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THE IMPACT OF ROCK CLIMBING ON THE PHYSICAL CONDITION AND ANXIETY LEVELS OF UNIVERSITY STUDENTS

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The impact of rock climbing on the physical condition and anxiety levels of university students

Abstract. The inclusion of rock climbing in university physical education is increasingly relevant. This study examines a four-month recreational rock climbing program's impact on the physical fitness and psycho-emotional state of university students. Twenty-six Nazarbayev University students (7 women, 19 men) participated in structured classes (9 hours/week) from February to May 2026, including an outdoor session in Burabay. Physical fitness was assessed via general and climbing-specific tests (grip dynamometry, 20mm hang time, IRCRA category). Psycho-emotional state was evaluated using the SAM questionnaire. Spearman's rank correlation analysis revealed that attendance regularity was the strongest predictor of outcomes, showing strong negative correlations with grip strength ($p=-0.709$, $p<0.01$) and maximum climbing difficulty ($p=-0.686$, $p<0.01$). Specific climbing skills highly correlated with finger flexor strength ($p=0.534$, $p<0.01$) and 20mm hang time ($p=0.573$, $p<0.01$), while general fitness tests showed no significant effect. Psychoemotional assessments indicated significant improvements in well-being and mood, peaking after outdoor classes, confirming a "nature immersion" effect. Recreational rock climbing effectively maintains functional capabilities and psycho-emotional regulation rather than achieving standardized fitness norms. Consistency is a key success factor.

Key words: student sports, physical training, psycho-emotional state, recreational rock climbing, psycho-emotional regulation.

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Влияние занятий скалолазанием на физическое состояние и уровень тревожности студентов ВУЗа

Аннотация. Включение скалолазания в программу физического воспитания в университетах становится все более актуальным. В данном исследовании изучается влияние четырехмесячной программы рекреационного скалолазания на физическую подготовку и психоэмоциональное состояние студентов университета. В структурированных занятиях (9 часов в неделю) с февраля по май 2026 года, включая занятия на открытом воздухе в Бурабее, приняли участие 26 студентов Назарбаевского университета (7 женщин, 19 мужчин). Физическая подготовка оценивалась с помощью общих и специфических для скалолазания тестов (динамометрия хвата, время висения на 20 мм, категория IRCRA). Психоэмоциональное состояние оценивалось с помощью опросника SAM. Анализ ранговой корреляции Спирмена показал, что регулярность посещения занятий является наиболее сильным предиктором результатов, демонстрируя сильные отрицательные корреляции с силой хвата ($p=-0.709$, $p<0.01$) и максимальной сложностью восхождения ($p=-0.686$, $p<0.01$). Специфические навыки скалолазания показали высокую корреляцию с силой сгибателей пальцев ($p=0.534$, $p<0.01$) и временем висения на 20 мм ($p=0.573$, $p<0.01$), в то время как общие тесты физической подготовки не выявили значимого эффекта. Психоэмоциональные оценки показали значительное улучшение самочувствия и настроения, достигающее пика после занятий на открытом воздухе, что подтверждает эффект «погружения в природу». Скалолазание как вид отдыха эффективно поддерживает функциональные возможности и психоэмоциональную регуляцию, а не достижение стандартизированных норм физической подготовки. Последовательность является ключевым фактором успеха.

Ключевые слова: студенческий спорт, физическая подготовка, психоэмоциональное состояние, рекреационное скалолазание, психоэмоциональная регуляция.

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Университет студенттерінің физикалық жағдайы мен мазасыздық деңгейіне жартасқа өрмелеудің әсері

Аңдатпа. Университеттің дене шынықтыру бағдарламасына жартасқа өрмелеуді енгізу өзекті болып келеді. Бұл зерттеу төрт айлық демалыс жартасқа өрмелеу бағдарламасының университет студенттерінің дене шынықтыруы мен психоэмоционалды жағдайына әсерін зерттейді. Назарбаев Университетінің жиырма алты студенті (7 әйел, 19 ер адам) 2026 жылдың ақпан айынан мамыр айына дейін Бурабайдағы ашық ауадағы сабақты қоса алғанда, құрылымдалған сабақтарға (аптасына 9 сағат) қатысты. Дене шынықтыру жалпы және өрмелеуге арналған тесттер (ұстау динамометриясы, 20 мм іліну уақыты, ICRSA санаты) арқылы бағаланды. Психоэмоционалды жағдай SAM сауалнамасын пайдаланып бағаланды. Спирманның рангтік корреляциялық талдауы сабаққа қатысудың тұрақтылығы нәтижелердің ең күшті болжаушысы екенін көрсетті, ол ұстау күшімен ($r = -0.709$, $p < 0.01$) және өрмелеудің максималды қиындығымен ($r = -0.686$, $p < 0.01$) күшті теріс корреляцияларды көрсетті. Арнайы өрмелеу дағдылары саусақ бүгетін бұлшықеттің күшімен ($r = 0.534$, $p < 0.01$) және 20 мм іліну уақытымен ($r = 0.573$, $p < 0.01$) тығыз байланысты, ал жалпы фитнес сынақтары айтарлықтай әсер көрсеткен жоқ. Психоэмоционалды бағалаулар ел-ауқат пен көңіл-күйдің айтарлықтай жақсарғанын көрсетті, ашық ауадағы сабақтардан кейін шыңына жетті, бұл «табиғатқа өну» әсерін растайды. Рекреациялық жартасқа өрмелеу стандартталған фитнес нормаларына қол жеткізудің орнына функционалдық мүмкіндіктерді және психоэмоционалды реттеуді тиімді түрде сақтайды. Тұрақтылық - табыстың негізгі факторы.

Түйін сөздер: студенттік спорт, дене шынықтыру, психоэмоционалдық жағдай, демалыс кезіндегі жартасқа өрмелеу, психоэмоционалдық реттеу.

Introduction. In recent years, rock climbing has undergone a transformation from a highly specialized extreme hobby into a widespread and familiar means of physical activity and recreation [1]. In addition to its successful inclusion in the Olympic program, rock climbing is also widely popular among students [2,3]. Further confirmation of the strong position of student rock climbing is the regular holding of the FISU World Student Championships [4].

In higher education, the use of rock climbing equipment is becoming more than just a substitute for physical education classes; it's becoming a full-fledged hobby club with psychological support, mentoring, and extracurricular activities [5, 6]. Scientific research confirms the complex and multifaceted effects of rock climbing [7].

Regular rock climbing has a positive impact on students' physical fitness. Research on a four-week rock climbing course for female university students demonstrated a positive effect on anthropometric, power, and strength indicators [8]. Research on Chinese university students also confirms an increase in physical performance after the introduction of a specialized rock climbing course into the undergraduate curriculum [9, 10]. Numerous Russian studies further confirm this general trend. The effect on physical qualities, particularly agility, strength, and endurance, is key and most noticeable among participating students [11, 12].

In addition to physiological changes, many authors note the psycho-emotional potential of rock climbing in young students. As a stress preventative, rock climbing has a pronounced effect on cognitive

function, emotional regulation, and mental resilience [13]. Furthermore, outdoor rock climbing on natural terrain reveals the phenomenon of "immersion" in the natural environment, emphasizing the role of reflection, team spirit, and environmental awareness in students [14].

Despite the growing interest and volume of empirical data on student rock climbing, certain problems and a shortcoming in the development and testing of methods for using rock climbing techniques in the student environment remain. The following issues should be highlighted:

1. A focus on short-term studies and a lack of description of the long-term effects of rock climbing among students [15];
2. A lack of specific proposals and examples of integrating rock climbing techniques into student learning, which limits the quality of research [16];
3. A lack of quantitative domestic data on examples of the use of rock climbing as a means of physical education and recreation [17, 18].

The aim of this study is to investigate the use of rock climbing classes in the educational process of university students.

The study's hypothesis is that the use of rock climbing classes will positively impact students' physical and psycho-emotional well-being, which will serve as the basis for recommending the introduction of rock climbing into the educational process at universities.

Study Objectives:

1. To analyze the effect of training sessions on students' physical performance;
2. To assess students' psycho-emotional state at the beginning and end of the training cycle;

3. To examine the impact of outdoor training on students' well-being.

Materials and methods.

Participants and organization of the experiment

Twenty-six students aged 18 to 23 years (7 girls, 19 boys) studying at Nazarbayev University participated in the experiment. The classes were part of the student rock climbing club and were extracurricular activities. Classes were held in the mornings at Nazarbayev University's Athletic Center, comprising nine academic hours per week. The experiment was conducted over a four-month period, from February to May 2026. All participants provided written informed consent to participate in the study after being fully informed about the purposes, procedures, and potential risks of the experiment.

An outdoor training trip was held on April 26, 2026, with all participants traveling to the Burabay resort area, considered the most suitable for recreational rock climbing. The trip was a one-day tour.

Testing

The basis for the physical tests were generally accepted and specialized tests that were carried out at the beginning and end of the experiment. Commonly accepted tests included:

1. Bend your arms while hanging on the bar / pull-ups (number of repetitions);
2. Bending the arms while lying down / push-ups (number of repetitions);
3. Bending the torso with bent legs while hanging on the bar (number of repetitions);
4. Standing long jump (cm);
5. Tilt (cm).

Specialized tests included:

1. Dynamometry (kg);
2. Deadhang on two hands on a 20 mm bar (s.);
3. Deadhang with two hands on the crossbar (p.) [19];
4. Sports route climbing (IRCRA category) [20].

All tests took place during one training session with a standard warm-up protocol used for all participants in the experiment.

To assess the psycho-emotional state of students, the "SAM" questionnaire was used: well-being, activity, mood [21, 22]. The questionnaire was completed simultaneously with tests for physical qualities. The test took 20 minutes.

Additionally, to analyze the opinion of the training program and the effect of the "outdoor" trip, a survey of trainees was conducted on the Google Forms platform.

Statistical analysis

All data obtained were subjected to statistical analysis. The following data were collected:

- Mean values;
- Standard deviation;
- Spearman's rank correlation analysis.

Statistical analysis was performed using IBM SPSS Statistics version 27.

Results.

Physical fitness tests.

Initial diagnostic testing conducted before the four-month experimental training cycle revealed that the baseline physical fitness indicators of the participating university students did not meet standardized normative requirements for their age and gender groups. This initial deficit was observed in both general fitness indicators (e.g., pull-ups, push-ups, standing long jump, flexibility) and specialized fitness indicators (e.g., finger dynamometry, hang time).

One important indicator is the evaluation of the experimental results against the standards and norms used to assess the physical fitness of rock climbers. The test group did not meet the accepted standards either before or after the experiment. This may indicate both the lack of a corresponding training goal for the selected group of climbers and the short-term nature of the experimental load. The training intervention served primarily as an adaptive phase, promoting the development of specific neuromuscular coordination and local strengthening of tendons and ligaments. A systematic approach to increasing hypertrophy, as well as enhancing specific strength indicators, can be considered a goal for subsequent stages of student-athlete training. This suggests the need to shift the focus to the relationship between climbing skill, strength indicators, and the psycho-emotional state of climbers. However, despite this, correlation analysis revealed highly significant relationships between specific physical indicators and climbing performance, including behavioral variables (Table 1).

Collected data indicate that general physical fitness does not transfer to specialized skills. Standard indicators of general physical fitness, such as push-ups, standing long jump, and forward bend flexibility, showed no statistically significant correlations with climbing category. This empirically supports the hypothesis that general physical development does not automatically translate into climbing mastery, and that adaptations are largely specific to the biomechanical demands of the climbing wall. A key finding of this study is the identification of behavioral and background

factors, particularly attendance, participation in extracurricular activities, and previous athletic experience, as critical determinants of physical and technical performance. In a short-term recreational program, these variables often outweigh an individual's physiological potential.

Percentage of absences (Percentage of absences, %) emerged as the most significant variable, demonstrating strong, statistically significant negative correlations with nearly all key performance and strength indicators. Specifically, higher rates of absence were significantly associated with decreased dynamometric grip strength ($\rho = -0.709$, $p < 0.01$) and a lower maximum climbing category ($\rho = -0.686$, $p < 0.01$). Moderate negative correlations were also found for pull-ups ($\rho = -0.512$, $p < 0.05$) and hang time on a 20 mm bar ($\rho = -0.473$, $p < 0.05$).

The amount of extracurricular or additional training, as well as previous athletic experience, did not show significant relationships with students' physical fitness.

Questionnaire.

To assess the psycho-emotional impact of the four-month rock climbing program, the CAM questionnaire was administered simultaneously with physical testing at both baseline and post-experiment (Figure 1). Analysis of self-reported psychological state data revealed three distinct positive trends, supporting the hypothesis that rock climbing benefits students' mental health and recreational pursuits:

1. Positive dynamics in overall well-being and mood.

Longitudinal comparison revealed a significant overall improvement in the students' baseline psycho-emotional state indicators over the course of the experiment. By the end of the four-month period, the average scores for "Well-being" and "Mood" showed a significant positive shift compared to the initial measurements in February. This overall psychological uplift can be attributed to regular physical activity, the structured social routine of the university rock climbing club, and the inherent stress-relieving properties of the sport. Judging by the survey results, the problem-oriented nature of rock climbing serves as an effective cognitive distraction. This, in turn, helps reduce academic anxiety and improve overall emotional regulation among student rock climbers.

2. Psychological recharge in natural terrain.

A one-day trip to the natural terrain of the Bura-bay resort area provides a profound psychological shift. The SAM assessment showed significant changes in activity and mood scales immediately after the outdoor session compared to standard assessments in a closed gym. This is likely due to immersion in the natural environment and the simul-

taneous strengthening of team cohesion, which is explained by the specific organization of work on rock routes in a natural environment and the tourist costs associated with off-site training. These results empirically confirm the unique restorative effect and psychological value of training rock climbing in natural terrain during a one-day tourist trip.

3. Assessing Engagement in the Training Process

The identified correlation between "Mood" and "Well-Being" with the climbing category and absences suggests a two-way synergistic relationship: students who train consistently achieve higher levels of mastery and experience significant psycho-emotional benefits. This finding works both ways, highlighting the need to engage students equally in both an active academic environment and climbing activities. **Discussion.** The results of this study challenge the traditional normative approach to university physical education and offer a new perspective on the role of recreational rock climbing in student health. The fact that absolute indicators of general physical fitness did not reach standardized normative thresholds after a four-month cycle suggests that recreational rock climbing should not be viewed solely as a tool for rapid systemic hypertrophy or general physical development. Instead, its primary value in a university setting lies in maintaining functional capacity and ensuring comprehensive psycho-emotional regulation.

When considering the driving forces of progress in university and recreational sports, the decisive predictor, in terms of both physiological adaptation and technical improvement, is not initial athletic ability or previous experience, but rather the consistency and continuity of training. This thesis is empirically supported by the results of the correlation analysis. The proportion of missed training sessions was found to be the most significant negative predictor of both physical and technical performance: a significant inverse correlation was recorded with the maximum difficulty category of the course ($\rho = -0.686$, $p < 0.01$), with wrist dynamometry parameters ($\rho = -0.709$, $p < 0.01$), and with shoulder girdle muscle endurance parameters, in particular, with the number of pull-ups ($\rho = -0.512$, $p < 0.05$) and the duration of hanging on a 20 mm hold ($\rho = -0.473$, $p < 0.05$). Taken together, these data convincingly demonstrate that for the non-professional contingent, consistent participation in the training process is more significant than existing physiological potential. Regularity acts as a basic catalyst for targeted neuromuscular coordination and localized restructuring of the hand connective tissue, without which rock climbing is impossible, whereas these adaptations do not develop with occasional training.

Table 1 – Correlation relationships of students' physical fitness indicators, (n=26)

	Absence from classes	Additional classes	Sports experience	Dynamometry	Deadhang 20 mm	Climbing category	Pull-ups	Push-ups	Hanging trunk flexion	Long jump	Forward Bend
Absence from classes	1										
Additional classes	-0.280	1									
Sports experience	-0.116	0.007	1								
Dynamometry	-0.709**	-0.062	-0.006	1							
Deadhang 20 mm	-0.473*	0.326	-0.308	0.375	1						
Climbing category	-0.686**	0.079	-0.251	0.534**	0.573**	1					
Pull-ups	-0.512*	0.215	0.233	0.430	0.398	0.416	1				
Push-ups	0.115	0.024	0.110	0.120	0.115	0.292	0.311	1			
Hanging trunk flexion	0.103	0.048	0.311	0.301	0.309	0.220	0.230	0.229	1		
Long jump	0.430	0.398	0.416	0.220	0.230	0.229	0.180	0.104	0.309	1	
Forward Bend	0.438	0.434	0.196	0.193	0.196	-0.051	0.410	0.460	0.406	0.424	1
Note: * — moderate correlation ($p < 0.05$); ** — strong correlation ($p < 0.01$)											

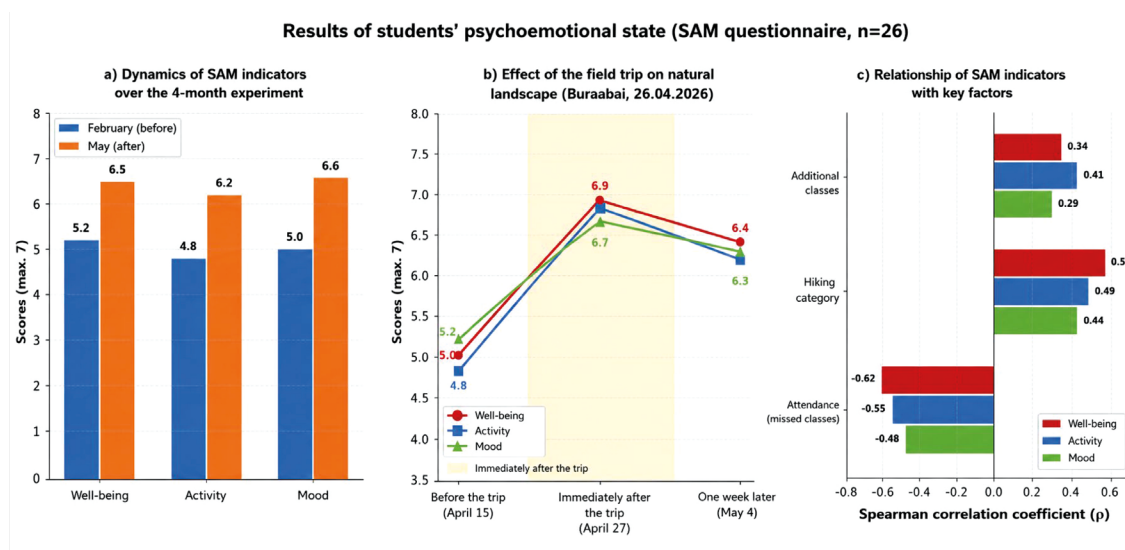


Figure 1 – Results of the psycho-emotional state of students (SAM questionnaire, n=26)

Furthermore, the lack of statistically significant correlations between standard general fitness standards (standing long jump, number of push-ups, flexibility level) and rock climbing scores is consistent with the principle of specific functional maintenance. This sport places demands on localized adaptive changes, primarily the development of finger flexor strength and local muscular endurance, as confirmed by the close correlation between rock climbing scores and the time it takes to hang on a 20mm bar. In other words, recreational rock climbing serves as a practical means of functional support, ensuring the maintenance and improvement of highly specialized motor patterns rather than stimulating broad, diffuse physical changes. It is crucial that maintaining this physical capacity is inseparable from holistic psycho-emotional self-regulation. Data from the SAM questionnaire recorded significant positive shifts in well-being and emotional state indicators over a four-month observation period. Particularly significant is the bidirectional synergy revealed by the correlation analysis: favorable psycho-emotional states are statistically associated with both higher technical performance and a lower rate of absences. The pronounced “nature effect” observed during outdoor classes in Burabay, where activity and mood parameters reached peak values, underscores the restorative potential of the natural environment in reducing academic stress and cognitive exhaustion.

This psycho-emotional resource serves as a key mechanism of positive reinforcement. Students who experience the psychological benefits of classes develop stronger intrinsic motivation, which translates into behavioral resilience (stable attendance) required for physical adaptation. Therefore, within the context of recreational rock climbing, psycho-emotional regulation is far from a secondary benefit, but a fundamental factor in the reinforcement of habits and behavioral stability, without which long-term functional well-being cannot be ensured.

Ultimately, the integration of rock climbing into university curricula should be reconsidered. The focus should shift from rigorous normative testing to the creation of a stable, psychologically supportive, and engaging environment. By prioritizing regular class attendance, incorporating elements of immersion in the natural environment, and leveraging the sport's stress-relieving properties, universities can effectively utilize recreational rock climbing as a sustainable strategy for supporting students' holistic health, functional capacity, and psychological resilience in the face of academic pressure.

Our results are consistent with the data of Li et al. (2018) and Cuerdo & Pagaduan (2013), who also noted the positive effect of rock climbing on specific strength indicators [7, 8]. However, unlike the studies by Fang (2024), which focused on general physical development, our study empirically proves that general fitness tests (push-ups, jumps) do not correlate with climbing success in students [9]. This highlights the novelty of our work: we shift the focus from a normative approach to specific functional adaptation. Regarding the psycho-emotional state, our data confirm the conclusions of Draper et al. (2024) about the stress-preventive effect of rock climbing, but for the first time in the context of the Kazakhstani student environment, we quantitatively substantiate the “nature immersion” effect (using the example of a trip to Burabay), which was not detailed in previous works (e.g., Jane et al., 2022, considered this rather from the point of view of outdoor education, not recreational sports) [14, 20].

Limitations.

Despite the significant results obtained, our study has several limitations. First, the sample size is relatively small ($n=26$), which may limit the statistical power and generalizability of the results to the entire student population. Second, the study was conducted at a single university, where students may initially have a higher level of motivation and access to sports infrastructure. Third, the four-month observation period does not allow us to evaluate the long-term effects of recreational rock climbing. Finally, the lack of a control group engaged in other types of recreational activity does not allow us to completely isolate the specific effect of rock climbing from the general influence of physical exercise. These limitations indicate the need for further multicenter studies with larger samples.

Conclusion. Based on the results obtained and in strict accordance with the objectives of the study, the following conclusions can be drawn:

1. A four-month course of recreational rock climbing did not ensure that students achieved standardized benchmarks for general physical fitness. However, significant specific adaptations were observed, primarily in components of local muscular endurance (finger flexor strength). The key result of the study was the empirical confirmation that, in a recreational format, it is the principle of consistency and regularity, rather than the initial level of physical fitness, that is the primary determinant of both physical and technical progress. The statistically significant negative correlations between the percentage of absenteeism and key performance indicators indicate that consistent

participation is crucial for maintaining specific body functions.

2. Monitoring of students' psychoemotional states demonstrated consistent positive dynamics throughout the training cycle, reflected in significant increases in the "Well-Being" and "Mood" indicators using the CAM method. The data obtained confirm that recreational rock climbing is an effective tool for comprehensive psychoemotional regulation and the prevention of academic stress. A synergistic relationship was discovered: a favorable psychoemotional state is statistically associated with higher technical achievements and a reduction in the number of absences. This allows us to consider psychoemotional relaxation not as a side effect, but as an independent mechanism of positive

reinforcement that fosters intrinsic motivation and reinforces the habit of regular physical activity.

3. Analysis of the results of an outdoor training session on natural terrain in the Burabay resort area confirmed the critical importance of environmental change for the restoration of psychoemotional resources. The outdoor session triggered a significant psychological shift, as evidenced by peak scores on the "Activity" and "Mood" scales. The "nature immersion" phenomenon provided a profound psychological recharge and reduced cognitive fatigue, substantiating the need for mandatory inclusion of outdoor formats in university recreation programs as a means of maximizing the restorative effect.

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