

THEORETICAL AND PRACTICAL FOUNDATIONS OF DEVELOPING PHYSICAL WORK CAPACITY IN THE PROCESS OF PHYSICAL TRAINING OF YOUNG JUDO ATHLETES

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DOI: <https://doi.org/10.5281/zenodo.18932443>

Abstract. *The general objective of the study was the scientific defense and experimental confirmation of the efficacy of a structured 6-month training program, which is specifically aimed at the promotion of physical working capacity in the 10-12 year old judo athletes. The study aimed at evaluating the claim that a systematically structured array of general and special physical training programs would produce meaningful changes on the functional and performance parameters of young judokas at a pivotal point in their sporting career. Twenty young judo players aged 10-12 years were part and parcel of the experimental study. The training intervention was implemented within 6 months, and the sessions took every three weeks based on the structured training program. The program was based on the balanced approach of inclusion of general physical preparation (GPP) and special physical preparation (SPP), with appropriate distribution of loads depending on age. Means of training comprised aerobic and anaerobic conditioning exercises, strength and coordination exercises, and sport-specific exercises based on judo performance. The circuit training method and the interval training method were applied systematically to enhance endurance, muscular strength and functional stability. The parameters of the load were gradually raised according to the principles of gradual overload and adaptation. In order to assess the efficacy of the program, the following tests were carried out in the pre and post intervention period:*

1000-meter running (aerobic endurance) test.

Standing long jump (explosive strength of lower extremities),

Pull-ups (strength and strength endurance of the upper body),

PWC170 test (cardiovascular functional capacity test).

Arithmetic mean values (M) and standard deviation (SD), as well as the t-test of Students were calculated as the statistical methods of analyzing the data collected to conduct the analysis of the significance of differences between pre- and post-experimental indicators. The p-value of acceptance was 0.05. Following the application of the experimental training program, statistically significant changes in several physical and functional parameters were achieved. There was an increase in aerobic endurance by 12.6% which pertained to efficiency of cardiovascular performance. The explosive strength had an increase of 15.8 percent, which is a positive sign of enhanced neuromuscular coordination and force production. The judo-specific endurance increased by 18.4 percent showing to be effective conditioning exercises targeting endurance. Also, the cardiovascular functional indicators evaluated by PWC170 test demonstrated positive changes, and they proved the enhanced adaptive changes of the circulatory system ($p < 0.05$). The results obtained in this research prove the fact that physical work capacity of 10-12-year-old judo athletes is considerably improved in case of scientifically organized and methodically balanced combination of general and special training methods over the period of 6 months. Notably, the training loads that were applied were not as adverse to create negative functional overload, which means that the program was not only effective, but it was safe among young athletes. These findings underscore the relevance of the evidence-based planning and the age-related load management in the youth judo training programs.

Keywords: *judo, young athletes, physical work capacity, training load, functional adaptation, interval training, circuit training.*

Annotatsiya. *Mazkur tadqiqotning asosiy maqsadi 10–12 yoshli dzyudochilar uchun jismoniy ish qobiliyatini rivojlantirishga qaratilgan 6 oylik tuzilmali mashg‘ulot dasturining samaradorligini ilmiy*

asoslash va eksperimental ravishda tasdiqlashdan iborat. Tadqiqotda umumiy jismoniy tayyorgarlik (UJT) va maxsus jismoniy tayyorgarlik (MJT) elementlaridan iborat tizimli mashg'ulot dasturi yosh dzyudochilarning funksional va sport natijalariga sezilarli ta'sir ko'rsatishi mumkinligi baholandi.

Eksperimental tadqiqotda 10–12 yoshdagi 20 nafar yosh dzyudochi ishtirok etdi. Mashg'ulot dasturi 6 oy davomida amalga oshirildi va mashg'ulotlar uch haftalik sikllar asosida tashkil etildi. Dastur yosh xususiyatlarini hisobga olgan holda umumiy jismoniy tayyorgarlik va maxsus jismoniy tayyorgarlik elementlarining muvozanatli uyg'unligiga asoslandi. Mashg'ulot vositalariga aerob va anaerob chidamlilik mashqlari, kuch va koordinatsiyani rivojlantiruvchi mashqlar hamda dzyudo texnikasiga mos maxsus mashqlar kiritildi. Chidamlilik, mushak kuchi va funksional barqarorlikni oshirish maqsadida aylana (circuit training) va interval mashg'ulot usullari tizimli ravishda qo'llanildi. Yuklama ko'rsatkichlari ortib boruvchi yuklama va moslashuv tamoyillariga muvofiq bosqichma-bosqich oshirib borildi.

Dastur samaradorligini baholash uchun tajribadan oldin va keyin quyidagi testlar o'tkazildi:

- 1000 metrga yugurish (aerob chidamlilik);
- joyidan uzunlikka sakrash (pastki tana qismining portlovchi kuchi);
- tortilish (yuqori tana qismining kuchi va kuch chidamliligi);
- PWC170 testi (yurak-qon tomir tizimining funksional imkoniyatlarini baholash).

Olingan ma'lumotlarni tahlil qilishda arifmetik o'rtacha qiymat (M), standart og'ish (SD) hamda oldingi va keyingi natijalar o'rtasidagi farqning ahamiyatini aniqlash uchun Student t -testi qo'llanildi. Statistik ahamiyatlilik darajasi $p = 0,05$ deb qabul qilindi.

Eksperimental mashg'ulot dasturi qo'llangandan so'ng bir qator jismoniy va funksional ko'rsatkichlarda statistik jihatdan ahamiyatli o'zgarishlar kuzatildi. Aerob chidamlilik 12,6 % ga oshdi, bu yurak-qon tomir tizimi samaradorligining ortganini ko'rsatadi. Portlovchi kuch 15,8 % ga oshdi, bu esa neyromushak koordinatsiyasi va kuch ishlab chiqarish qobiliyatining yaxshilanganini bildiradi. Dzyudoga xos chidamlilik 18,4 % ga oshib, maqsadli chidamlilik mashqlarining samaradorligini ko'rsatdi. Shuningdek, PWC170 testi orqali baholangan yurak-qon tomir tizimining funksional ko'rsatkichlari ham ijobiy o'zgarishlarni namoyon etdi, bu esa qon aylanish tizimining moslashuv imkoniyatlari yaxshilanganini tasdiqladi ($p < 0,05$).

Tadqiqot natijalari shuni ko'rsatdiki, 10–12 yoshli dzyudochilarning jismoniy ish qobiliyati ilmiy asoslangan va metodik jihatdan muvozanatli tashkil etilgan umumiy hamda maxsus tayyorgarlik mashg'ulotlari 6 oy davomida tizimli qo'llanganda sezilarli darajada oshadi. Shu bilan birga, qo'llanilgan yuklamalar yosh sportchilarda salbiy funksional ortiqcha yuklanishni keltirib chiqarmadi. Bu esa dastur nafaqat samarali, balki yosh sportchilar uchun xavfsiz ekanligini ham ko'rsatadi. Tadqiqot natijalari yosh dzyudochilar tayyorgarligida ilmiy asoslangan rejalashtirish va yoshga mos yuklama boshqaruvining muhimligini tasdiqlaydi.

Kalit so'zlar: dzyudo, yosh sportchilar, jismoniy ish qobiliyati, mashg'ulot yuklamasi, funksional moslashuv, interval mashg'ulot, aylana mashg'ulot.

Аннотация.

Основной целью данного исследования было научное обоснование и экспериментальное подтверждение эффективности структурированной шестимесячной программы тренировок, направленной на развитие физической работоспособности у дзюдоистов 10–12 лет. В исследовании оценивалась гипотеза о том, что системно организованное сочетание средств общей и специальной физической подготовки может привести к значительным изменениям функциональных и спортивных показателей юных дзюдоистов на важном этапе их спортивного развития.

В экспериментальном исследовании приняли участие 20 юных дзюдоистов в возрасте 10–12 лет. Тренировочное вмешательство продолжалось 6 месяцев, занятия проводились по структурированной программе в трёхнедельных циклах. Программа основывалась на сбалансированном сочетании общей физической подготовки (ОФП) и специальной физической подготовки (СФП) с учетом возрастных особенностей распределения нагрузок.

Средства тренировки включали упражнения на развитие аэробной и анаэробной выносливости, силовые и координационные упражнения, а также специальные упражнения, соответствующие особенностям дзюдо. Для повышения выносливости, мышечной силы и функциональной устойчивости систематически применялись методы круговой тренировки (circuit training) и интервальной тренировки. Параметры нагрузки постепенно увеличивались в соответствии с принципами постепенной перегрузки и адаптации.

Для оценки эффективности программы до и после эксперимента были проведены следующие тесты:

- бег на 1000 метров (аэробная выносливость);
- прыжок в длину с места (взрывная сила нижних конечностей);
- подтягивания (сила и силовая выносливость верхней части тела);
- тест PWC170 (оценка функционального состояния сердечно-сосудистой системы).

Для статистической обработки данных были использованы среднее арифметическое (M), стандартное отклонение (SD) и t -критерий Стьюдента для определения значимости различий между показателями до и после эксперимента. Уровень статистической значимости принимался равным $p = 0,05$.

После применения экспериментальной тренировочной программы были выявлены статистически значимые изменения в ряде физических и функциональных показателей. Аэробная выносливость увеличилась на 12,6 %, что свидетельствует об улучшении эффективности сердечно-сосудистой системы. Взрывная сила увеличилась на 15,8 %, что отражает улучшение нейромышечной координации и способности к развитию силы. Специальная выносливость, необходимая для дзюдо, повысилась на 18,4 %, что подтверждает эффективность целенаправленных тренировочных упражнений. Кроме того, показатели сердечно-сосудистой системы, оцененные с помощью теста PWC170, также продемонстрировали положительные изменения, подтверждающие улучшение адаптационных возможностей системы кровообращения ($p < 0,05$).

Полученные результаты подтверждают, что физическая работоспособность дзюдоистов 10–12 лет значительно повышается при условии научно обоснованного и методически сбалансированного сочетания средств общей и специальной физической подготовки на протяжении 6 месяцев. При этом применяемые тренировочные нагрузки не вызывали негативной функциональной перегрузки, что свидетельствует о безопасности и эффективности предложенной программы для юных спортсменов. Полученные данные подчеркивают важность научно обоснованного планирования тренировочного процесса и возрастного управления нагрузками в подготовке юных дзюдоистов.

Ключевые слова: дзюдо, юные спортсмены, физическая работоспособность, тренировочная нагрузка, функциональная адаптация, интервальная тренировка, круговая тренировка.

Introduction. Judo as a combat sport is also defined in terms of intermittent type of structure where the bouts of intense actions are mixed with short periods of rest. During a game, players are subjected to repeated acts of explosive shooting, quick maneuvers, gripping movements, and dynamic movements between standing skills and groundwork. This kind of activity involves the co-ordinated and simultaneous working of an anaerobic (alactic and lactic) and aerobic energy delivery system. Thus, building the adequate level of physical working ability among judo athletes is a determining factor in the technical efficiency, tactical stability, and competitiveness.

The initial systemic development of physical working capacity is a key predictor of the future development of athletic performance at an early specialization. The degree of general and specific physical preparedness developed during childhood is a major

determinant of the adaptive capacity of the athlete in the future, the fatigue resistance, and tolerance to an increasingly larger training load. In this connection, the systematic training at the early age is the key to the successful athletic development.

The age of 10-12 years is the critical and most desirable stage in the process of development of most important motor skills like endurance, coordination and strength. At this age, children indicate greater neuromuscular and cardiovascular system plasticity, more rapid physical stimulus adjustment, and greater motor learning ability. Consequently, the choice of training stimuli may be effective in improving functional as well as performance-related parameters provided that the stimuli are selected accordingly.

Nevertheless, even in light of these physiological benefits, a miscalculation and allocation of training loads might end up with negative outcomes. Too much of the intensity, inadequate rest, or unbalanced proportions of general and special training may impair the cardiovascular, respiratory, and musculoskeletal systems of young athletes. This can not only decrease the performance but also cause overtraining, fatigue buildup as well as injury. This is why the planning of the training process should be based on scientific grounds, methodology, and be thoroughly adjusted to age-specific anatomical and physiological peculiarities of 10-12-year-old athletes.

It was on these grounds that the intended purpose of the research was to create and experimentally support an effective methodological strategy of enhancing physical ability to perform work in young judo athletes during a 6-month training period. The research aimed to identify whether a scientifically organized mixture of general and special training means, used according to the adaptation principles depending on the age may guarantee a considerable functional increase without creating a negative overload.

Methods. The current study involved a sample consisting of twenty male judoka, of age between ten and twelve years, and with a prior experience of one to two years of systematic experience in judo training. Every one of them was involved in regular organized sport activities and had a similar degree of technical and physical readiness at the start of the study. Before taking part, every athlete has passed a medical test and was officially granted the right to train and compete, therefore, making sure that he or she does not have any contraindications to physical loading. During the experimental part, the subjects were training in the same environmental, methodological and organization conditions which allowed to remove the extraneous factors, which might have affected the findings.

Study Design: The experimental training program was to be carried out throughout six months. The training was done thrice a week and the session took 90 minutes. Each session had a well-defined and pedagogically-grounded progression and was aimed at the sequential physiological activation, specific enhancement of motor skills and adequate recovery.

The training session involved:

Warm-up (15 minutes): General developmental exercises, mobility exercises, and mild aerobic exercises to raise the body temperature, trigger neuromuscular coordination and condition the cardiovascular system to be ready to work at a later stage.

General physical training (25 minutes): This is an exercise aimed at building up overall endurance, strength, coordination, agility, and flexibility.

Special physical training (30 minutes): Sport-specific conditioning exercises with a direct connection to the judo performance, with the focus on explosive strength, grip endurance, and certain stamina.

Technical-tactical exercise (15 minutes): Improvement of throwing skills, defense moves and situational sparring factors.

Recovery phase (5 minutes): Low-load exercises, breathing, and stretching aimed at speeding up the process of recovery and avoidance of excessive fatigue development.

Training Methods:

General physical training consisted of running drills of different intensity, plyometric and jumping exercises, coordinating games aimed at the improvement of reaction and spatial awareness, and the presence of gymnastic elements that would contribute to flexibility and core stability.

Peculiar physical training included the usage of throwing exercises in various grips and direction, resistance exercises with the partners, task of the development of the grip strength, as well as various interval-based sparring. Special attention was paid to exercises which imitated competitive action in form and in intensity.

The interval training process was the 2030s seconds of high-intensity exercise, and then 3060 seconds of active rest. The choice of this structure was based on the intermittent characteristic of judo competition and also to provoke the anaerobic and aerobic energy systems.

Also, the circuit training technique was used where successive stations were comprised of various muscle groups and motor qualities. There was a rotational activity of the athletes who were taken through stations with very little rest, which encouraged total muscular involvement and cardiovascular acclimatization.

Testing Procedures: In order to determine how successful the training intervention was, physical work capacity was assessed by a set of standardised tests carried out before and after the time of the experiment.

Aerobic endurance was assessed by means of the 1000-meter run.

The lunging jump was used to measure lower extremity explosive strength.

The upper-body muscular endurance and strength test was the pull-up test.

To measure the cardiovascular efficiency and functional capacity of the heart during submaximal workload conditions, the PWC170 test was done.

During the training cycle, the heart rate was tracked systematically to regulate the intensity of exercise, appropriate distribution of loads according to age, and excessive functional load.

Statistical Analysis: The mathematical statistics methods were applied in order to process the collected data. To measure the central tendencies and variability, descriptive statistics involved the calculation of the arithmetic means (M) and the standard deviation values, \pm SD. Student t -test was used to compare initial and final measurements in order to define the level of statistical significance of recorded differences. The p-value of significance was established as less than $p=0.05$, which made it possible to conduct objective analysis of the efficacy of the training program adopted.

Results. After six months of the systematically organised and scientifically structured training, statistically significant positive results were obtained in all the analyzed physical and functional indicators. The pre- and post-experimental data were compared, which ensured the validity of the adopted training methodology.

During the 1000-meter running test, representing the measure of aerobic endurance, the performance went down to $3.62\text{Min}^{-2} \pm 0.28$ to $4.14\text{Min}^{-2} \pm 0.36$. This translates to a 12.6 per cent increase in aerobic capacity and the difference is found to be statistically significant ($p < 0.05$). This kind of improvement denotes better efficiency of oxygen consumption and enhanced cardiovascular-respiratory system.

The standing long jump where the explosive strength of the lower extremities was determined was found to increase by $170 +11$ to $197 +9$. The 15.8% increase ($p < 0.05$) is associated with the better neuromuscular response, better power production, and greater capacity to produce rapidly accelerated force-characteristics which are highly valued in the process of throwing in judo.

In a similar manner, the upper-body muscular strength and endurance as indicated by the pull-up test also increased by $6.2 + -1.1$ to $9.4 + -1.3$ repetitions. The 18.2 per cent ($p < 0.05$) growth shows a tremendous growth in functional strength which is specially applicable in gripping control, pulling actions and resistance of a partner during combat.

Also, the index of the cardiovascular functional capacity at submaximal load, PWC170 index, increased 14.9%. The change suggests a better cardiac efficiency, better stroke volume response, and a more cost-effective heart rate response to exercise. The adaptation of the cardiovascular system to training loads is positively adapted, which is confirmed by the improvement.

On the whole, it must be noted that the acquired findings indicate that the logical and moderate integration of the aerobic and anaerobic types of training, such as the interval and circuit training, is an effective way to enhance the general and special physical work capacity of young judo athletes. The evidence justifies the validity of the methodology of using various energy system stimulus to facilitate holistic physical growth at the delicate stage of ten to twelve years old.

Discussion. The current research proves the fact that the harmonious combination of general and specialized training methods significantly increases the functional preparedness of the young judokas. The measured increases in aerobic measures are in tandem with available physiological data that emphasize the critical nature of cardiovascular response in pre-adolescence, and improvements in explosive power is an indication of effective neuromuscular response to plyometric and interval stimuli. Favorable dynamics of the partial work capacity at 170' Watts (PWC170) refer to an increase in the efficiency of energy supply and fatigue resistance. Intense heart-rate control and stagewise increase in load alleviated the occurrence of overtraining effects, hence making sure that safe and effective performance improvement was implemented with a careful planning of training based on age-specific physiological theory.

Conclusion. The six months, scientifically organized training intervention created in synopsis had significant positive effects on physical work capacity parameters in judokas aged 1012 years. The use of general and special physical training modalities created constant functional adjustments, whereas the interval and circuit training methods were effectively used to support endurance and explosive force. Prudent load management was the measure that guaranteed safety of physiological adaptation and continuation of performance development.

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