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# EDUCATIONAL AND INFORMATIONAL SUPPORT FOR BIOMECHANICALLY BASED DESIGN OF CORRECTIONAL AND PROPHYLAXIS TECHNOLOGIES FOR WOMEN OF THE SECOND MATURE AGE PERIOD

***Резюме. Мета*** *– обґрунтувати зміст і структурні компоненти освітньо-інформаційного забезпечення як передумови біомеханічно обґрунтованого проєктування корекційно-профілактичних технологій оздоровчого фітнесу для жінок другого періоду зрілого віку.* ***Матеріали і методи****: аналіз та узагальнення наукової літератури, соціологічні методи, методи математичної статистики; обстежено 18 жінок другого періоду зрілого віку.* ***Результати.*** *Встановлено достатній, але неоднорідний рівень теоретичної обізнаності щодо постави, її детермінант і засобів профілактики у 77,8 %. Інформаційні дефіцити стосувалися наслідків гіподинамії, анатомо-біомеханічних характеристик хребта та диференціації функціональних і структурних порушень постави. Окремі компоненти обізнаності статистично значуще асоціювалися з функціонально-біомеханічними показниками (p<0,05–0,01), однак причинно-наслідкова інтерпретація цих зв'язків є недоцільною. Виявлена невідповідність між теоретичною обізнаністю та руховою поведінкою обґрунтовує інтеграцію освітньо-інформаційного, мотиваційно-поведінкового та практичного компонентів корекційно-профілактичної технології.* ***Висновок.*** *Освітньо-інформаційне забезпечення доцільно розглядати як когнітивно-регуляторну складову біомеханічно обґрунтованого проєктування, спрямовану на формування функціонально значущих знань, самоконтролю та їх практичної реалізації в оздоровчому фітнесі.*

***Ключові слова****: жінки, оздоровчий фітнес, постава, освітньо-інформаційне забезпечення, корекційно-профілактична технологія*

***Summary. Objective*** *– to substantiate the content and structural components of educational and informational support as a prerequisite for the biomechanically grounded design of corrective and preventive technologies in health-oriented fitness for women in the second period of adulthood.* ***Materials and methods****: analysis and generalization of scientific literature, sociological methods, and methods of mathematical statistics. A specially developed questionnaire on knowledge about posture was used, which contained 10 test tasks with one correct answer choice. The questionnaire content covered basic anatomical and physiological concept. The study involved 18 women in the second period of adulthood (aged 36–45).* ***Results.*** *A generally sufficient but heterogeneous level of theoretical knowledge regarding posture, its determinants, and preventive measures was established (7.78 ± 1.67 points out of 10; a sufficient level was demonstrated by 77.8% of participants). Information deficits concerned the consequences of physical inactivity, the anatomical and biomechanical characteristics of the spine, and the differentiation between functional and structural postural disorders. Individual components of knowledge were statistically significantly associated with functional and biomechanical indicators (p < 0.05–0.01); however, these associations should not be interpreted causally. The identified discrepancy between theoretical knowledge and actual movement behavior supports the integration of educational and informational, motivational and behavioral, and practical components into the structure of corrective and preventive technology.* ***Conclusion.*** *Educational and informational support should be considered a cognitive-regulatory component of biomechanically grounded design, aimed at developing functionally relevant knowledge, self-monitoring skills, and their practical implementation in health-oriented fitness.*

***Key words****: women, health-oriented fitness, posture, educational and informational support, corrective and preventive technology*

**Problem statement and analysis of recent researches**. The problem of preserving and optimizing the motor function of women in the second mature age period in modern conditions acquires an interdisciplinary nature, covering biomechanical, physiological, pedagogical, information-analytical and social aspects [1,2]. Its relevance is due to the combined effect of age-related morphofunctional transformations, changes in postural regulation and motor stereotypes, adaptive reserve decrease, motor activity limits, prolonged static loads and psycho-emotional stress [3,4]. Under such conditions, it is advisable to consider health fitness not only as a means of motor activity level increasing, but also as a potential tool for targeted modification of the functional-biomechanical state and maintaining the motor system functional capacity [5,6].

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The results of modern studies [7,8] indicate increased attention to the biomechanical characteristics of the body spatial organization and the functional state of the musculoskeletal system of mature women. The expediency of differentiated application of corrective and preventive measures depending on the type and severity of postural disorders, as well as taking into account individual characteristics of the biogeometric profile when designing programs of health-related motor activity [9] is substantiated. This reflects a gradual transition from the averaged characteristics of the studied contingent to taking into account the structural and functional variability of the individual motor status and creates the prerequisites for the personification of corrective and preventive influences [10,11].

An important direction of modern research is the development of theoretical and methodological foundations of corrective and preventive technologies. The transition is traced from the use of individual physical exercises, aimed mainly at correcting local manifestations of functional dysfunction, to the systematic design of programs, the content of which is determined by the characteristics of the spatial body organization, the functional state of the musculoskeletal system, physical fitness level and the peculiarities to physical exertion adaptation [12,13]. However, a significant part of the existing developments is focused on individual age or nosological contingents, specific types of postural disorders or local functional characteristics, which limits the possibilities of forming a universal algorithm for the transition from complex diagnostics to a substantiated technological solution.

The development of digital technologies has significantly expanded the possibilities of quantitative assessment of the spatial body organization, postural control, kinematic structure of movements and the functional state of individual motor system links. The use of digital photogrammetry, computerized analysis of posture, stabilography, functional testing and other biomechanical methods provides a significant array of objective information about motor system state [14,15]. At the same time, the fact of diagnostic field expanding itself does not guarantee an increase in the corrective and preventive technologies effectiveness [16,17]. The practical value of diagnostic data is determined by the possibility of their systematization, functional interpretation, integration and further transformation into decisions regarding the content, direction and parameters of physical activity.

In this context, the educational and information component of technological design acquires special importance. Modern research demonstrates a gradual expansion of ideas about corrective and preventive technologies as multi-level systems in which diagnostics, interpretation of information, individualization of physical influences, monitoring and correction form an interconnected management cycle. At the same time, the information and educational component in such systems is mainly considered as auxiliary and insufficiently conceptualized. Information about the motor system state is often used mainly as a diagnostic basis, while the mechanisms of its pedagogical interpretation, structuring and transformation into knowledge, recommendations and decision-making algorithms available for practical use remain insufficiently developed. The relationships between the level of biomechanical awareness, understanding of the principles of organizing motor activity and the ability to consciously implement personalized corrective and preventive recommendations also require clarification.

Thus, the current state of scientific development of the problem is characterized by a significant expansion of the capabilities of biomechanical diagnostics, the accumulation of data on age-related motor system peculiarities and the development of differentiated technologies of health fitness. At the same time, the mechanism for integrating complex biomechanical information with its educational and pedagogical interpretation and transformation into personalized technological solutions remains insufficiently developed. The scientific gap is, therefore, not in the absence of individual diagnostic methods or correctional means, but in the insufficient conceptualization of their relationship in the system of educational and information support of the correctional and preventive process. This necessitates the development of educational and information support that would combine

biomechanical diagnostics, systemic interpretation of results, formation of individually significant knowledge and recommendations, prediction of the reaction to physical activity, justification of a personalized technological solution. This approach creates the prerequisites for the transition from the use of diagnostic information mainly in the evaluative function to its use as a tool for managing the content and parameters of corrective and health fitness preventive technologies for women in the second mature period.

**Purpose of the study** is to substantiate the content and structural components of educational and information support as a prerequisite for biomechanically substantiated design of corrective and health fitness preventive technologies for women in the second mature period.

**Materials and methods**. *Participants*. The study involved 18 women aged 36–45 years, who also underwent instrumental examination, functional testing, and participated in the experimental program. To ensure confidentiality, each participant was assigned an individual research code, which was used when comparing the results of the questionnaire, testing, and experimental observation. The personal data of the participants were not included in the reporting materials and were not disclosed; the analysis was carried out using anonymized codes. The ethical principles of the study were in accordance with the main provisions of the Declaration of Helsinki of the World Medical Association, the Universal Declaration on Bioethics and Human Rights, and the Council of Europe Convention on Human Rights and Biomedicine [18]. *Research methods*. To determine the theoretical awareness level of women in the second mature period regarding the posture essence, risk factors for its violations, possible results for musculoskeletal system functional state and means of preventive and corrective influence, such sociological method as questionnaires was used. A specially developed questionnaire on knowledge about posture was used, which contained 10 test tasks with one correct answer choice. The questionnaire content covered basic anatomical and physiological concepts, in particular the essence of hypodynamia, the features of physiological spine curvatures, the classification of posture disorders, as well as questions about the relationship between postural disorders and musculoskeletal system functional state and awareness of priority means of their prevention and correction, in particular the nature of physical activity and the role of gymnastic exercises. *Statistical analysis*. Statistical analysis of the obtained data was carried out using the IBM SPSS Statistics 17.0 software. To summarize the survey results, the frequency distribution of responses, mean values, and variability indicators were determined. The relationships between the indicators of theoretical awareness and the studied functional and biomechanical characteristics were assessed using correlation analysis.

**Results**. The use of the questionnaire had a diagnostic and design direction: along with a quantitative assessment of basic knowledge formation level about posture, identification of typical misconceptions and information deficits, the results of the questionnaire were used as an empirical basis for determining the content components of educational and information support for future technology. The structural distribution of answers for each test task is presented in Fig. 1.

The analysis of the obtained data showed the heterogeneity of the theoretical awareness of the subjects in individual thematic blocks. Thus, in the question about the consequences of reduced motor activity, 55.6% of women chose the correct answer “hypodynamia”, while 33.3% mistakenly associated this phenomenon with hypertrophy, and 11.1% with hypoxia. This distribution of responses indicates insufficient differentiation of basic physiological concepts, which is fundamentally important for understanding the consequences of motor activity lack and its impact on the functional body state.

At the same time, the revealed nature of the responses has design significance, since it demonstrates the need to include in the educational and informational component not only general information about the meaning of motor activity, but also an accessible explanation of the causal relationships between hypodynamia, the functional state of the motor system and

the risk of postural disorders. This creates the prerequisites for the transition from formal assimilation of individual terms to the formation of a systemic understanding of the biomechanical and functional consequences of insufficient motor activity.

1. Reduced physical activity causes the condition
   - Correct: hypodynamia → 55.6 %
   - Incorrect: hypertrophy → 33.3 %
   - Incorrect: hypoxia → 11.1 %

2. The main rule of health-oriented training
   - Correct: gradual increase in the intensity and duration of exercise → 61.1 %
   - Incorrect: use of LFK exercises → 38.9 %

3. Subjective indicators of the body's condition
   - Correct: well-being, sleep, appetite → 83.3 %
   - Incorrect: weight, height, body parameters → 11.1 %
   - Incorrect: training loads, results, pain → 5.6 %

4. The concept of "posture"
   - Correct: the usual position of a person at rest → 100 %

5. What does NOT determine the characteristics of posture?
   - Correct: body mass index → 77.8 %
   - Incorrect: curvature of the spine → 22.2 %

6. A disease that is NOT a consequence of poor posture
   - Correct: diabetes → 94.4 %
   - Incorrect: osteochondrosis → 5.6 %

7. Forward convex curvature of the spine
   - Correct: lordosis → 66.7 %
   - Incorrect: kyphosis → 33.3 %

8. Which is NOT a functional postural disorder?
   - Correct: scoliosis → 55.6 %
   - Incorrect: flat back → 33.3 %
   - Incorrect: round back → 11.1 %

9. Lateral curvature of the spine in the frontal plane…
   - Correct: scoliosis → 94.4 %
   - Incorrect: lordosis → 5.6 %

10. Exercises for correction and prevention of postural disorders
    - Correct: gymnastic exercises → 88.9 %
    - Incorrect: athletic exercises → 11.1 %

Fig. 1. Structure of responses of women with posture disorders to the questionnaire on posture knowledge (n=18)

A similar variability was found when assessing knowledge about the principles of organizing health training. Only 61.1% of the subjects correctly identified a gradual increase in the intensity and duration of physical activity as one of the key principles of safe training process organization. Instead, 38.9% of respondents associated the correct answer mainly with the use of therapeutic physical culture exercises. The revealed structure of the answers may indicate a partial identification of health training with therapeutic physical culture and insufficiently formed ideas about the general dosage regularities and physical activity progression.

At the same time, the highest level of awareness was established regarding subjective indicators of the functional state of the body: 83.3% of women correctly attributed well-being, sleep and appetite to them. At the same time, 11.1% of respondents mistakenly attributed body weight, height and physique to subjective indicators, and 5.6% of them training loads, sports results and pain sensations. The results obtained indicate the presence of certain terminological and conceptual difficulties in distinguishing between objective characteristics of physical condition and subjective manifestations of well-being, which is fundamentally important for the formation of self-control skills during health fitness classes.

The highest level of basic knowledge was recorded regarding the fundamental concept of "posture": all respondents (100%) correctly defined it as the usual position of the human body at rest. The obtained result indicates a sufficiently formed general idea about the essence of posture, but cannot be considered as evidence of a full-fledged system of knowledge about its biomechanical organization, determinants of formation, disorders mechanisms and targeted correction principles.

Analysis of ideas about factors that do not determine the features of posture formation showed that 77.8% of women correctly noted the absence of a determining relationship with body mass index indicators, while 22.2% mistakenly denied the relationship between posture features and physiological curvatures of the spine. The latter result indicates insufficient formation in some of the studied ideas about structural and biomechanical determinants of the spatial organization of the body and the role of the spine configuration in posture formation.

When assessing knowledge about the pathological consequences of posture disorders, 94.4% of respondents correctly identified diabetes mellitus as a disease that does not belong to their direct consequences, while only 5.6% mistakenly indicated osteochondrosis. This structure of responses generally characterizes an adequate understanding of the relationship between disorders of the spatial organization of the body and pathological changes in the musculoskeletal system, although it does not exclude the presence of individual erroneous causal ideas.

The most pronounced deficiencies in biomechanical knowledge were identified in the responses concerning the anatomical characteristics of the physiological curvatures of the spine. Only 66.7% of the respondents correctly associated an anteriorly convex spinal curvature with lordosis, whereas 33.3% incorrectly identified it as kyphosis. These findings indicate insufficient differentiation of fundamental anatomical and biomechanical concepts essential for a conscious understanding of the spatial organization of the human body and the mechanisms underlying the development of postural disorders.

A similar trend was observed in the assessment of knowledge concerning functional postural disorders. A total of 55.6% of the women correctly indicated that scoliosis is not classified as a functional postural disorder. Meanwhile, 33.3% incorrectly classified flat back as a non-functional postural disorder, while 11.1% identified round back as belonging to the same category. This distribution of responses indicates insufficient differentiation between functional postural alterations and structural spinal deformities, which is of fundamental importance for an adequate understanding of the potential for preventive and corrective interventions through health-oriented fitness programmes.

At the same time, the concept of scoliosis as a lateral curvature of the spine in the frontal plane was found to be sufficiently well established: 94.4% of the respondents provided

the correct answer, whereas only 5.6% incorrectly associated the given definition with lordosis. Thus, despite a generally adequate understanding of the most common terms related to postural disorders, the respondents demonstrated fragmented knowledge of more specialized anatomical and biomechanical concepts, particularly those concerning the spatial organization of the spine and the classification of postural disorders.

The analysis of perceptions regarding the means of preventing and correcting postural disorders showed that 88.9% of the women considered gymnastic exercises to be the primary means, whereas 11.1% selected athletic exercises. This distribution generally indicates an adequate orientation towards the use of specifically targeted physical exercises. However, the proportion of responses favouring athletic exercises may reflect an overemphasis on the role of strength training and resistance exercise equipment without a sufficiently comprehensive understanding of their place within an integrated system of preventive and corrective interventions.

The overall assessment of theoretical knowledge, determined by the total number of correct answers to 10 test questions, ranged from 5 to 10 points. The mean score was 7.78 ± 1.67 points, indicating an overall adequate level of knowledge, although with considerable inter-individual variability. The majority of participants (77.8%) demonstrated an adequate level of awareness, scoring between 7 and 10 points, while 33.3% achieved high scores of 9–10 points. At the same time, 22.2% of the women obtained total scores of 5–6 points, indicating substantial gaps in their understanding of fundamental principles related to postural biomechanics, the classification of postural disorders, and the principles of preventive and corrective interventions.

Correlation analysis enabled a more detailed examination of the relationships between the level of educational and informational awareness and selected biomechanical, functional, and behavioural characteristics of the women included in the study (Fig. 2).

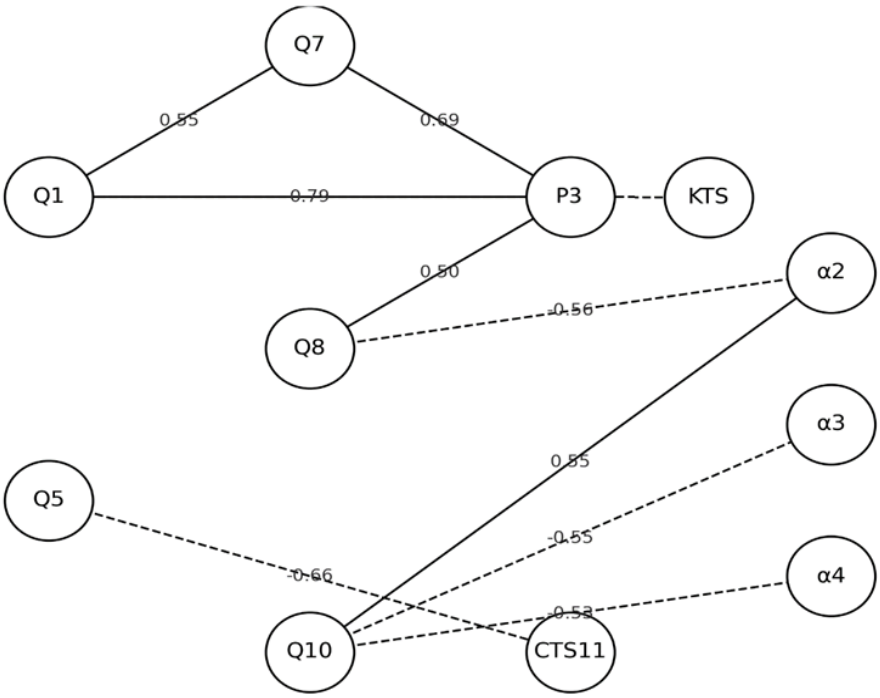



Fig. 2. Relationships between the awareness indicators of women aged 36–45 with postural disorders regarding the posture nature, risk factors, consequences of postural disorders, and preventive measures, and the biomechanical characteristics of the musculoskeletal system and functional capabilities (n = 18) where Q1 is knowledge of the consequences of reduced physical activity; Q5 is knowledge of the relationship between

posture and spinal curvatures; Q7 is knowledge of measures for the correction and prevention of postural disorders; Q8 is knowledge of spinal curvatures types; Q10 is knowledge of the principles of exersice prescription; RZ is total awareness score; angles in the sagittal plane: $\alpha_2$ is shoulder girdle alignment, $\alpha_3$ is pelvic inclination, $\alpha_4$ is trunk deviation; CTS11 is difficulties in exersices requiring fine hand motor skills; KTC is total score of carpal tunnel syndrome symptoms; solid lines mean positive associations; dashed lines mean negative associations; numbers mean values of Spearman's correlation coefficient ($\rho$).

The total awareness score demonstrated close statistically significant associations with the accuracy of responses to individual thematic questions, particularly those concerning the consequences of physical inactivity (Q1; $p < 0.01$) and the selection of exercises for the correction of postural disorders (Q7; $p < 0.01$). This pattern of associations confirms that the overall level of awareness is primarily determined by the acquisition of causal and applied aspects of postural health, particularly the interrelationship between physical activity, the functional state of the musculoskeletal system, and the possibilities for preventive and corrective intervention.

At the same time, analysis of individual questionnaire items revealed statistically significant associations with functional and clinical characteristics. In particular, the correct identification of hypodynamia as a consequence of reduced physical activity (Q1) was associated with a lower total symptom score for carpal tunnel syndrome according to the Boston Questionnaire (KTC; $p < 0.05$). In addition, greater awareness of factors that do not determine postural characteristics (Q5) was associated with the absence of difficulties in performing fine hand movements (CTS11; $p < 0.01$). These associations suggest that the level of educational and informational awareness may coexist with specific characteristics of the functional state of the musculoskeletal system. However, given the correlational nature of the analysis, awareness cannot be regarded as a direct causal factor underlying the respective clinical manifestations. At the same time, these associations emphasize the relevance of incorporating information on early signs of functional overload into the educational component of the proposed intervention technology.

Statistically significant correlations were also identified between biomechanical knowledge and parameters of the spatial organization of the body. Correct understanding of the characteristics of spinal curvatures and their relationship to postural disorders (Q8) was associated with a lower magnitude of shoulder girdle inclination in the sagittal plane ($\alpha_2$; $p < 0.05$), which may correspond to less pronounced anterior displacement or a stooped posture. Meanwhile, knowledge concerning measures for the prevention of postural disorders (Q10) demonstrated statistically significant inverse correlation with the magnitude of pelvic inclination ($\alpha_3$; $p < 0.05$) and forward trunk displacement ($\alpha_4$; $p < 0.05$). These associations indicate an interrelationship between the cognitive and biomechanical components of functional status; however, they do not provide grounds for directly concluding that greater awareness causes a reduction in the severity of postural deviations.

The moderate positive statistically significant correlation between Q10 and the magnitude of the shoulder girdle inclination angle ($\alpha_2$; $p < 0.05$) deserves particular attention. Its nature permits an alternative interpretation, according to which a higher level of awareness of preventive measures may not be the cause of a more favourable biomechanical status but rather a consequence of previous exposure to preventive or corrective recommendations in connection with pre-existing postural deviations. This interrelationship highlights the potentially bidirectional nature of the association between the condition of the musculoskeletal system and educational and informational experience and further substantiates the need to consider the educational component not in isolation, but as part of a closed-loop process: assessment – information provision – physical practice – monitoring – correction.

Statistically significant correlations were also observed between knowledge level and characteristics of everyday physical behaviour. In particular, correct responses to question Q2 concerning the principles of health-oriented training were correlated with a greater duration of sitting during the week ($p < 0.05$). This finding is methodologically important, as it demonstrates that theoretical knowledge does not necessarily translate into corresponding behavioural practices. Therefore, informational awareness alone cannot be regarded as a sufficient condition for optimizing physical activity patterns; its functional effectiveness depends on the ability to integrate acquired knowledge into everyday behaviour, self-monitoring, and regular physical activity.

**Discussion.** The synthesis of the identified associations makes it possible to consider educational and informational prerequisites not as a one-dimensional characteristic of the amount of theoretical knowledge, but as a complex functional and behavioural construct associated with cognitive readiness to understand biomechanical patterns, characteristics of functional status, parameters of the spatial organization of the body, and the nature of everyday motor behaviour [19,20].

At the same time, the pattern of correlations indicates the absence of an unambiguous linear relationship between awareness and the actual condition of the musculoskeletal system: in some cases, greater awareness was associated with more favourable functional and biomechanical characteristics, whereas in others, it was accompanied by unfavourable behavioural parameters [21,22].

The findings provide grounds for considering educational and informational prerequisites as a cognitive and regulatory basis for the biomechanically informed design of corrective and preventive intervention technologies [23,24]. Despite the generally adequate level of awareness, its content-related heterogeneity was identified: the acquisition of basic concepts concerning posture was accompanied by fragmented understanding of the consequences of hypodynamia, the anatomical and biomechanical characteristics of the spine, and the differentiation between functional and structural postural disorders.

Statistically significant associations between individual knowledge components and functional and biomechanical indicators ($p < 0.05$–$0.01$) demonstrate their potential functional significance. However, given the study design, these associations do not provide grounds for causal interpretation. At the same time, the identified discrepancy between theoretical awareness and the nature of physical behaviour confirms that knowledge alone does not ensure its practical implementation.

From a design perspective, these findings substantiate the need to integrate the educational and informational component with motivational, behavioural, and practical components, focusing not on expanding the volume of theoretical information, but on developing functionally relevant knowledge concerning postural biomechanics, factors contributing to postural disorders, safe prescription of physical loads, corrective measures, and self-monitoring of physical behaviour.

**Conclusions**.

An adequate but heterogeneous level of educational and informational awareness was established among women aged 36–45 ($n = 18$) regarding the nature, determinants, and prevention of postural disorders. The mean score was $7.78 \pm 1.67$ points out of 10. An adequate level of awareness was demonstrated by 77.8% of the participants, including 33.3% who achieved a high level, whereas insufficiently developed knowledge was identified in 22.2% of the women.

Selective deficiencies in biomechanical and physiological understanding were identified. Despite a high level of awareness of the concept of posture (100%) and the nature of scoliosis (94.4%), the most substantial information deficits concerned the consequences of hypodynamia, the anatomy of physiological spinal curvatures, and the differentiation between functional and structural postural disorders.

Statistically significant correlations were established between individual educational and informational characteristics and functional and biomechanical indicators. Understanding the consequences of hypodynamia was associated with lower severity of carpal tunnel syndrome symptoms ($p < 0.05$), while knowledge of factors determining postural characteristics was associated with the absence of difficulties in fine hand motor skills ($p < 0.01$). Individual components of awareness were also associated with parameters of sagittal body alignment ($p < 0.05$).

A discrepancy between the level of theoretical awareness and physical behaviour was identified. An accurate understanding of the principles of health-oriented training did not preclude a substantial amount of sedentary activity, confirming that informational influence alone is insufficient in the absence of its behavioural implementation.

**Prospects for further research** include the development and experimental validation of an educational and informational component of a corrective and preventive intervention technology integrated with the results of biomechanical assessment, individualized prescription of physical loads, and motivational and behavioural support for women in the second period of adulthood.

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