POSTURAL CONTROL OF STUDENTS OF DIFFERENT BODY TYPES

ПОСТУРАЛЬНИЙ КОНТРОЛЬ СТУДЕНТОК РІЗНИХ ТИПІВ ТІЛОБУДОВИ

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DOI https://doi.org/10.32782/2522-1795.2024.18.8

Abstracts

Introduction. Numerous sensory signals from the visual, somatosensory, and vestibular systems are used to control postural control. It is well known that to maintain postural stability, the central nervous system keeps the overall center of mass of the body within the boundaries of the supporting surface. The postural control of people with different body types has been studied in detail in static conditions, but this problem has not yet been investigated in steady-state conditions.

The purpose of the study is to study the features of statodynamic stability of female students of different body types.

Research methods: theoretical analysis and generalization of literature sources, pedagogical observation, anthropometric examination. The diagnostic and training complex "SportKat 650 TS" on the basis of a moving platform, a pedagogical experiment, and methods of mathematical statistics were used to determine the statodynamic stability of the students' body.

The study established the following stratification of 121 female students involved in the study, taking into account their inherent body type: 64 people have mesomorphic, 35 people – ectomorphic, 22 people – endomorphic somatotypes.

The data obtained during the experiment reveal the tendency of the subjects (representatives of all experimental groups) to significant body vibrations in the sagittal plane, which emphasizes the difficulty of the latter in maintaining the desired body posture, i.e., the inability to minimize body vibrations on a moving support.

Based on the analysis of the results of tests for performing motor tasks with more active body movements, such as the "Dynamic Test – Clockwise Movement" and the "Dynamic Test – Counterclockwise Movement", girls aged 17–18 years who participated in the experiment had certain difficulties, including the inability to clearly display or maximize the result of the movement set by the Sport Kat 650 TS software.

Conclusions. In general, postural stability can be considered as its ability to be maintained and remain qualitatively unchanged in response to interventions or fluctuations (including postural fluctuations) in control. Control over the state of statodynamic stability of the body is a very important and basic requirement in everyday life. Controlling the body's statodynamic stability requires visual and vestibular influences, as well as proprioceptive and tactile somatosensory influences, to control the muscles that regulate posture throughout the body, especially in the lower extremities and trunk. Performing test exercises on the diagnostic and training complex "Sport Kat 650TS" made it possible to establish the absence of specific differences that make up obvious patterns that reflect the peculiarities of statodynamic stability of girls aged 17–18 years of different body types.

Key words: postural control, body building, students, statodynamic stability of the body, musculoskeletal system, posture, physical education.

Вступ. Численні сенсорні сигнали від зорової, соматосенсорної та вестибулярної систем використовуються для постурального контролю людини. Загальновідомо, що для підтримки постуральної стабільності центральна нервова система утримує загальний центр мас тіла у межах опорної поверхні. Постуральний контроль людини з різними типами тілобудови детально вивчений у статичних умовах, але ще не досліджено цю проблему у статодинамічних умовах.

Мета дослідження – вивчити особливості статодинамічної стійкості студенток різних типів тілобудови.

Методи дослідження: теоретичний аналіз і узагальнення літературних джерел, педагогічне спостереження, антропометричне обстеження. Для визначення статодинамічної стійкості тіла студенток використовувався діагностико-тренувальний комплекс «SportKat 650 TS» на базі рухомої платформи, педагогічний експеримент, методи математичної статистики.

Результати. У дослідженні встановлено таку стратифікацію залучених до дослідження 121 студентки з огляду на притаманний їм тип тілобудови: 64 особи мають мезоморфний, 35 осіб – ектоморфний, 22 особи – ендоморфний соматотипи.

Одержані під час експерименту дані розкривають схильність обстежуваних (представників усіх піддослідних груп) до істотних коливань тіла у сагітальній площині, що увиразнює наявність у останніх труднощів з утриманням потрібної пози тіла, тобто неспроможність мінімізувати коливання тіла на рухомій опорі.

На основі аналізу результатів «Динамічний тест – рух за годинниковою стрілкою» та «Динамічний тест – рух проти годинникової стрілки» у дівчат 17–18 років, які брали участь у експерименті, зафіксовані певні труднощі, серед яких: неможливість чіткого відображення та максимального наближення до результату руху, заданого програмним забезпеченням «Sport Kat 650 TS».

Висновки. Загалом постуральну стійкість можна розглядати, як її здатність зберігатися і залишатися якісно незмінною у відповідь на втручання або коливання (включаючи постуральні коливання) в управлінні. Контроль за станом статодинамічної стійкості тіла є дуже важливою і основною вимогою у повсякденному житті людини. Контроль статодинамічної стійкості тіла вимагає зорових та вестибулярних впливів, а також пропріоцептивних та тактильних соматосенсорних впливів, щоб керувати м'язами, які регулюють поставу, у всьому тілі, особливо в нижніх кінцівках та тулубі. Виконання тестових вправ на діагностико-тренажерному комплексі «Sport Kat 650TS» дало змогу встановити відсутність конкретних відмінностей, які становлять очевидні закономірності, що відображають особливості статодинамічної стійкості дівчат 17–18 років різних типів тілобудови.

Ключові слова: постуральний контроль, тілобудова, студенти, статодинамічна стійкість тіла, опорно-руховий апарат, поза, фізичне виховання.

Introduction. From the point of view of biomechanics, the human body is a multi-linked hinge system [8; 11] designed to perform two tasks, such as ensuring stability and orientation in the surrounding space, which is the result of the highly complex interaction of a significant number of neural networks of the body with its skeletal and muscular apparatus [8; 11].

A person adopts the most appropriate posture in relation to the environment and mobility goals in static and dynamic conditions. Thus, the ultimate goal of posture is to maintain balance in both static and dynamic conditions [2]. By analyzing the vertical posture of the body, it is possible to identify deviations from the normal state of the musculoskeletal system in terms of altered kinematic patterns [3; 4], and then use them to assess neuromuscular and skeletal conditions to help in the further planning of corrective and preventive measures [7]. The parameters of the amplitude-frequency characteristics of the general center of mass of the human body reflect both the age-related, genetically determined, dynamics of the balance function and the effect of physical exercises on the neuromuscular system, the articular and ligamentous apparatus [1; 5; 9], muscular and vestibular receptions, those components of the functional system of balance regulation that are leading in ensuring the stability of the orthograde posture [6; 14].

The purpose of the study is to study the features of statodynamic stability of female students of different body types.

Materials and methods of the study. The experimental studies were conducted at the Department of Physical Education of the Kyiv National Economic University named after V. Hetman. The study involved 121 female students of the main educational department aged 17 to 18 years [12]. All participants provided written consent to participate in the study. The research was conducted in compliance with the requirements of the World Medical Association's Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects".

The fulfillment of the tasks set in the work involves the involvement of a set of methods such as: theoretical – to study and substantiate

the fundamental principles of the study, outline its problem field; empirical: pedagogical observation as a method of empirical research – to get acquainted with the process of organizing physical education at the Department of Physical Education of the Kyiv National Economic University named after V. Hetman; anthropometric examination of female students using standard tools and on the basis of a generally accepted unified methodology (the examination involved the use of anthropometric points with a fairly specific localization in relation to the skeletal bone formations selected for the study as a reference point for measurements, and for more accurate measurements – the somatic axis of coordinates. The location of a particular anthropometric point was determined by palpation, painless pressing, and then marking it with a demographic pencil; the type of body type of female students was determined using the Piniere index; method of registration and analysis of statodynamic stability of students' bodies (diagnostic and training complex "SportKat 650 TS" based on a movable platform, the degree of mobility of which is adjustable); pedagogical experiment; statistical – all research results were processed using the software package SPSS Statistics v. 17.0 [10].

Results. Based on the use of the Pinier index, the study established the following stratification of the 121 students involved in the study, taking into account their inherent body type: 64 people have mesomorphic, 35 people – ectomorphic, 22 people – endomorphic somatotypes [12; 13].

Execution of test exercises on the diagnostic and training complex "Sport Kat 650TS" allowed to establish the absence of specific differences which make up obvious regularities reflecting features of statodynamic stability of girls of 17–18 years old of different types of a body constitution.

The results obtained during the experiment should be recognized as a manifestation of a mostly individual approach to the performance of the motor task of maintaining balance (the determinant of this is primarily the rather high complexity of the proposed tests on a moving support). Here are some summarized results and some generalizations.

Thus, the "Static test" made it possible to observe in all subjects the predominance of oscillations in the sagittal plane (forward and backward body oscillations) (individual results of these tests are shown in Fig. 1).

The data obtained during the experiment reveal the tendency of the subjects (representatives of all experimental groups) to significant body vibrations in the sagittal plane, which emphasizes the difficulty of the latter in maintaining the desired body posture, i.e., the inability to minimize body vibrations on a moving support.

Based on the analysis of the results of tests for performing motor tasks with more active body movements, such as the "Dynamic Test – Clockwise Movement" and the "Dynamic Test – Counterclockwise Movement", girls aged 17–18 years who participated in the experiment had certain difficulties, including the inability to clearly display or maximize the result of the movement set by the Sport Kat 650 TS software.

This refers to the need to repeat the trajectory of the point (circle shape; clockwise or counterclockwise direction), the movement of which is displayed on the monitor screen, taking into account the position of the body's central tendon on a moving support (platform), the movement of which is also demonstrated on the monitor screen. In addition to the above, it is worth mentioning such a tendency as the worst among other groups results of the tests performed by girls of 17–18 years of age of endomorphic body type (Fig. 2 shows that for the experimental group a rather chaotic movement of the body's central tendency with corresponding rather sharp changes in the direction of movement due to macro-oscillations, which forms a certain form of the trajectory of the body's central tendency on a moving support, is typical).

Girls of 17–18 years old of ectomorphic and mesomorphic body types during the tests specified in the dissertation realized the form of the body's CT trajectory, which is closer to the specified one (however, the nature of movement should be associated with rather sharp changes in the direction of movement due to macro fluctuations). We consider interesting a feature common to the two groups, which is the closeness of the

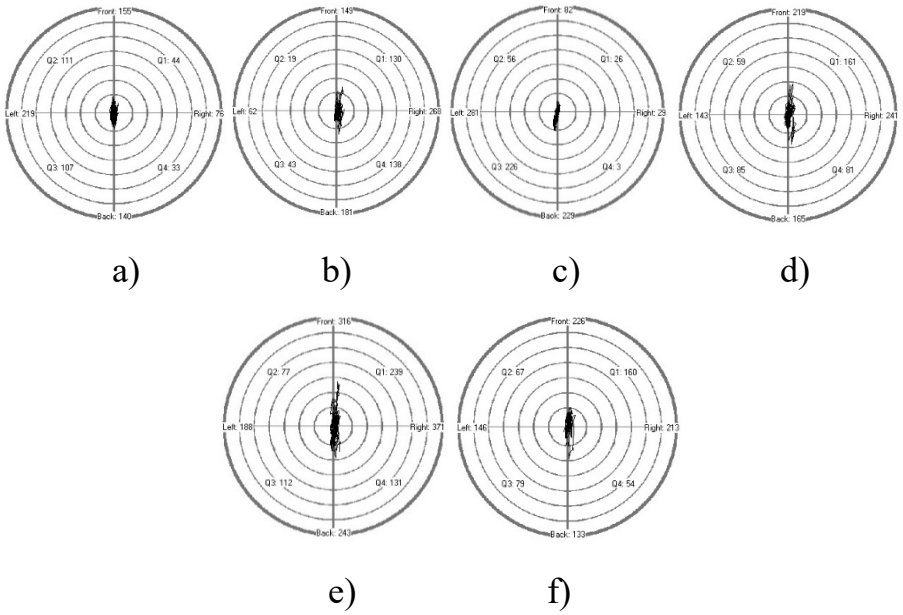

Fig. 1. Examples of results of performance of "Static test" on the diagnostic and training complex "Sport Kat 650 TS" by girls of 17–18 years old of different body type: a, b – students of 17–18 years old of mesomorphic body type; c, d – students of 17–18 years old of ectomorphic body type; e, f – students of 17–18 years old of endomorphic body type

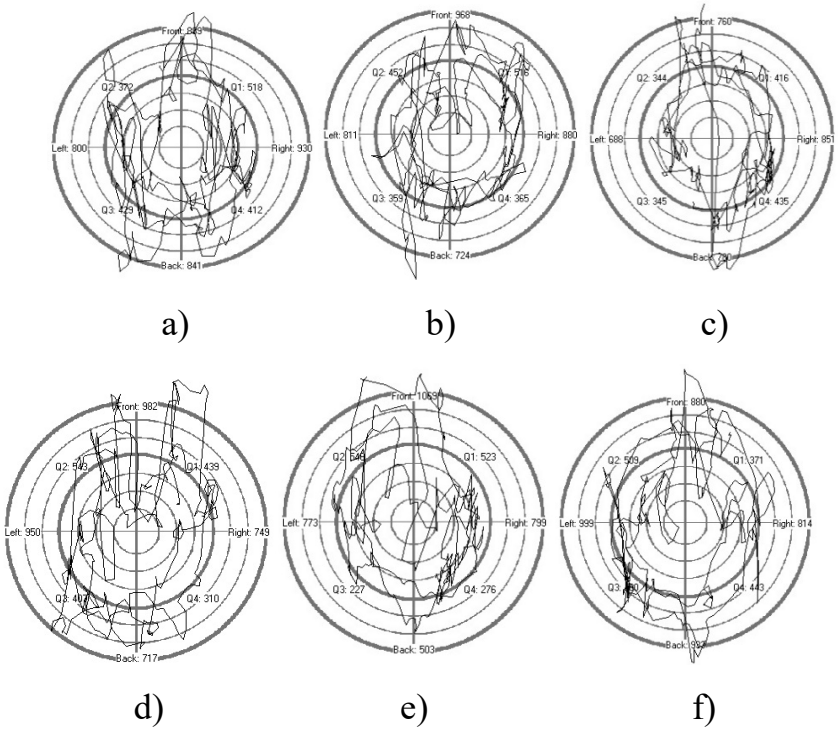

Fig. 2. Examples of results of tests on the diagnostic and training complex "Sport Kat 650 TS" of girls of 17–18 years old of endomorphic type of a body constitution: a), b), c) – "Dynamic test – clockwise movement"; d), e), f) – "Dynamic test – counterclockwise movement"

trajectory of the body's central body temperature (CBT) movement during the "Dynamic test – clockwise movement", usually to the shape of an ellipse with a predominance of the anterior-left and posterior-right zones of movement (Fig. 3).

It is noteworthy that the performance of the "Dynamic test – counterclockwise movement" by girls of 17–18 years of age of mesomorphic and ectomorphic body types led to the trajectory of movement of the body's central tendon, which is also close to the shape of an ellipse, where the anterior-right and posterior-left zones of movement prevail, that is, the opposite, as in the previous version (Fig. 4).

The available factual material serves as a basis for the statement that in case of complication of conditions of exercises, in particular test tasks, girls of 17–18 years old of endomorphic body type demonstrate results worse than indicators of girls of 17–18 years old of mesomorphic and ectomorphic body types. This suggests that it is the increased body weight that negatively affects the performance of more complex test exercises.

Discussion. Posture is not only about maintaining the position of the body parts relative to each other and the whole body in space, but also about adapting to changes in standing conditions during the performance of arbitrary motor acts, complex pre-adjustment, preliminary active movements, and ensuring stability during locomotion [6; 8; 11]. Given their importance, understanding the structural and functional features of the system of maintaining an upright posture is an urgent bioinformatics task of modern biomechanics of movements [3; 4], which is of general theoretical (deepening the general principles of organizing a system for controlling human movements) and practical (development of diagnostic postural tests for both clinics and human health testing) importance. Postural mechanisms are also a subject of scientific interest because of their status as intermediate between motor automatisms such as locomotion and voluntary movements [5; 7]. Therefore, it seems logical to consider familiarization with the principles of posture regulation as a prerequisite

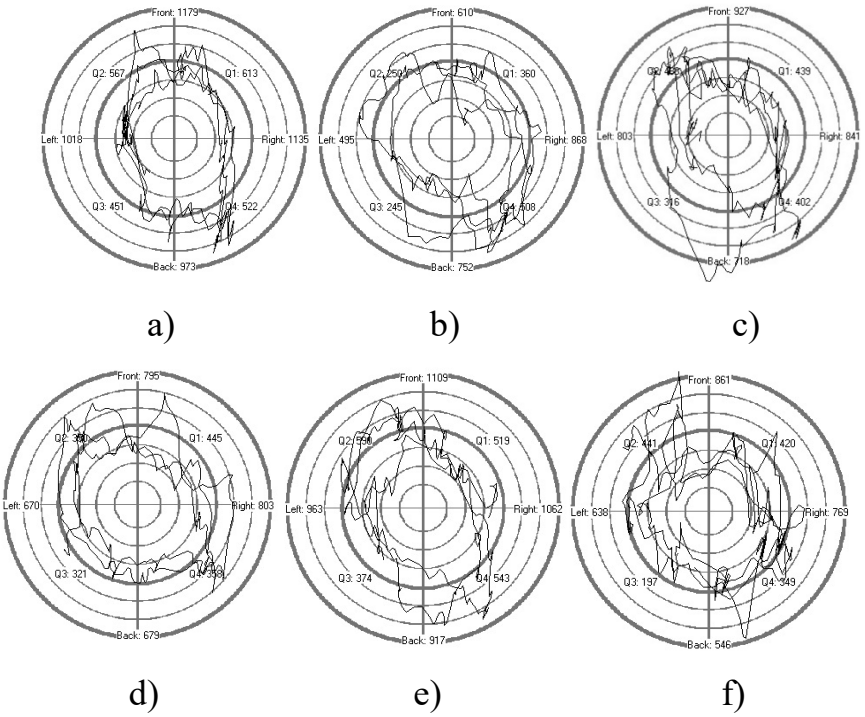

Fig. 3. Examples of results of performance of "Dynamic test – clockwise movement" on the diagnostic and training complex "Sport Kat 650 TS" of girls of 17–18 years old of different body types: a), b), c) – girls of 17–18 years old of mesomorphic body type; d), e), f) – girls of 17–18 years old of ectomorphic body type

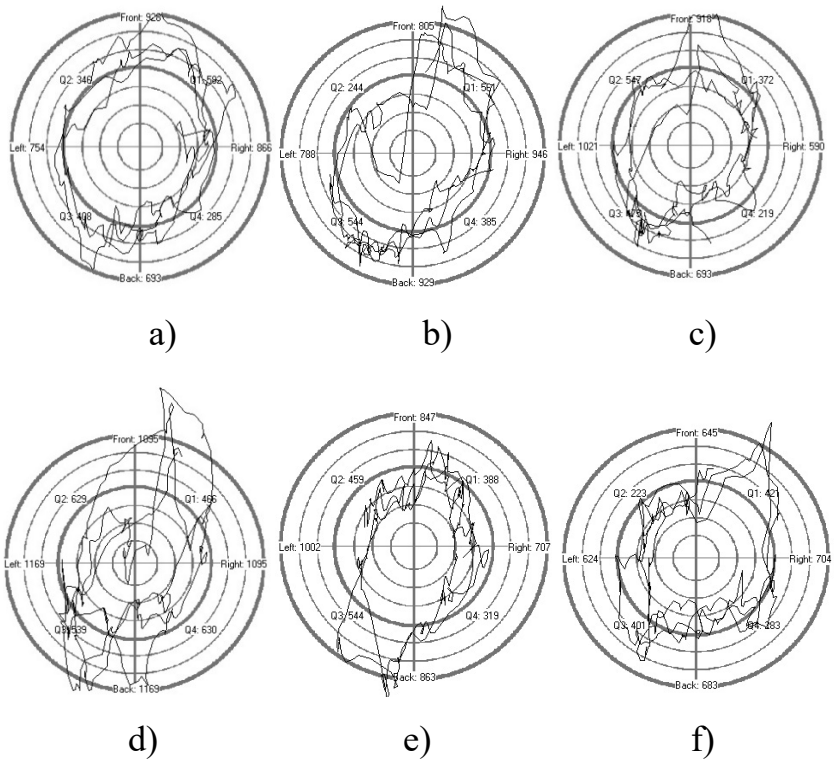

Fig. 4. Examples of the results of the "Dynamic test – counterclockwise movement" on the diagnostic and training complex "Sport Kat 650 TS" of girls of 17–18 years old of different constitution a), c), e) – girls of 17–18 years old of mesomorphic type of a body constitution; b), d), f) – girls of 17–18 years old of ectomorphic type of a body constitution

for understanding the principle of organizing the control of voluntary movements [6]. It should be noted that scientists describe several models for maintaining the body's balance in the sagittal plane, but mostly they model the body as a single-link pendulum tipped upward. The latter model is obviously unstable [13]. On the contrary, in the vertical plane, stability is achieved through the work of muscles that ensure a return to a state of balance. This model is used to describe oscillations. Minimal oscillations involve a person using an "ankle" strategy by changing the angle in the ankle joint, and large oscillations involve a "hip" strategy, in which stability is achieved by engaging the hip joints [14].

The data on the content and direction of biomechanical monitoring of students' statodynamic stability in the process of physical education were further developed.

Conclusions. Performing test exercises "Static test", "Dynamic test – clockwise movement", "Dynamic test – counterclockwise movement" with the use of diagnostic and training complex "Sport Kat 650TS" revealed the presence of significant body fluctuations of girls of 17–18 years old in the sagittal plane, which indicates difficulties with holding the necessary body posture, that is, the impossibility of minimizing body oscillations on a movable support by representatives of all groups, and test exercises on performing motor tasks with more active body movements, in particular "Dynamic test – clockwise movement", as well as "Dynamic test – counterclockwise movement", – the presence of certain difficulties in students, namely students of endomorphic body type have the worst results of test exercises among students of other experimental groups (chaotic movement of the center of pressure of the body with sharp changes of direction of movement due to macro-oscillations, which leads to the acquisition of a certain form of movement of the center of pressure of the body on a moving support) in students of ectomorphic

and mesomorphic somatotypes, the shape of the trajectory of the center of body pressure was closer to the specified one (the nature of the movement should be associated with rather sharp changes in the direction of movement and macro-oscillations). A common feature for the latter two groups was observed, which is the approximation of the trajectory of movement of the center of body pressure obtained during the "Dynamic test – clockwise movement" to the shape of an ellipse with a predominance of the front-left and rear-right zones of movement.

Conflict of interest. The authors declare that there is no conflict of interest.

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Отримано: 8.02.2024
Прийнято: 1.03.2024
Опубліковано: 29.04.2024

Received on: 8.02.2024
Accepted on: 1.03.2024
Published on: 29.04.2024