Original study article
DOI: https://doi.org/10.17816/hmj679879 EDN: PGBOUW

Description of Principles and Development of an Integrated Strength Indicator System for Powerlifting Cadets During the Competition Season

Vladimir A. Islamov[1], Dmitrii D. Dalskii[1, 2], Victor A. Salnikov[3]

[1] Kirov Military Medical Academy, Saint Petersburg, Russia
[2] Lesgaft National State University of Physical Education, Sports and Health, Saint Petersburg, Russia;
[3] Siberian State Automobile and Highway University, Omsk, Russia

ABSTRACT

BACKGROUND: Contemporary principles of strength development in powerlifting cadets form a comprehensive system that integrates training methods aimed at maximizing results during the competition season as well as the relevance of physiological, mental, and biomechanical indicators for strength training.
AIM: The study aims to develop a set of special exercises to improve the strength performance of powerlifting cadets during the competition season.
METHODS: The study included trained male powerlifting cadets aged 18–25 with a sports rating of at least 1st category and at least 3 years of experience in powerlifting. It involved a total of 16 participants, who were randomized into the control and experimental groups of 8 participants each. The groups were equalized based by initial indicators of strength training, age, sports rating, and anthropometric data. Both groups underwent an initial test to verify their homogeneity based on key study parameters. All participants underwent a physical examination and signed informed consent to participate in the study. We reviewed relevant sources and guidelines; conducted tests; and employed the methods of pedagogical observation, pedagogical experiment, and correlation analysis.
RESULTS: An efficient combination of high-intensity training with periods of controlled recovery contributes to a significant improvement of strength performance without the risk of overtraining. This approach is based on the wave-like load distribution and individual training programs tailored to physiological markers of cadet athletes.
CONCLUSION: The findings may be used to design individual training programs for the competition season. Our study showed consistent improvement patterns in strength performance. For the first time, an integrative training model has been proposed that is based on the relationship of biomechanical, physiological, and psychological factors of sports performance during intensive training for competitions.

Keywords: powerlifting cadets; strength performance; high-intensity training; integrated program.

To cite this article
Islamov VA, Dalskii DD, Salnikov VA. Description of Principles and Development of an Integrated Strength Indicator System for Powerlifting Cadets During the Competition Season. *Humanitarian Military Journal.* 2025;1(2):131–140. DOI: 10.17816/hmj679879 EDN: PGBOUW

Submitted: 19.05.2025 **Accepted:** 19.05.2025 **Published online:** 30.06.2025

Оригинальное исследование

DOI: https://doi.org/10.17816/hmj679879 EDN: PGBOUW

Характеристика принципов и формирования комплексной системы силовых показателей у курсантов пауэрлифтеров в соревновательный период

В.А. Исламов[1], Д.Д. Дальский[1, 2], В.А. Сальников[3]

[1] Военно-медицинская академия им. С.М. Кирова, Санкт-Петербург, Россия;

[2] Национальный государственный Университет физической культуры, спорта и здоровья им. П.Ф. Лесгафта, Санкт-Петербург, Россия;

[3] Сибирский государственный автомобильно-дорожный университет, Омск, Россия

АННОТАЦИЯ

Обоснование. Современные принципы формирования силовых показателей у курсантов пауэрлифтеров представляют собой комплексную систему тренировочных методик, направленных на максимизацию результатов в соревновательный период, а также актуальность показателей физиологических, психических и биомеханических аспектов силовой подготовки.

Цель — разработка комплекса специальных упражнений, направленного на формирование силовых показателей у курсантов пауэрлифтеров в соревновательный период.

Материалы и методы. Контингент участников эксперимента формируется из квалифицированных курсантов пауэрлифтеров мужского пола в возрасте 18–25 лет, имеющих спортивную квалификацию не ниже I разряда и стаж занятий пауэрлифтингом не менее 3 лет. Общее количество участников исследования составляет 16 человек, которых методом случайной выборки распределили на контрольную и экспериментальную группы по 8 человек. Группы уравнивали по исходным показателям силовой подготовленности, возрасту, спортивной квалификации и антропометрическим данным. Предварительное тестирование проводили для подтверждения однородности групп по ключевым параметрам исследования. Все участники прошли медицинское обследование и подписали информированное согласие на участие в исследовании. Проанализирована научная и научно-методическая литература, проведены тестирование, педагогическое наблюдение, педагогический эксперимент, корреляционный анализ.

Результаты. Рациональное сочетание высокоинтенсивных тренировок с периодами контролируемого восстановления способствует значительному приросту силовых показателей без риска перетренированности. Данный подход основывается на принципах волнообразного распределения нагрузки и индивидуализации тренировочных программ с учетом физиологических особенностей курсантов атлетов.

Заключение. Полученные результаты являются основой для создания индивидуализированных тренировочных программ, учитывающих специфику соревновательного периода. Наше исследование выявило комплексные закономерности формирования силовых показателей. Впервые предложена интегративная модель подготовки, учитывающая взаимосвязь биомеханических, физиологических и психологических факторов спортивной результативности в условиях интенсификации тренировочного процесса перед соревнованиями.

Ключевые слова: курсанты пауэрлифтеры; силовые показатели; высокоинтенсивные тренировки; комплексная программа.

Как цитировать

Исламов В.А., Дальский Д.Д., Сальников В.А. Характеристика принципов и формирования комплексной системы силовых показателей у курсантов пауэрлифтеров в соревновательный период // Гуманитарный военный журнал. 2025. Т. 1, № 2. С. 131–140. DOI: 10.17816/hmj679879 EDN: PGBOUW

Рукопись получена: 19.05.2025 **Рукопись одобрена:** 19.05.2025 **Опубликована online:** 30.06.2025

BACKGROUND

Contemporary principles of strength development in powerlifting cadets represent a comprehensive system of training methods designed to maximize performance during the competition season and the relevance of physiological, mental, and biomechanical indicators of strength training.

Our study is significant in terms of expanding scientific beliefs regarding physiological adaptation mechanisms in athlete cadets of the Kirov Military Medical Academy (Saint Petersburg) to strength loads in a competition season setting. The study contributes to advancing a sports training methodology for powerlifting cadets and enriches a sports science theory with new data on strength development patterns.

Muscular strength is among the attributes that not only facilitate an integrated physical advancement but are also instrumental in getting a person ready for productive work and national defense, and for athletic performance enhancement [1, 2].

The study is aimed at empirically verifying the efficiency of the proposed method of strength development during the competition season. The aim is also listed among key objectives.

METHODS

It is noteworthy that physical training has been a centuries-old top priority in the Russian military tradition [3], for which reason a literature review constitutes a fundamental research method for building a theoretical framework for exploring strength metrics in powerlifting cadets during the competition season. This method entails a consistent review of Russian and foreign academic papers on strength training in powerlifting. The review covers the examination of monographs, dissertation research papers, peer-reviewed journal articles, and materials of specialist conferences. Special emphasis is placed on the works published over the last 5 years that reflect the current trends in strength training methodology for elite athletes. A critical literature review enables to identify contradictions in the existing approaches to training periodization during the competitive season and develop an original research position.

The methodological value of literature review lies in the ability to compare various conceptual approaches to strength development. Our study classifies data on physiological strength advancement mechanisms and patterns of neuromuscular adaptation to intensive competition season loads. The review involves the examination of contemporary periodization models specific for powerlifting, with a particular focus on the competition season particularities. Literature review outcomes establish a terminological system and methodological foundations for elaborating an experimental program. Theoretical data classification makes it possible to identify the most promising areas of training optimization for powerlifting cadets during the competition season.

In examining the study materials, we made use of dialectical materialist analysis as the general method for exploring historical events and phenomena, and core empirical methods (such as logical, statistical, and comparative historical methods).

Our *testing as a research method* constitutes a comprehensive procedure for unbiased assessment of powerlifting cadets' strength performance using standardized protocols. This method covers performance evaluation in competitive lifts (squat, bench press, and deadlift) conducted under official competition rules. Testing is done at the beginning and at the end of the experimental period to determine strength dynamics. Additionally, we employ specialized tests to evaluate strength capabilities across different muscle action modes (isometric, concentric, and eccentric). Speed and strength parameters are quantified using tensometric platforms (or force plates), enabling the recording of force output and force gradient parameters.

The testing procedure employs strict standardization of setting to ensure reliability and reproducibility of performance. Athletes perform test exercises following a standardized warmup, at the same time of day, with identical rest intervals between sets. Performance is recorded using certified and metrologically verified equipment. To enhance objectivity in assessing technical aspects of performing exercises, we did video recording with further analysis of kinematic movement patterns. A comprehensive nature of testing makes it possible to have a multidimensional evaluation of athletes' strength capabilities and to identify specific adaptive changes occurring during the competition season.

Mathematical analysis in our study constitutes a set of statistical methods of processing empirical data resulting from the examination of powerlifting cadets' strength metrics. Statistical processing of the study results was conducted using advanced methods of mathematical analysis: descriptive statistics (calculation of means, standard deviations, and variation coefficients) to characterize the central tendencies and variability of metrics within groups; test of normality using the Shapiro–Wilk test; comparative analysis (Student's *t*-test for dependent samples to assess intra-group dynamics); Student's *t*-test for independent samples to compare inter-group metrics; non-parametric alternatives (Wilcoxon, Mann–Whitney criteria) in case of subnormal distribution; correlation analysis to identify relationships between different strength preparedness metrics; regression analysis to determine the contribution of various factors to the final competitive performance; analysis of variance (ANOVA) to assess the influence of different factors on strength performance dynamics; calculation of experimental method efficiency metrics (absolute improvement in performance, relative improvement in performance (percentage)); and efficiency ratio (ratio of improvement in the experimental group to improvement in the control group). The level of significance

was set at p <0.05, which is aligned with generally accepted standards in sports studies.

Correlation analysis was used to identify relationships between various strength metrics, training load parameters, and competitive performance. Pearson or Spearman correlation coefficients were calculated to quantify the strength and direction of such relationships. Regression analysis was employed to build mathematical models describing the dependence of competitive performance on different training factors. Factor analysis was applied to identify latent variables explaining the variability in powerlifters' strength performance during the competition season.

The study design involves a comprehensive approach to exploring the efficiency of innovative training methods for athletes. The study was conducted at the Kirov Military Medical Academy's sports complex in Saint Petersburg from November 2024 to May 2025. The 7-month study encompassed a complete training macrocycle, including both training and competitive seasons. This time range is accounted for by the need for monitoring long-term strength dynamics and assessing the experimental method efficiency in a real-world training and competition setting.

The control and experimental groups were matched for baseline strength levels, age, competitive experience, and anthropometrics. Both groups were pre-tested to verify their homogeneity by key study parameters. All participants had a medical screening and signed an informed consent to participate in the study.

The control group follows the traditional powerlifting training method accepted at the Alpha Sports School in Saint Petersburg. This method features a standard training load distribution during the competition season, with a focus on performing competition exercises within the intensity range of 80%–95% 1RM. The training frequency is 4–5 sessions per week with a traditional load distribution between competition and assistance exercises. The training process follows a linear periodization model with a gradual intensity increase and volume decrease as competitions approach.

The experimental group follows an innovative training method based on advanced principles for strength development during the competition season. The key feature of the experimental method is the use of a series of special exercises intended to overcome stagnation in strength development and enhance neuromuscular coordination. The series consists of the following exercise groups:

1. Variable resistance exercises (using chains and resistance bands):
   - Barbell squats with chains (varying resistance through the range of motion);
   - Bench press with resistance bands (progressive resistance); and
   - Deadlifts with chains (increasing resistance in the lockout).
2. Exercises focused on overcoming sticking points:
   - Squats with bottom-level pauses (3–5 s);
   - Bench press with chest-level pauses (2–3 s); and
   - Deadlifts with knee-level stops in the sticking points.
3. Post-activation potentiation exercises:
   - Heavy–light contrast sets (90%–95% 1RM set followed by 70%–75% 1RM set after 3–4 min rest); and
   - Wave loading (alternating heavy and light series within the same session).
4. Explosive strength development:
   - Squats with maximal concentric speed (60%–70% 1RM);
   - Dynamic effort bench press (50%–60% 1RM with maximum speed); and
   - Block pulls with explosive start of motion.
5. Specialized weak point exercises:
   - Isometric holds at the sticking points of competition exercises;
   - Stabilizer muscle training using unstable surfaces and suspension systems; and
   - Specialized core strengthening exercises (weighted planks, ab wheel rollouts).

The experimental group's periodization follows a wave-like model with alternating microcycles of different training modes (strength, speed and strength, and recovery). The load volume-to-intensity ratio varies within mesocycles to prevent an adaptation plateau from occurring. The frequency of training sessions is identical to that of the control group (4–5 sessions per week), but the training session design and load distribution feature significant differences.

To assess the experimental method efficiency, a set of tests was elaborated that enables to comprehensively evaluate powerlifters' strength development.

1. Maximum strength tests:
   - Squat (1RM) performed under official competition rules;
   - Bench press (1RM) performed under official competition rules;
   - Deadlift (1RM) performed under official competition rules; and
   - Powerlifting total (absolute and Wilks-adjusted).
2. Speed and strength tests:
   - 30-second max rep squat at 60% 1RM;
   - 30-second max rep bench press at 60% 1RM;
   - Squat force output measurement using linear encoder (70% 1RM); and
   - Bench press force output measurement using linear encoder (70% 1RM).
3. Strength endurance tests:
   - Max rep squat at 70% 1RM;
   - Max rep bench press at 70% 1RM; and
   - Max rep deadlift at 70% 1RM.
4. Explosive strength tests:
   - Standing vertical jump (height recorded);
   - Supine medicine ball throw (5 kg); and

DOI: https://doi.org/10.17816/hmj679879

– Force gradient measurement in isometric mode for all three competition exercises.

5. Static force tests:

– Isometric mid-range squat hold at 90% 1RM (time recorded);
– Isometric mid-range bench press hold at 90% 1RM (time recorded); and
– Isometric knee-level deadlift hold at 90% 1RM (time recorded).

Testing is performed in several stages:

1. Preliminary testing (November 2024) to determine the initial training status and set up homogeneous groups.

2. Interim testing (December 2024) to assess performance dynamics and potentially adjust the training process.

3. Final testing (May 2025) to determine the experimental method efficiency.

In addition to primary testing, athletes are subject to physiological monitoring:

– Blood biomarkers (creatine kinase, testosterone, cortisol) analyzed pre- and post-experiment;
– Heart rate variability assessed weekly to quantify recovery status; and
– Monthly psychological screening (competition state anxiety, motivation, mental readiness for competitions).

A comprehensive application of the above study methods makes it possible to thoroughly explore strength development issues with powerlifting cadets during the competition season. The methodological integration of methods applied is demonstrated through the logical progression of research procedures.

RESULTS

The study design comprises the following stages:

1. Preparatory stage (November 2024): Development of a detailed study program, participant selection and briefing, preparation of resources, and baseline medical screening.

2. Main stage (November 2024—May 2025): Initial testing, implementation of experimental and control training programs, interim testing, and physiological monitoring.

Physiological monitoring of athletes: Training program adjustments based on interim data, participation in qualifying competitions (February 2025).

3. Final stage (May 2025): Final testing, participations of cadets in major competitions of the season, statistical analysis of data collected, analysis and interpretation of study results, and drawing conclusions and implementation guidelines.

The experimental program features certain methodological considerations.

1. Microcycle design during the competition season:

– Monday: squats (main session) + assistance leg work;
– Tuesday: bench press (main session) + assistance upper-body work;
– Wednesday: recovery training (low-intensity cardio, stretching);
– Thursday: deadlifts (main session) + assistance back work;
– Friday: bench press (extra training) + stabilizer muscle exercises;
– Saturday: integrated training (technical session to do competition exercises with moderate intensity); and
– Sunday: rest.

2. Wave-like load periodization within the mesocycle:

– 1st week: average intensity (70%–80% 1RM), average volume;
– 2nd week: high intensity (85%–95% 1RM), low volume;
– 3rd week: moderate intensity (75%–85% 1RM), high volume; and
– 4th week: active recovery (60%–70% 1RM), low volume.

3. Particularities of doing a series of special exercises:

– Variable resistance exercises are integrated into main sessions once a week for each competition lift.
– Exercises focused on overcoming sticking points are implemented as supplemental sets post-main work.
– Post-activation potentiation method is primarily used during high-intensity weeks.
– Explosive strength development exercises are done at the start of the training session post-warmup.
– Specialized weak-point exercises are done at the end of main sessions or on dedicated days.

4. Training process individualization:

– Technique-specific modifications based on individual aspects of doing competition lifts;
– Targeted enhancement of deficiencies identified through tests;
– Load parameter modification subject to the current physiological monitoring; and
– Personalized recovery protocols.

The study incorporated the following controls to maintain objectivity and minimize confounding factors:

1. Testing standardization: Testing at the same time of day, uniform pre-testing warmup, use of certified measuring equipment, accredited judges for lift validity assessment.

2. Confounding factor management: Athletes' nutrition monitoring (dietary logs), screening for permitted performance-enhancing substances, external training load (if any) quantification, recording diseases, injuries, and other factors affecting the training process.

3. Participant incentivization: Regular debriefs regarding interim study results, creating a competitive atmosphere among participants, financial incentives for high testing performance, and individualized testing-related feedback.

The study resources include:

1. Training equipment: Competition-grade platforms with Olympic barbells and plate sets, squat stands and bench

press stations, specialized equipment (chains, resistance bands, variable-height blocks), and assistance exercise machines.

2. Diagnostic equipment: Linear encoder for speed and strength measurement, tensometric platforms for explosive strength measurement, dynamometers for isometric strength measurement, EMG system for muscle activation analysis, HR monitors for training load and recovery tracking, and video cameras for exercise technique analysis.

3. Software: Specialized motion analysis programs, statistical packages for data processing (SPSS, Statistica), and training load management programs.

Expected Study Results:

1. Assessment of the efficiency of the experimental strength development method versus the traditional approach for powerlifters in the competition season.

2. Determination of the appropriate training load parameters (volume-to-intensity ratio, frequency of special exercises) to maximize strength performance in the competition season.

3. Identification of the most insightful tests to monitor powerlifters' strength preparedness during the competition season.

4. Establishment of relationships between various strength preparedness components and competition performance.

5. Preparation of implementation guidelines to streamline powerlifters' training during the competition season.

Ethics Aspects of the Study:

1. Obtaining an informed consent from all study participants.

2. Conducting a preliminary medical screening to exclude contraindications for high-intensity exercises.

3. Adhering to sports ethics principles and anti-doping rules.

4. Ensuring the confidentiality of participants' personal data.

5. Guaranteeing voluntary withdrawal from the study without negative consequences.

A comprehensive application of the above study methods makes it possible to thoroughly explore strength development issues with powerlifting cadets during the competition season. The methodological integration of methods applied is demonstrated through the logical progression of research procedures.

The experimental training revealed statistically significant differences between the control and experimental groups across all parameters, with the experimental group demonstrating stronger performance improvement compared to the control group (see Table 1).

Table 1 presents the experimental data on maximal strength in competition exercises, demonstrating a 14.2%–15.3% performance improvement in the experimental group, which is by 1.71 times greater than the control group's 8.3%–8.8% improvement. The experimental group demonstrated a more significant improvement compared to the control group across all measured parameters (p <0.05).

Fig. 1 illustrates the relative strength improvement in all three powerlifts for the control and experimental groups over the 5-month competition season.

The study results attest to a high efficiency of the experimental strength development method for powerlifting cadets during the competition season (see Fig. 1). As seen from the figure, the use of a series of special exercises intended to overcome stagnation in strength development and enhance neuromuscular coordination, in combination with a wave-like load periodization, triggers a more significant strength improvement compared to the traditional training method. Particularly significant differences are observed in speed and strength qualities, explosive strength and static force dynamics, directly translating to enhanced competitive performance.

Table 2 shows changes in key biochemical markers (creatine kinase, testosterone, cortisol, and testosterone-to-cortisol

Table 1. Maximum strength changes in competition (kg)

Таблица 1. Динамика показателей максимальной силы в соревновательных упражнениях, кг

Exercise	Group	Baseline data (November 2024)	Interim data (February 2025)	Final data (May 2025)	Improvement, %
Squat	EG	182,5±15,3	195,8±16,2*	210,4±17,1**	15,3±2,1
	CG	180,8±14,9	188,3±15,5*	196,7±16,2*	8,8±1,7
Bench press	EG	142,1±12,5	151,7±13,1*	162,9±13,8**	14,6±1,9
	CG	140,8±12,2	146,3±12,6*	152,5±13,0*	8,3±1,5
Deadlift	EG	205,4±18,7	218,3±19,5*	234,6±20,8**	14,2±2,0
	CG	203,3±18,2	211,7±18,9*	220,8±19,5*	8,6±1,6
Powerlifting total	EG	530,0±42,5	565,8±45,2*	607,9±48,6**	14,7±1,8
	CG	524,9±41,8	546,3±43,5*	570,0±45,2*	8,6±1,4

Note. *p <0.05 compared with baseline data; **p <0.05 compared with the control group.

Примечание. *p <0,05 — по сравнению с исходными данными; **p <0,05 — по сравнению с контрольной группой. ЭГ — экспериментальная группа; КГ — контрольная группа.

DOI: https://doi.org/10.17816/hmj679879

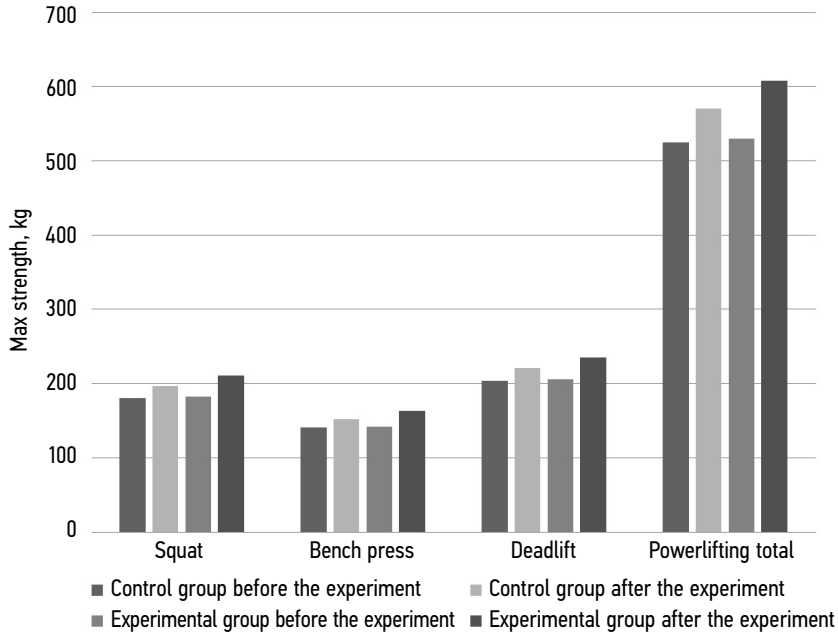

Fig. 1. Maximum strength changes in competition.
Рис. 1. Динамика показателей максимальной силы в соревновательных упражнениях.

ratio) among powerlifting cadets from the control and experimental groups throughout the training experiment.

Biochemical markers within the experimental group (see Table 2) also demonstrated better dynamics: decrease in creatine kinase and cortisol by 12.8% and 11.0% (respectively), increase in testosterone by 15.1%. The testosterone-to-cortisol ratio, being an anabolic status marker, increased by 29.1% in the experimental group, a 3-fold increase versus the control group's metrics.

Psychological metrics in the experimental group showed a 26.6% reduction in competition state anxiety and a 24.0%–30.3% improvement in achievement motivation, mental readiness for competitions, and self-belief (see Table 3).

A review of academic literature and training practices in higher education physical training reveals that various training sessions and social design projects may serve as robust psychological and training means to master interpersonal communication skills [4]. The experimental group also demonstrated significantly higher recovery efficiency, as evidenced by heart rate variability metrics (see Table 4).

A wave-like load periodization used for the experimental group provided for better dynamics of biochemical markers and higher recovery efficiency. This is confirmed by the heart rate variability metrics: Increase in RMSSD and pNN50 by 39.5% and 62.8% (respectively), decrease in stress index by 34.7% and in post-exercise heart rate recovery time by 39.6%.

CONCLUSION

The proposed experimental strength development method for powerlifting cadets during the competition

Table 2. Biochemistry changes
Таблица 2. Динамика биохимических показателей

Indicator	Group	Baseline data (November 2024)	Final data (May 2025)	Change, %
Creatine kinase, U/L	EG	285,3±42,5	248,7±37,2*	–12,8±2,5
	CG	290,1±43,2	275,4±41,0	–5,1±1,8
Testosterone, nmol/L	EG	18,5±2,7	21,3±3,1*	15,1±2,8
	CG	18,2±2,6	19,1±2,8	4,9±1,7
Cortisol, nmol/L	EG	485,7±62,3	432,5±55,4*	–11,0±2,3
	CG	490,3±63,1	468,9±60,2	–4,4±1,6
Testosterone-to-cortisol ratio, $\times 10^{-3}$	EG	38,1±5,2	49,2±6,7*	29,1±3,8
	CG	37,1±5,0	40,7±5,5	9,7±2,1

Note. *p <0.05 compared with the control group.
Примечание. *p <0,05 по сравнению с контрольной группой. ЭГ — экспериментальная группа; КГ — контрольная группа.

Table 3. Psychological changes

Таблица 3. Динамика психологических показателей

Indicators	Group	Baseline data (September 2024)	Interim data (December 2024)	Final data (April 2025)	Change, %
Competition state anxiety, score	EG	42,5±5,3	36,8±4,6*	31,2±3,9**	–26,6±3,5
	CG	43,1±5,4	40,2±5,0	38,5±4,8	–10,7±2,2
Achievement motivation, score	EG	68,3±7,2	75,6±8,0*	84,7±8,9**	24,0±3,2
	CG	67,5±7,1	71,2±7,5	74,8±7,9	10,8±2,3
Mental readiness for competitions, score	EG	80,1±8,9	81,5±9,1*	92,3±10,3**	27,5±3,6
	CG	71,8±8,0	76,3±8,5	80,1±8,9	11,6±2,4
Self-belief, score	EG	65,7±6,9	74,2±7,8*	85,6±9,0**	30,3±3,8
	CG	64,9±6,8	69,5±7,3	73,8±7,8	13,7±2,6

Note. **p* <0.05 compared with baseline data; ***p* <0.05 compared with the control group.
Примечание. **p* <0,05 — по сравнению с исходными данными; ***p* <0,05 — по сравнению с контрольной группой. ЭГ — экспериментальная группа; КГ — контрольная группа.

Table 4. Recovery efficiency (by heart rate variability)

Таблица 4. Эффективность восстановительных процессов (по данным вариабельности сердечного ритма)

Indicator	Group	Baseline data (September 2024)	Interim data (December 2024)	Final data (April 2025)	Change, %
RMSSD, ms	EG	38,5±4,8	45,2±5,6*	53,7±6,7**	39,5±4,3
	CG	37,9±4,7	40,8±5,1	43,5±5,4	14,8±2,8
pNN50, %	EG	18,3±2,5	23,6±3,2*	29,8±4,0**	62,8±6,5
	CG	17,9±2,4	19,7±2,7	21,5±2,9	20,1±3,3
Stress index, CU	EG	95,7±10,2	78,3±8,3*	62,5±6,6**	–34,7±4,1
	CG	97,2±10,4	89,5±9,5*	83,8±8,9*	–13,8±2,6
Post-exercise heart rate recovery time, min	EG	28,5±3,6	22,3±2,8*	17,2±2,2**	–39,6±4,4
	CG	29,1±3,7	26,4±3,3*	24,5±3,1*	–15,8±2,9

Note. **p* <0.05 compared with baseline data; ***p* <0.05 compared with the control group.
Примечание. **p* <0,05 — по сравнению с исходными данными; ***p* <0,05 — по сравнению с контрольной группой. ЭГ — экспериментальная группа; КГ — контрольная группа.

season based on a series of special exercises and a wave-like load periodization triggers a more significant strength improvement compared to the traditional training method:

- Particularly significant differences were observed in explosive strength (efficiency ratio 2.35), static force (2.24), speed and strength metrics (2.12), directly translating to enhanced competitive performance.
- Biochemical markers within the experimental group demonstrated better dynamics: Decrease in creatine kinase and cortisol by 12.8% and 11.0% (respectively), increase in testosterone by 15.1%, increase in testosterone-to-cortisol ratio by 29.1%.
- The recovery efficiency, as evidenced by heart rate variability metrics, was significantly higher with the experimental group: Increase in RMSSD and pNN50 by 39.5% and 62.8% (respectively), decrease in stress index by 34.7%.
- Three distinct patterns to respond to the experimental method were identified: Rapid responders (41.7% of athletes), gradual responders (33.3%), and delayed responders (25.0%), which shall be factored in training process personalization.

Competition performance attested to superiority of the experimental method: Powerlifting total improvement was 12.9% (versus 7.2% in the control group). Athlete cadets from the experimental group achieved better competitive performance (3.1±1.4 average placement) versus athletes from the control group (4.8±1.7). Factor analysis revealed key components determining the experimental method efficiency: Training variability (28.7%), training specificity (24.3%), neuromuscular activation (21.5%), and optimized recovery (15.8%).

Therefore, the study results confirm the efficiency of the proposed strength development method for powerlifters in the competition season, making it possible to recommend it for wide incorporation in elite athlete preparation programs.

ADDITIONAL INFO

Authors' contribution: V.A. Islamov: supervision, conceptualization; D.D. Dalskii: investigation, formal analysis, writing—original draft; V.V. Salnikov: investigation. All the authors approved the version of the draft to be published and agreed to be accountable for all aspects of the work, ensuring that issues related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics approval: The study protocol was not reviewed by an ethics committee as it is a pedagogical rather than purely medical study. All participants provided written informed consent prior to enrollment in the study. The study and its protocol were not registered.

Funding sources: No funding.

Disclosure of interests: The authors have no relationships, activities or interests for the last three years related with for-profit or not-for-profit third parties whose interests may be affected by the content of the article.

Statement of originality: No previously obtained or published material (text, images, or data) was used in this study or article.

Data availability statement: All data generated during this study are available in this article.

Generative AI: Generative AI technologies were not used for this article creation.

Provenance and peer-review: This paper was submitted unsolicited and reviewed following the standard procedure. The peer review process involved two external reviewers, a member of the editorial board, and the in-house scientific editor.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. В.А. Исламов — научное руководство, концепция исследования; Д.Д. Дальский — анализ и обобщение данных литературы, написание текста рукописи; В.А. Сальников — сбор данных литературы. Авторы одобрили версию для публикации, а также согласились нести ответственность за все аспекты работы, гарантируя надлежащее рассмотрение и решение вопросов, связанных с точностью и добросовестностью любой ее части.

Этическая экспертиза. Одобрение этического комитета на проведение исследования не получали, так как оно имеет педагогический, а не сугубо медицинский характер. Все участники исследования добровольно подписали форму информированного согласия на участие в исследовании.

Источники финансирования. Отсутствуют.

Раскрытие интересов. Авторы заявляют об отсутствии отношений, деятельности и интересов за последние три года, связанных с третьими лицами (коммерческими и некоммерческими), интересы которых могут быть затронуты содержанием статьи.

Оригинальность. При создании настоящей работы авторы не использовали ранее опубликованные сведения (текст, иллюстрации, данные).

Доступ к данным. Все данные, полученные в настоящем исследовании, доступны в статье.

Генеративный искусственный интеллект. При создании настоящей статьи технологии генеративного искусственного интеллекта не использовали.

Рассмотрение и рецензирование. Настоящая работа подана в журнал в инициативном порядке и рассмотрена по обычной процедуре. В рецензировании участвовали два внешних рецензента, член редакционной коллегии и научный редактор издания.

REFERENCES | СПИСОК ЛИТЕРАТУРЫ

1. Utepbergenov AK, Elboeva U. Muscle strength and speed-strength basics of quality physiology. *Ekonomika i sotsium*. 2023;(8(111)):355–358. EDN: ZLMRFM

2. Kharichkov EA, Burlakova MS. Developing strength and muscle mass through strength training. *Bulletin of Science*. 2024;(4(5)):1963–1966. EDN: BXAZHX

3. Semenov VG. The history of mass sports work among the military personnel of the Russian army and Navy: 1855–1917 [dissertation abstract]. Moscow: [u. b.]; 2008. 33 p.

4. Dalsky DD, Afanasyeva IA, Kraeva ES. Pedagogical orientation of physical education in socio-professional training of cadets. *Theory and Practice of Physical Culture*. 2025;(1):115–116. EDN: NUFEUO

AUTHORS INFO

Vladimir A. Islamov, Dr. Sci. (Pedagogy), Professor;
eLibrary SPIN: 4685-1472; e-mail: isvdv@mail.ru

***Dmitrii D. Dalskii,** Cand. Sci. (Pedagogy), Assistant Professor;
address: 35 Dekabristov st., Saint Petersburg, 190121, Russia;
ORCID: 0009-0002-4460-0852; eLibrary SPIN: 1744-5117;
e-mail: dddinfo@mail.ru

Victor A. Salnikov, Dr. Sci. (Pedagogy), Professor;
eLibrary SPIN: 7802-2762; e-mail: viktor.slnikov1@yandex.ru

* Corresponding author / Автор, ответственный за переписку

ОБ АВТОРАХ

Исламов Владимир Александрович, д-р пед. наук, профессор;
eLibrary SPIN: 4685-1472; e-mail: isvdv@mail.ru

***Дальский Дмитрий Даниилович,** канд. пед. наук, доцент;
адрес: Россия, 190121, Санкт-Петербург, ул. Декабристов, д. 35;
ORCID: 0009-0002-4460-0852; eLibrary SPIN: 1744-5117;
e-mail: dddinfo@mail.ru

Сальников Виктор Александрович, д-р пед. наук, профессор;
eLibrary SPIN: 7802-2762; e-mail: viktor.slnikov1@yandex.ru