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УДОСКОНАЛЕННЯ ФІЗИЧНОЇ ПІДГОТОВКИ СТУДЕНТОК У ПРОЦЕСІ ЗАНЯТЬ ВОЛЕЙБОЛОМ: КІЛЬКІСНИЙ І ЯКІСНИЙ АНАЛІЗ ДАНИХ УПРОВАДЖЕННЯ ЕКСПЕРИМЕНТАЛЬНОЇ МОДЕЛІ

Анотація. *Дослідження присвячене обґрунтуванню та експериментальній перевірці ефективності моделі диференційованої методики удосконалення фізичної підготовки студенток педагогічних спеціальностей у процесі занять волейболом. Актуальність роботи зумовлена необхідністю підвищення рівня фізичної підготовленості студентської молоді в умовах зниження загальної фізичної активності та обмежених можливостей індивідуалізації навчально-тренувального процесу у закладах вищої освіти. Теоретичну основу дослідження становлять сучасні концепції індивідуалізації, поступовості та варіативності тренувального навантаження, що враховують вихідний рівень фізичної підготовленості та індивідуальні особливості студенток. У дослідженні взяли участь 101 студентка. На констатувальному етапі підтверджено однорідність вибірок за основними показниками. Протягом формувального етапу у* ЕГ *впроваджувалася модель диференційованої методики, що передбачала поділ студенток на підгрупи за профілем розвитку фізичних якостей і цілеспрямовану корекцію завдань та навантажень. Оцінювання ефективності здійснювалося на основі комплексу кількісних та якісних показників. Результати свідчать, що* ЕГ *продемонструвала статистично значущі покращення у всіх тестах (*p *< 0,001) з середнім і великим розміром ефекту (Cohen's* d *= 0,56–1,21). Якісний аналіз підтвердив зростання мотивації, підвищення рівня залученості, покращення командної взаємодії та зростання самооцінки студенток* ЕГ*. Отримані результати узгоджуються з попередніми дослідженнями, що підтверджують важливість індивідуалізації тренувального процесу у студентському спорті, та демонструють потенціал моделі диференційованої методики як ефективного засобу комплексного розвитку фізичних і психологічних компонентів підготовленості майбутніх педагогів. Методика може бути рекомендована для впровадження у програми фізичного виховання ЗВО, з подальшою адаптацією до різних категорій студентської молоді та інтеграцією цифрових засобів моніторингу.*

Ключові слова: *фізична підготовка; студентки; волейбол; диференційована методика; індивідуалізація; мотивація; фізична культура; вища освіта.*

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IMPROVING FEMALE STUDENTS' PHYSICAL FITNESS THROUGH VOLLEYBALL TRAINING: A QUANTITATIVE AND QUALITATIVE ANALYSIS OF THE IMPLEMENTATION OF AN EXPERIMENTAL MODEL

Abstract. *The study focuses on the rationale and experimental verification of the effectiveness of a differentiated training model aimed at improving the physical fitness of female students in pedagogical specializations through volleyball training. The relevance of the research is determined by the need to enhance the physical fitness of university students under conditions of declining overall physical activity and limited opportunities for the individualization of the educational and training process in higher education institutions. The theoretical foundation of the study lies in modern concepts of individualization, progression, and variability of training load, which take into account the initial level of physical fitness and the individual characteristics of the students. A total of 101 female students participated in the research. At the ascertaining stage, the homogeneity of the samples was confirmed based on the main indicators. During the formative stage, the experimental group (EG) implemented the differentiated training model, which involved dividing the students into subgroups according to their physical quality profiles and making targeted adjustments to tasks and loads. The effectiveness of the model was evaluated using a set of quantitative and qualitative indicators. The results show that the EG demonstrated statistically significant improvements in all tests (p < 0.001), with medium to large effect sizes (Cohen's d = 0.56–1.21). The qualitative analysis confirmed an increase in motivation, a higher level of engagement, improved team interaction, and enhanced self-assessment among EG students. These findings are consistent with previous research confirming the importance of individualizing the training process in university sports and demonstrate the potential of the differentiated training model as an effective tool for the comprehensive development of both the physical and psychological components of future teachers' preparedness. The model can be recommended for implementation in physical education programs at higher education institutions, with further adaptation for different categories of students and integration of digital monitoring tools.*

Keywords: *physical fitness; female students; volleyball; differentiated training model; individualization; motivation; physical education; higher education.*

Problem Statement. The modern system of physical education in higher education institutions is aimed not only at maintaining the physical activity of university students but also at fostering a high level of

professional readiness, especially among future teachers [7]. In the context of an intensified academic process and a decline in overall physical activity levels among female students, the development and implementation of effective methods capable of improving physical fitness and motivation for regular sports participation become particularly important [11].

Volleyball, as a sport, combines a variety of physical exercises that comprehensively contribute to the development of strength, speed, coordination, endurance, and flexibility [13]. In addition, it has significant socio-psychological potential: it promotes the formation of teamwork, responsibility, and the ability to make quick decisions in game situations [14]. In the context of the professional training of future teachers, particularly women, volleyball serves not only a health-promoting and educational function but also becomes an effective means of developing professionally significant qualities such as leadership, communication skills, and the ability to work with a group [6].

Previous research indicates that traditional approaches to volleyball training in higher education are often designed for an average level of preparedness and do not take into account individual differences in the physical indicators of female students [1]. This reduces the effectiveness of the educational and training process and leads to slower progress, especially among those with a lower initial level of preparedness.

Therefore, there is a need to introduce differentiated training methods based on preliminary testing, grouping students according to their physical fitness level, and targeted adjustment of training programs in accordance with identified needs. This approach allows for a more effective distribution of training loads, ensures the gradual development of each physical quality, and increases motivation for sports participation [2].

Review of Current Research. The physical training of university students is viewed not only as a means of promoting health but also as a key component in developing the professional competence of future specialists, particularly in the pedagogical field [5]. For female students in pedagogical specializations, who will later act as organizers and facilitators of physical education and health-related activities, it is essential to ensure the development of a set of physical qualities that enable them to work effectively in both school and extracurricular environments.

Volleyball holds particular potential in this context, as it combines exercises that simultaneously stimulate the development of speed–strength, coordination, and endurance components of physical preparedness [10; 13]. The specific nature of the game demands a high level of spatial–temporal orientation, rapid decision-making, and instant responses to changes in the playing situation, thereby contributing to the development of cognitive functions and psychomotor coordination [4].

Theoretical models of physical training in volleyball are based on the principles of progression, variability, and specificity of training stimuli [1]. Research shows that adaptive changes in physical preparedness occur most effectively when individual differences, related to morphofunctional characteristics, training level, and motivational factors, are taken into account [9].

A differentiated approach in physical training involves dividing the group into subgroups according to the level of development of specific physical qualities and purposefully applying exercises that best match the participants' current abilities and objectives [2]. The application of such an approach in student sports, particularly in volleyball, makes it possible to optimize the workload, increase training intensity for more advanced students, and at the same time prevent overload in those with a lower level of preparedness [11].

In addition to physiological benefits, the individualization of the training process enhances students' motivation and engagement, as they can see their own progress and receive tasks that match their abilities [3]. In the long term, this positively influences the formation of sustainable physical activity habits and helps maintain a high level of physical activity even after graduation.

Thus, the theoretical foundations for improving the physical preparedness of female students through volleyball training are based on combining classical principles of sports training with innovative methods of a differentiated approach that takes individual differences into account and aims at the comprehensive development of physical, technical, and psychological components of preparedness.

The **aim of the study** was to determine the effectiveness of a differentiated model for improving the physical fitness of female students in pedagogical specializations through volleyball training, using both quantitative and qualitative analysis of the results.

Methods. The study was conducted at a pedagogical higher education institution with the aim of testing the effectiveness of a model for improving the physical fitness of female students through volleyball training (hereinafter referred to as the differentiated training model). The model was designed in accordance with the principles of individualization, progression, and variability [1]. For each subgroup of students, priority training directions were defined (for example, for the subgroup with a low level of speed–strength preparedness, ball exercises focused on explosive power and coordination; for the subgroup with a high level, complex game combinations of increased intensity).

The participants were first- to third-year female students. The total sample consisted of N = 101, with the experimental group (EG, n = 51), in which the developed model was implemented, and the control group

(CG, n = 50), which was trained according to the traditional program. All participants provided informed consent; the procedures complied with the ethical standards of a pedagogical experiment.

The research process consisted of three stages:

1. Ascertaining stage, determining the baseline level of physical fitness, and conducting a motivation survey.
2. Formative stage: integrating the differentiated training model into the EG training process.
3. Control stage re-testing all indicators, conducting the motivation survey again, and analyzing changes in physical fitness and attitudes toward volleyball training.

A comprehensive approach combining quantitative and qualitative analysis was applied to obtain an objective assessment of the effectiveness of the experimental model and to trace its influence not only on the physical qualities of the students but also on their motivation and attitude toward physical activity:

- Quantitative indicators (results of standard physical fitness tests in accordance with ISO testing standards in physical education and sport, anthropometric measurements, analysis of changes in volleyball game performance);
- Qualitative indicators (survey results on motivation for training, self-assessment of physical fitness, expert evaluations by instructors).

Primary data were processed using descriptive statistics (mean, standard deviation, standard error). To assess the significance of differences between groups and over time, Student's t-test for dependent and independent samples was applied. To determine the strength of the intervention effect, Cohen's d was calculated in accordance with S. Sawilowsky's [12] recommendations. The statistical significance level was set at $p < 0.05$.

Results. The results of the ascertaining stage indicated that the baseline level of physical fitness in the EG and CG did not differ statistically ($p > 0.05$) for any of the measured indicators, confirming the homogeneity of the samples and the validity of their comparison. The average baseline test scores were generally at a moderate or below-moderate level, underscoring the need for a training approach capable of intensifying the development of physical qualities.

The implementation of the differentiated training model during the formative stage led to significant improvements in most indicators in the EG. In the aerobic endurance test (1000 m run), the EG improved by an average of –16.4 seconds (+4.8%; t = 6.27; $p < 0.001$), while in the CG the improvement was statistically insignificant (–3.2 seconds; $p > 0.05$).

A similar trend was observed in speed and coordination tests. In the 4×9 m shuttle run, the EG showed an average improvement of –0.31 seconds (–3.6%; t = 5.88; $p < 0.001$), whereas changes in the CG were minimal (–0.05 seconds; $p > 0.05$).

In the strength endurance test (push-ups), EG students increased their repetitions by +4.8 (+17.5%; t = 7.41; $p < 0.001$), while CG improvement was only +1.1 repetitions (+4.1%; $p > 0.05$).

Flexibility indicators (sit-and-reach test) also improved: in the EG by +3.6 cm (+8.4%; t = 4.97; $p < 0.001$), and in the CG by only +0.8 cm (+1.8%; $p > 0.05$).

Significant differences were recorded in the test for sensorimotor balance control (one-leg stance with eyes closed): the EG increased the time by +4.1 seconds (+15.2%; t = 5.21; $p < 0.001$), while changes in the CG were not significant (+0.6 seconds; $p > 0.05$).

Overall, statistical analysis confirmed the significant effect of the differentiated training model on developing aerobic endurance, speed, coordination, strength endurance, flexibility, and balance in the EG. Effect size calculations (Cohen's d) indicated medium to large effects for most indicators (d = 0.56–1.21), demonstrating high practical effectiveness [12].

In addition to objective test scores, subjective changes resulting from the implementation of the differentiated training model were assessed through motivation surveys, expert evaluations by instructors, and observation of behavioral manifestations during the training process.

Motivational changes. At the start of the experiment, the motivation level for volleyball participation among most EG students could be described as moderate: 53% reported attending mainly due to curriculum requirements rather than personal interest. By the end of the formative stage, the proportion of students with high motivation rose to 78%, while the proportion with low interest more than halved (from 21% to 9%). Students noted that task individualization and visible personal progress increased their confidence and desire to achieve new goals.

Technical–tactical preparedness. Expert observations showed that EG students demonstrated improved orientation in tactical schemes, faster decision-making, and higher levels of team coordination by the end of the experiment. Notably, the accuracy of passes and the speed of defensive movements improved significantly. Although some progress was observed in the CG, it was mostly limited to basic technical skills without marked improvement in tactical interaction.

*Behavioral changes and self-assessment***.** Post-experiment surveys indicated that 84% of EG students felt more physically resilient in daily activities, and 71% reported improved general well-being and mood.

Open-ended responses frequently highlighted that the differentiated approach allowed them to train at a comfortable pace, avoid excessive strain, and experience steady, confident growth in their abilities.

*Engagement analysis***.** Instructors observed increased activity and initiative among EG students during training sessions. This was reflected in their more frequent assumption of leadership roles in team drills, greater willingness to discuss tactical decisions, and readiness to propose alternative play combinations. In contrast, CG engagement levels remained mostly average, with a slight decline toward the end of the semester.

The qualitative data confirm that the differentiated training model not only influenced the development of physical qualities but also had a significant motivational and psychological impact. Increased intrinsic motivation, enhanced self-esteem, and improved team interaction in the EG are important factors for sustaining interest in physical activity and sport beyond graduation.

Discussion. The results of the experiment demonstrate the high effectiveness of implementing the differentiated training model in the physical fitness program for female students during volleyball training. The combination of quantitative and qualitative analyses made it possible to identify both objective improvements in physical performance and positive changes in motivational and psychological domains.

According to the quantitative data, the EG showed statistically significant gains in all key tests, from aerobic endurance and speed to strength endurance, flexibility, and balance stability. The most substantial changes occurred in the 1000 m run, push-ups, and the 4×9 m shuttle run, where improvements were accompanied by medium to large effect sizes (Cohen's $d > 0.8$). These findings are consistent with previous studies showing that individualizing the training process in collegiate sports leads to faster and more sustained adaptive changes [2; 7].

The qualitative analysis confirmed that the differentiated training model affected not only physical preparedness but also the students' intrinsic motivation. Increased interest in training, improved self-esteem, and enhanced team interaction align with the self-determination theory [3], according to which the satisfaction of basic psychological needs (autonomy, competence, relatedness) is a key factor in sustaining long-term physical activity.

Comparison with CG results confirms that traditional approaches aimed at the "average" student do not ensure sufficient gains in physical qualities within a single semester. This finding correlates with L. Podrigalo et al. [11], who argue that students with different baseline fitness levels require adapted programs to avoid overtraining while maintaining an adequate training stimulus.

The results also align with current understandings of the specificity of training effects in volleyball, which requires integrating speed–strength, coordination, and endurance components [10; 13]. Incorporating these features into the development of the differentiated training model made it possible to optimize workload distribution and make the training process more efficient and safer.

However, certain limitations of the study should be noted. First, the duration was limited to one academic semester, which does not allow assessment of the long-term sustainability of the achieved results. Second, participant selection was limited to students in pedagogical specializations, which may restrict the generalizability of the findings to other categories of university students. Third, the qualitative analysis relied on self-reports and expert judgments, which, although complementing the quantitative data, still include a degree of subjectivity.

Thus, the results of the study not only confirm the short-term effectiveness of the differentiated training model but also open perspectives for its further improvement and adaptation to other groups of university students. A recommended direction for future research is to examine the long-term impact of this method on physical fitness, as well as its integration with digital monitoring and feedback technologies that are increasingly used in modern training processes [8].

Conclusions. The results of the study confirm the effectiveness of the differentiated training model as a tool for targeted improvement of female students' physical fitness during volleyball training. The quantitative analysis showed that EG students achieved statistically significant improvements in all key indicators of physical preparedness (aerobic endurance, speed, strength endurance, flexibility, and balance stability), whereas changes in the CG were minimal and mostly statistically insignificant. Effect size calculations confirmed medium to large effects of the intervention. The qualitative analysis revealed substantial increases in motivation, self-assessment of physical abilities, and team interaction in the EG, accompanied by higher engagement and initiative during training sessions. The model's effectiveness is explained by the individualization of workloads, targeted development of specific physical qualities, and the variability of training tasks tailored to each student's baseline preparedness level. The findings are consistent with current scientific perspectives on the importance of adaptive approaches in collegiate sports and confirm their potential for training future teachers.

Practical Recommendations. Implement the differentiated training model in the educational and training process, taking into account preliminary testing and grouping of students according to the level of development of specific physical qualities.

- Ensure systematic monitoring of physical preparedness, adjusting the volume and intensity of loads according to the dynamics of individual results.
- Combine game-based exercises, general and specific endurance drills, speed–strength complexes, and coordination tasks adapted for each subgroup.
- Engage students in active planning of the training process, encouraging self-analysis of progress and personal goal setting.
- Integrate traditional physical training methods with digital tools (video analysis, mobile applications for activity monitoring, fitness trackers) to enhance feedback and motivation.

In conclusion, the differentiated training model demonstrated a comprehensive positive effect encompassing both the physical and psychological components of student preparedness and can be recommended for wide-scale implementation in higher education institutions.

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