body height (cm). For adults, the average Quetelet's BMI ranges from 350-400 g•cm^{-1} for men and 325-375 g•cm^{-1} for women. Values above 500 g•cm^{-1} suggest obesity, while below 300 g•cm^{-1} indicate underweight. Applying this to elite athletes, such as basketball players, boxers, or super-heavyweight weightlifters, yields Quetelet's BMI of 500-650 g•cm^{-1} or higher (e.g., Arvydas Sabonis, 221 cm, 130 kg, Quetelet's BMI 588 g•cm^{-1}). For female athletes in disciplines like rhythmic gymnastics, high jump, or long-distance running, the Quetelet's BMI is significantly lower than 325 g•cm^{-1} (e.g., Hanna Bezsonova, 175 cm, 50 kg, Quetelet's BMI 286 g•cm^{-1}). Analyzing these data, the basketball player might be considered overweight, and the gymnast underweight, despite their visually harmonious physiques. This results in values that either exceed proposed norms or are significantly lower, even when athletes appear well-proportioned.

Some researchers propose the Pignet Index to assess bodily robustness, though critics rightly point out its "imprecision and illogicality stemming from an empirical approach." The index's creator attempted to establish correlations between body mass, chest circumference, and height, combining average chest circumference and body mass, then subtracting this sum from standing height for various height groups. From a modern biometric perspective, the Pignet Index is a crude empirical regression equation. It erroneously combines dissimilar components – centimeters (chest circumference) and kilograms (body mass) – by summing them. While height is considered, a shorter height indicates greater robustness, which is not always true. Furthermore, the Pignet Index fails to account for sex, age, or the specific sport practiced. Consequently, "the use of the Pignet Index at the current level of knowledge cannot be justified".

When evaluating physical development, it is essential to analyze the interrelationships of various characteristics, not just individual indicators.

Any physical development indicator must be assessed in conjunction with the individual's age and sex. For athletes, sports specialization and qualification are crucial, as the same indicator value can be beneficial or detrimental depending on the sport.

In summary, we have addressed critical issues in modern sports medicine terminology, including "trained" vs. "untrained", "successful" vs. "unsuccessful" athletes, and "elite" athletes. We have proposed approaches for research on athletes and veteran athletes, differentiated the concept of "sprinter" in sports, and offered critical remarks on applying Quetelet's BMI and the Pignet Index for assessing athletes' physical development.

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