



Features of the initial training stage of athletes in sport climbing

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Abstract. This study aimed to provide a theoretical justification for the specificities of physical and technical preparation of athletes at the initial stage of preparation in sport climbing. The study was based on the theoretical and methodological framework using theoretical analysis of scholarly sources and logical-structural modelling. The results showed that the training of novice athletes is multifaceted and based on the interconnection of physical qualities and technical skills. Among them, grip strength, coordination abilities and endurance are the priority ones. It is shown that grip strength can improve the athlete's ability to maintain positions in a variety of positions and transitions, and it is necessary to develop it with gradual changes, taking into account the physical possibilities of the athlete. It has been established that the coordination abilities play a system-forming function, as they ensure the correct mastery of technical movements, precision of movement and adaptation to track conditions. A review of the scientific literature has made it possible to select and substantiate such training methods and means: hanging and holding exercises, climbing on simple routes, balance and coordination exercises, as well as prolonged and interval adaptive workloads. It is also proven that the effectiveness of training at the initial stage can be ensured through the integrated implementation of these methods, variability of performing conditions and gradual complication of motor tasks. The developed model of the structural-logical structure of training has made it possible to establish the interrelationship between physical qualities and technical training, the development of coordination skills, and provided for the gradual development of motor skills. It was established that the rational regulation of the training load contributes to the safe preparation of sportsmen and the prevention of overload. The practical significance of the study lies in the possibility of applying its findings by coaches for sport climbing, teachers of physical education and instructors at children's and youth sport schools when organising training, in order to build the training process to ensure the correct and safe preparation of physical and technical qualities

Keywords: physical qualities; grip strength; endurance; training process; effectiveness of technical skill acquisition

Introduction

With the expansion of sport climbing into an Olympic discipline, the number of children and teenagers training systematically has grown, necessitating the scientifically grounded organisation of initial preparation. The initial

phase of long-term athletic training plays a critical role in the formation of fundamental motor skills, coordination abilities, and prerequisites for further athletic improvement. Contemporary studies emphasise the necessity of

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balancing general physical training with specialised training methods, while also accounting for the psychophysiological and developmental characteristics specific to youth athletes. The lack of a systematic approach to defining the content and organisation of the preparatory stage in sport climbing remains a significant obstacle to optimising training outcomes. It is substantiated that the organisation of initial preparation in sport climbing is related to the need to reconcile the goals of training in such aspects as the development of the main physical qualities and skills, acquiring skills, techniques and coordination skills, and maintaining the safety of training with children and adolescents. In practice, this creates a tension between the pressure to implement specialised skills from an early age and the age-appropriate recommendation to prioritise general physical development. These competing aims make identifying the optimal training structure for the early phase of sport climbing particularly challenging.

The impact of various training approaches on physical capacity and sport-specific performance has been explored by numerous scholars. For instance, N. Stien *et al.* (2023) evaluated the efficacy of combining specialised exercises with strength work within athlete training programmes. It was found that the integration of these methods leads to gains in strength, endurance, and skill execution efficiency. Furthermore, they noted that the training response differed based on the athlete's current level of conditioning, underscoring the need for differentiated training plans. The value of climbing movements for developing balance in youth was studied by M. Cășăneanu *et al.* (2025). They focused on the coordination-related aspects of motor activity. They measured static and dynamic balance under the influence of specially selected exercises. The researchers observed notable improvements in balance control, which they attributed to the unique movement patterns in climbing. These findings highlight the crucial contribution of such exercises to overall coordination development during childhood. In their research, B. Gilic & D. Vrdoljak (2023) investigated select preparation indices for young elite climbers with respect to their sex, age and biological maturity. They assessed the physical and functional qualities that determine performance in this sport. The differences found the strength, endurance and coordination indices according to the characteristics of the athletes. The study emphasised the necessity for taking into account individual physiological features in organising the training process in the initial period of preparation.

A. Saeterbakken *et al.* (2024) studied the relationship between strength training, climbing performance and injury prevention. They summarised the available evidence on the effect of various types of strength training on the performance indices of sport-specific and functional capacities of athletes. It is concluded that the presence of strength loads in the training process is associated with an increase in performance and a decrease in injury. P. Diez-Fernández *et al.* (2023) conducted a systematic analysis of the performance factors in sport climbing. Their study summarised data on the physical, technical and physiological qualities of athletes. They revealed strength, endurance and specific motor skills as key determinants of performance. The research also systematised approaches to performance assessment. K. Mulyk *et al.* (2021) assessed the efficiency of

special equipment used for the development of muscular strength. They identified changes in strength characteristics as a result of using the training equipment of different types. The results obtained confirmed the role of technical training equipment in physical preparation.

M. Kovářová *et al.* (2024) performed an analysis of the injuries in climbing, taking into consideration risk factors. The study examined the types of injuries, their origin and training conditions. They also revealed the most common injuries and risk factors in the climbing process. The findings made it possible to reveal specific features of training organisation ensuring safety. M. Bingöl (2023) analysed the impact of climbing training on the physical qualities of athletes. The study examined the changes in strength, flexibility, speed and agility after undergoing a training programme. The group of study subjects showed the improvement of these indicators. The data obtained showed the effect of climbing training on the formation of physical qualities. H. Gürer *et al.* (2024) studied the effects of climbing training on psycho-emotional state in adolescents. The study analysed indices of mental health, emotional well-being and self-esteem. The researchers found changes in psychological qualities under the effect of climbing training.

The previously mentioned studies were limited to the investigation of specific components of preparation. They mainly focused on the formation of strength abilities, coordination abilities and psychophysiological characteristics. However, they failed to provide a detailed picture of the complex relationship between physical and technical preparation in initial training. At the same time, the systematisation of approaches to the development of grip strength, coordination and endurance abilities, including their inclusion into the structure of training, also requires further elucidation. This study aimed to establish the particular features of physical and technical preparation of novice athletes in the process of training in sport climbing. The objectives of the study included analysing scientific views on the content of physical and technical preparation of athletes in sport climbing, to identify means and methods of developing grip strength, coordination abilities and endurance at the initial stage of preparation and to construct a logical-structural model of athletes' initial preparation in sport climbing.

Materials and Methods

The study was conducted within a theoretical and methodological framework. The following methods were used: theoretical analysis of scholarly sources, the method of logical-structural modelling, and the method of systematic synthesis. The theoretical analysis of scholarly sources was carried out to determine the specific features of physical and technical preparation of athletes at the initial stage of preparation in sport climbing. The studies of C.M. Mermier *et al.* (2000) and E. López-Rivera & J. González-Badillo (2012) are used to identify the approaches to the development of grip strength and strength qualities, as well as the specifics of physical loads in climbing. The publications by S. Sterkowicz *et al.* (2014), D. Orth *et al.* (2016), and D. Saul *et al.* (2019) were used to describe coordination abilities, forming the motor actions and fundamental technical skills in novice athletes. The analysis of the articles by N. Taylor *et al.* (2020) and L. Rappelt *et al.* (2023) made

it possible to identify the most effective approaches to the development of endurance and ways of implementing adaptive forms of training loads. The units of analysis included types of physical qualities, methods of development and technical elements of sport climbing, methods of their development. The analysis allowed for the systematisation of the most common training methods used in the process of training. In particular, hanging and holding exercises, climbing on simple routes, coordination and balance, and adaptive forms of the interval and prolonged workloads.

To explore the theoretical principles in greater depth, the method of logical-structural modelling was used for the purpose of constructing the model of initial preparation in sport climbing. The model was developed on the basis of a synthesis of theoretical and methodological approaches to the preparation of athletes, as well as principles of sports training theory related to the stage-by-stage formation of motor skills and physical qualities development. The idea of the model was based on the interrelationship of physical and technical preparation, the priority of the development of coordination abilities during the initial stage of preparation, and the principles of progressive increase and variability of the training load. The model was built on the principle of sequential structuring, which involves the definition of training goals, followed by the selection of methods and means for achieving them. In the structure of the model, the main components were identified, namely: training objectives, leading physical qualities, methods of training influence, sequence of formation of technical skill, as well as the principles of load regulation. The logic of the model is based on a stage-by-stage formation of motor skills, progressing from the acquisition of basic coordination elements to the integration of technical skills into the holistic activity of climbing. During the modelling, functional relationships between the level of development of physical qualities and the results of mastering climbing techniques were revealed, which allowed substantiating the priority of developing coordination abilities at the initial stage of athlete preparation, on which the formation of technique is based. The constructed model was theoretically verified by comparing the model units and logical basis of its construction with the data of the analysed sources (Vasile *et al.*, 2021; Skriver *et al.*, 2024). The interpretation of the results was based on the principles of the systems approach (initial preparation is an integrated dynamic system of interrelated factors: physical qualities, skills and technique; parameters of the training load). The obtained results created a theoretical basis for substantiating effective approaches to organising the training process at the initial stage of preparation in sport climbing and made it possible to identify optimal methods for developing key physical qualities and forming fundamental technical skills in novice athletes.

Results

The preparation of novice athletes in sport climbing is based on the integration of key physical qualities and technical skills. The structure of such preparation includes the main areas of development, namely grip strength, coordination abilities, endurance, and the formation of fundamental technical skills. One of the key areas in the preparation of athletes at the initial stage of training in sport climbing is

the development of grip strength, as it is this that enables them to effectively maintain the body weight in interaction with the grips of different configurations and shapes, with different sizes and locations. In this regard, the development of both static and dynamic strength of the muscles of the hand, fingers and forearm is especially important, since this affects the ability of an athlete not only to hold the body position, but also to move from one position to another. An important aspect is also the development of grip endurance, which ensures the sustained maintenance of working capacity during route completion. At the initial stage of preparation, this component is developed gradually, taking into account the age-related and functional capacities of athletes, which makes it possible to avoid overload of the musculoskeletal system and ensure safe development (Labott *et al.*, 2020; Buraas *et al.*, 2025).

Coordination abilities are regarded as a system-forming component of preparation that determines the effectiveness of acquiring technical actions and the quality of movement execution. Their content includes the development of spatial-temporal accuracy, the ability to maintain balance in unstable positions, the differentiation of muscular effort, and the coordination of upper and lower limb movements (Orth *et al.*, 2016). In sport climbing, coordination is manifested in the ability to position the body accurately in relation to supports, to change the position of the centre of mass in a timely manner, and to adapt movements to the specific features of the route. At the initial stage of preparation, one of the most important things is the development of coordination, since this lays the foundation for the formation of technique and the reduction of unnecessary energy consumption. In addition, a high level of coordination abilities contributes to increased training safety by ensuring movement control in complex positions (Sterkowicz *et al.*, 2014). Within the system of preparation for novice athletes, endurance is understood as the body's ability to resist fatigue and maintain the required level of working capacity throughout the climbing process. Under the specific conditions of sport climbing, endurance has a complex character and combines both general and specialised endurance. General endurance creates the functional basis for performing prolonged workloads, whereas specialised endurance is directly associated with maintaining grip and repeatedly executing technical actions. A particular characteristic of the development of this component at the first stage is the implementation of adaptive load modes with a gradual increase in the duration and intensity of exercise (Saul *et al.*, 2019). This ensures the balanced development of the body's functional capacities without the risk of overfatigue and contributes to improving the overall working capacity of athletes (Rappelt *et al.*, 2023).

Technical preparation is an integrative component that brings together the results of physical development in the form of a holistic system of motor action. Its content implies mastery of key elements of movement along the route: the correct positioning of the feet, the most rational use of the holds, the best body position with respect to the vertical surface, and choosing a rational movement sequence. Special attention is paid to the development of skills aimed at economising motor activity, which involves reducing superfluous effort and distributing loads more rationally across different groups of muscles. Technical skills are

developed in the initial stage of preparation under simplified conditions, with a gradual increase in the level of complication of the tasks to ensure the acquisition of stable skills. At the same time, technical preparation has a close relationship with the development of coordination and strength, the joint improvement of which is necessary (Taylor *et al.*, 2020). In summary, each of the identified components performs a complementary function within the structure of athlete preparation at the initial stage, while their purposeful development provides the foundation for the further improvement of sporting mastery.

The process of formation and development of these components of the training of the athlete at the initial stage takes place under the systematic and consistent implementation of a number of specially selected methods, the purpose of which is the complex development of grip strength, coordination abilities, endurance and the most important technical skills. It was determined that the implementation of such an approach does not imply the use of individual isolated exercises, but the combination of a variety of exercises within the framework of a coherent training system. A characteristic feature of these methods is the variability of execution conditions, the gradual complication of motor tasks, and adaptability to the individual capacities of athletes, which ensures an optimal balance between educational and developmental effects. The development of grip strength takes place mainly through exercises on hanging and holding, during which the athlete maintains a stable body position on various types of holds (flat, active, passive, and crack holds) with different widths and positions of the fingers and hands, using different support points. The most common methods include hanging on straight and bent arms, maintaining a stable position of partial unloading of the lower limbs, as well as complex exercises with the transfer of load on the upper limbs from the minimum amount of load on the lower limbs to their gradual disengagement.

Key aspects that need to be taken into account include a gradual increase in the duration of the support, the use of repeated repetitions, the timing of the rest period and the maintenance of a certain degree of muscle tension. This type of training strengthens the muscles of the hand, fingers, and forearm, in addition to developing neuromuscular coordination. This enables the athlete to properly regulate effort and avoid excessive fatigue. This also increases the efficiency of acquiring technical skills. Climbing routes on simple routes is a fundamental tool for an integrated approach, combining the development of physical abilities with the acquisition of technical skills. At the initial stage, such routes should consist of a large, comfortable hold and a slight or vertical incline. It has a sufficiently complex sequence of movements. This creates favourable conditions for a more accurate execution of technical elements, particularly foot placement, choosing the best points of support and moving the body efficiently. Both methods are common in practice: ascent continuously in a steady rhythm, repetition in sections with a focus on learning separate movements. There was proof that such variability in conditions (change of rhythm of movement, conditions of restriction on the use of separate holds, movement from position holds) has a positive effect on the development of motor variability, increases the accuracy of performing

movements and ability to act in changing environmental situations (López-Rivera & González-Badillo, 2012).

The exercises for developing balance and coordination are directed to develop the ability to maintain an equilibrium of the body and move effectively while performing complex supporting conditions. For these purposes, exercises on an unstable support are recommended, moving along a limited support, maintaining equilibrium in a standing asymmetrical position, and coordination exercises for changing body position under certain conditions. In the context of climbing, exercises with an emphasis on footwork are widely used, in particular, precise foot placement on small holds, shifting the centre of mass without using the hands, and performing movements with pauses in extreme positions. The use of such methods promotes the development of spatial awareness, improves intermuscular coordination, and supports the formation of rational movement strategies. Endurance development is achieved through the use of prolonged and interval training loads with an adaptive character, selected in accordance with the athletes' level of preparedness. Prolonged loads are implemented through continuous low-intensity climbing or sets of exercises with moderate intensity, which contribute to the development of general endurance and the functional capacity of the cardiovascular system. Interval training is based on the principle of alternating work-rest intervals, for example, by repeating the passing of sections of a route with a prescribed rest time. This ensures the development of a separate type of endurance and speed of recovery. When implementing this method, it is important to control the volume and intensity of training and, more importantly, gradually increase these parameters to ensure the quality of adaptation to training loads without overloading the athlete (Mermier *et al.*, 2000).

At the same time, it should be noted that these methods are not used independently of each other. This is part of a single process of sports training. Each of them has its own role here. It is both a specific as well as a complementary function. The combination of strength, coordination, and endurance exercises with technical tasks ensures the comprehensive development of athletes and creates the conditions for the formation of stable motor skills. It is also worth noting that at the initial stage, it is educational and developmental exercises that predominate, which contribute to the qualitative acquisition of fundamental elements, rather than achieving maximum indicators of the level of physical fitness. Consequently, the effectiveness of novice athlete preparation in sport climbing largely depends on the rational selection and combination of training methods that ensure gradual, safe, and diversified development of physical qualities and technical skills.

A structural-logical model of the initial stage of the preparation of athletes for sport climbing is presented. It shows how physical and technical preparation are interrelated in the process of learning. Physical preparation acts as the functional basis for the formation and implementation of technical actions. Meanwhile, technical preparation makes it possible to use the physical potential of the athlete more rationally during climbing. The main idea of the presented model is the priority development of coordination abilities at the initial stage of preparation, as it will affect the speed of formation of motor skills, the exactitude of the performance

of technical skills and adaptation to variable climbing conditions. This provides a basis for further development of grip strength, endurance, and technical skills of athletes.

The construction of the model was based on the principles of gradual progression and variability in training. The principle of gradual progress entailed the increase in the complexity of tasks and the volume of the training load step by step, depending on the level of training readiness. The principle of variability was realised through the variability of exercise conditions and the use of various work regimes, as well as taking into account the individual

characteristics of the athletes in the training process. The training concept was based on the formation of motor actions in stages: the formation of elements of complex co-ordination was preceded by learning the basic technical movements of the activity, climbing. This principle ensured a stable nature of training and the formation of motor skills on a lasting basis. For a more systematic presentation of the content of the training process, its main components are presented with their structure and components depending on their functional goal in the training process, content and mechanisms of training are implemented (Table 1).

Table 1. Structure of the model of initial preparation for athletes in sport climbing

Model component	Content	Functional purpose	Expected outcome
Training objectives	Formation of a basic level of physical fitness and acquisition of fundamental technical skills	Define the overall direction of the training process and preparation targets	Achievement of an initial level of readiness for participation in climbing activities
Key physical qualities	Grip strength, coordination abilities, endurance	Provide the physical foundation for performing technical actions	Improved ability to maintain grip, coordinate movements, and sustain prolonged effort
Training methods	Hanging exercises, climbing on simple routes, coordination exercises, interval training loads	Deliver targeted development of physical qualities and technique	Formation of basic motor skills and development of physical capacities
Technical skills	Foot placement, use of holds, body positioning, movement sequencing	Integrate physical qualities into sport-specific motor activity	Development of an efficient climbing technique
Load regulation	Control of volume, intensity, and variability	Ensure adaptation and prevent overload	Gradual improvement in preparedness without excessive fatigue

Source: compiled by the authors based on data from A. Vasile *et al.* (2021), S. Skriver *et al.* (2024)

As the presented model suggests, initial preparation in sport climbing is a system, the physical training and technical training components of which are interrelated and interdependent. The presented components allow the formation of motor skills, taking into account an individual athlete's level of preparedness and the specificity of their activity. In the practical application of the model, the priority in the initial training was given to the development of coordination abilities as the basis for improving the technical skills of climbing, grip strength and special endurance. The efficiency of preparation is also related to the diversity of training methods and the appropriate dosage of the physical workload, which allows for a gradual adaptation of the athlete's body to the requirements of the activity, without any overloads.

The resulting structure of the proposed model can be considered the theoretical and methodological basis for planning the training process of novice athletes in sport climbing and selecting the most appropriate methods for developing the necessary physical qualities and forming basic technical skills. Furthermore, in order to further develop the theoretical framework in order to improve the structure of the initial training, the functional relationships between key physical qualities and technical training in competitive rock climbing were analysed. The summary of the analysis allowed identifying that there is a specific effect of the coordination ability, strength of the hands, and endurance on the formation of technical skills in novice athletes. The corresponding functional relationships are presented in Table 2.

Table 2. Functional relationships between physical qualities and technical preparation of athletes at the initial stage

Physical quality	Nature of influence on technical preparation	Manifestation in climbing
Coordination abilities	Determine the speed and quality of acquiring technical elements; ensure precision and synchronisation of movements	Accurate body positioning, effective transfer of the centre of mass, adaptation to varying route conditions
Grip strength	Enables the execution of technical actions related to holding and transitions	Hold retention, positional stability, execution of dynamic transitions
Endurance	Influences the ability to maintain technical quality over extended periods	Sustained movement accuracy, reduced impact of fatigue, stability of technical actions

Source: compiled by the authors based on data from D. Stanković *et al.* (2019), R. MacKenzie *et al.* (2019)

t the first sub-stage, basic coordination skills development prevails, which provides for mastering basic methods of movement control, balance maintenance, and spatial orientation. During this period, attention is paid to the

formation of simple motor actions and the development of proprioceptive sensitivity and control of the position of the body, as the foundation for subsequent steps to the more complex technical task. The following stage is characterised

by the gradual integration of established coordination elements with the development of strength and endurance, which makes it possible to master more complicated motor actions and withstand higher workload. At this level, the formation of motor skills of athletes occurs through an expansion of motor experience, an increase in the accuracy of execution of movements, and the ability to use them depending on the way they are carried out. The final stage of initial preparation is associated with the integration of developed physical qualities and technical training in the overall work of sport climbing, which is manifested in the ability to perform sequences of motor actions with the right technical execution and rhythm and with minimal effort. At this level, coordination movements become more organised, motor skills are better automated, and they are performed stably with variable loads. It is also proven that a step-by-step training is a prerequisite for forming motor skills correctly. This means that learning should have a logical course, and the tasks should increase gradually, while the physical and technical part of novice athletes should fit into the structure in the most effective way.

It is important to keep in mind that physical fitness acts not only as a condition that makes it possible to execute motor actions, but also as a factor that affects the quality, accuracy and stability of technical actions. Coordination abilities affect the development of technical skills, since they provide the accuracy of movements, coordination of movements in individual body parts, as well as the ability to quickly adjust motor programmes to certain conditions, that is, to certain tasks. The higher the level of coordination, the more quickly technical elements are learned, the more varied they are, and the smaller the costs of effort during the climb. Grip strength reflects the ability to perform technically associated actions; that is, it is possible to maintain a body position or change grips. A low level of grip strength does not allow technically correct movements to be effective; however, its gradual increase allows for an increase in the functional opportunities of the athlete and makes the execution of technical movements more reliable. Endurance acts as a factor that provides the stability of technical actions over time. A high level of endurance allows for the maintenance of movement accuracy during the exercise, prevents the occurrence of fatigue in an advanced manner and ensures that the required level of coordination and strength is maintained. All these relationships are interdependent, which means that, for example, the improvement of one component of physical fitness indirectly affects the development of other preparation components and the effectiveness of the technique. In particular, coordination allows the most efficient use of strength in the movements of climbing, while the development of endurance ensures the stability of the coordination of the actions of the climber for a long period of loading. Coordination plays a key role in the formation of the structure of the initial training of athletes, as they determine the speed and quality of mastering technical elements. A well-developed level of coordination ensures an accurate movement, effective balance and the correct use of physical effort during a climb. At the same time, grip strength and endurance form a functional basis of the stability of technical performance in the process of training. It has been established that the combined development of coordination abilities, grip strength and

endurance provides effective formation of sports mastery in novice athletes.

At the first stage of preparation for sport climbing, it is necessary to use training means and techniques, which will contribute to the steady and gradual improvement of the basic physical qualities of the athlete, and the development of coordination abilities and skills. The main task at this stage is to form an adaptation of the body of an athlete to specific loads, to develop proper movement technique and provide conditions for safe work during training. In order to improve grip strength in sport climbing, exercises can be used, such as hanging on a large hold with a short-term fixing of the position and movement at low height hand grip exercises with an average level of resistance for finger fixation. It is necessary to do with small volumes and long rests, as it is important to avoid overworking the hands and fingers at the beginning. The volume can be increased by adding duration to the exercise, adding more reps, and then adding the more challenging kinds of holds. However, novice athletes should avoid campus board training, small holds, and exercises with added weight, as this puts athletes at a higher risk of ligament and tendon injuries. Coordination abilities can be improved as a result of exercises to maintain balance, tasks on orientation in the space, and exercises to synchronise movement. It is beneficial to use coordination ladders, perform balance exercises on unstable supports, climb routes without technical difficulty, while focusing on accurately placing the feet, and train with a steady movement tempo. At the initial stage, it is recommended to use simple routes and exercises without psychological stress in order to prevent height phobia and loss of control over the technique. Complexity can be raised by changing the features of the wall, adding more coordination elements, or doing exercises in non-standard positions. Endurance can be achieved by working at an average intensity, without reaching a state of marked exhaustion, for a long time. Methods could be extended to include climbing on easy routes, sets of traverses, running exercises, jump roping, and individual exercises of circuit-style training. It is suggested that novice athletes use an interval approach, performing exercises for short time periods and then resting for an adequate period of time. The workload can be gradually increased by extending the duration of exercises, increasing the number of reps, and reducing the rest between exercises. The workloads that are used at this age should not be too large and lead to complete fatigue due to the low level of physiological adaptation in young athletes.

Technical exercises for beginners include fixing the feet, transferring the centre of gravity, and maintaining the position of the body. These exercises help to master and improve their technique and at the same time economise energy. It would be good to start with learning movements gradually, having the teacher explain and show them, and doing these exercises at an easier level, increasing the level gradually until they move to the most difficult elements. Special attention should be given to learning the correct technique of movement along the track as the athlete first gains fundamental motor skills. The principle of individualisation of training and the safety of the training process are of primary importance for novice athletes in terms of learning climbing in general. Before starting the exercises,

it is recommended to do a full warm-up, and special emphasis should be put on the wrists, shoulders, and trunk. Training sessions should be organised on easy routes using reliable belay systems and certified equipment. In the first stages of training, the athlete is not recommended to perform movements of an intense nature, with high loads or a long static loading of one hand, in order to avoid overloads of the musculoskeletal system.

Discussion

The results of this study showed that the training of sports climbing is complex and is based on the interaction of physical and technical qualities. This is consistent with the results of S. Faggian *et al.* (2025), where they revealed the multifactorial nature of the sporting activity, focusing attention on the physical and technical components that make up the complex. It was further demonstrated in the study that a successful training process is formed due to the holistic interaction of the qualities and not by a separate, isolated study. This can be explained by the interrelated and interdependent impact of the strength, coordination, and endurance on the formation of technical perfection. It helps to make the performance of movements more rational and economical. This study has also shown that coordination abilities have a priority influence, which is consistent with the data of A. Kurniawan *et al.* (2026), where it is noted that balance and coordination are the basic abilities for effective climbing performance. The priority of the development of coordination abilities allows an improvement in movement accuracy, an increase in stability of the body, and an overall impact in terms of improving the quality of execution of motor actions. Coordination abilities are an important component of the process of mastering and formation of motor skills, which is consistent with the study of H. Zhang *et al.* (2026), where it was demonstrated that movement accuracy and control of the position of the body are key factors of the kinematics of performing a movement for climbing performance. Similarly, the study found that a high level of coordination contributes to adapting to different conditions of the route and saving energy. An important component of the preparation of novice athletes is the strength of grip, because holding the grip helps to maintain positions and perform transitions. This is in line with the results of K. Langer *et al.* (2023), who showed that the specific strength affects climbing performance. At the same time, the results of the current study showed that the development of strength should be done gradually, considering the age and functional characteristics of the athlete, as in the study of Z. Kozina *et al.* (2020), where they emphasised the importance of gradual progression of the physical qualities. The study specifies that staging the training process involves not only a gradual accumulation of loads but also changes in the conditions of performing exercises and a certain control over muscle tension, which makes it possible to avoid overloading the musculoskeletal system. In addition, authors stressed that the combination of different means within one system allows for a higher degree of sporting performance, which coincides with the data obtained in the present study.

Endurance in climbing has a complex character and includes both general and special components, which corresponds to the conclusions of M. Maciejczyk *et al.* (2022)

regarding the participation of different energy systems in maintaining performance during the implementation of sport-specific exercises. The results obtained in the current study confirmed that a complex training method is more effective than individual isolated exercises. The technical preparation in climbing is an integrative part of a single motor system that unites different physical qualities, which is supported by the studies of F. García-Heras *et al.* (2025) on the importance of properly working with the lower extremities and a perfect technique of movements in the climbing process. In addition, the present study revealed that the efficient work of the lower extremities reduced the load on the upper limbs and improved the economy of movements, which is especially important at the beginning of the preparation process. It is this factor that determines the more efficient mastering of motor skills and the stability of the movement performance. The results of this study showed that different training conditions contribute to the improvement of adaptability of athletes, which is consistent with the conclusions of M. Turchetto *et al.* (2025) on the impact of experience, training frequency and psychological factors on the development of competence in the sport of climbing. The article also specifies that changes in the tempo, the position of support, and the execution of different elements in movement allow for improving the variability of motor activity and the ability to act in accordance with the changing conditions. As a result, this contributes to the development of stable motor skills and increases performance in the conditions of different routes. The importance of an individual approach to training was also noted in the current study, which corresponds to these conclusions. In addition, the study has shown that the appropriate dosing of loads is an important condition for effective training and prevention of injuries, which is confirmed by the conclusions of A. Obcowska *et al.* (2025) pointed out the risk of injury in climbing and the need to control training loads. The current study has also noted the need for a gradual increase in loads during training, which allows a safe training process and promotes the development of athletes. In addition, the presented study shows that coordination abilities perform a system-forming function in novice athlete preparation structure, which also matches the results of K. Nema *et al.* (2025), who reported a connection between levels of physical condition and performance of young athletes. This study additionally explains that the coordination component is an important factor in the effectiveness of other physical qualities. Prioritised development of coordination abilities leads to more rational formation of technical movements and reduced unnecessary energy costs. This also creates prerequisites for more effective development of grip strength and endurance because their realisation is also based on previously formed coordination abilities.

The results additionally indicate that at the initial stage, technical preparation should be implemented based on rational use of biomechanical movement principles, which also corresponds to the conclusions of S. Dech & R. Kitel (2026), who systematised the biomechanical bases of climbing technique and noted the need to create an effective distribution of loads along body segments. Also, this study shows that forming a rational body position and its sequence contributes to economising the activity, which also corresponds to the authors' opinion about optimising

the kinematic parameters of movements. The use of climbing as a universal means of training results in the comprehensive development of physical qualities and techniques, which also corresponds with the conclusions of W. Deng & D. Ding (2023), who reported the results that climbing is an effective means of physical training for athletes of various disciplines. Training in sport climbing at the stage of initial training contributes to the simultaneous formation of key motor abilities of the body and the improvement of its functional capabilities. The study also points out that this approach increases the efficiency of forming technical movements through the combined integration of motor and physical components of activity. The results also indicate that the step-by-step increase in the level of complexity of training tasks is a prerequisite for the formation of technical mastery, which also corresponds to the conclusions of A. Blay *et al.* (2025), who noted the need to improve techniques as a result of progressive changes in the complexity of technical movements. This provides the stability and accuracy of movements in climbing practice. It is also important to unite the separate components of the training system as a whole into a unified framework that allows for a more efficient training process, which corresponds with the conclusions of G. Levernier & G. Laffaye (2021), who noted that for a more comprehensive study and development of the athletes' level of preparedness, it is necessary to implement a combined approach of training and testing. Such an approach is especially important at the initial stage of training, when the foundations for future athletic development are being laid. Therefore, the present study's outcomes not only validate the mentioned scientific approaches but also expand upon them, specifically concerning the early phases of sport climbing training, with a focus on movement biomechanics, the combined nature of training outcomes and stages of the technical preparation.

Conclusions

The results of the theoretical analysis show that the preparation of novice athletes for sport climbing consists of the joint development of physical qualities and techniques. The major blocks in its structure are the development of grip strength, coordination abilities, endurance and formation of basic technical skills. Grip strength is one of the main components, as it ensures support of the athlete's body in the ascent and the performance of motor skills with a static and dynamic muscle effort. Coordination abilities are a system-forming component; they determine the quality of movement technique, effectiveness and safety of the process of training. Their development establishes the foundation for efficient movement and reduced energy expenditure. Endurance is regarded as a complex quality that combines general and specific qualities through the progressive growth of physical activity. Technique preparation consists of the complex use of the physical qualities in the system of movements, and the acquisition of basic elements of climbing in a dynamic, progressive manner. The mentioned components are connected and interwoven with each other and provide mutual support. Their focused development lays the groundwork for the further improvement of sporting achievements.

Development of training components at the first stages of sport climbing training is implemented through the

systematic use of special methods that ensure the combined development of grip strength, coordination ability, endurance, and technique. The effectiveness of training at the first stages is ensured through the integrated use of exercises, their connection with each other, and a certain logic of training content. The characteristics of the above-mentioned methods are their variability, progressive training tasks and adaptation to the individual characteristics of athletes. Grip strength is developed through exercises in hanging and static holding, in which variation of exercise conditions is used, thus strengthening the muscles of the athlete and developing coordination abilities. Basic training method to develop the technical skills and physical qualities is climbing along routes of low difficulty. Variation in execution conditions contributes to the development of movement accuracy and adaptive capacity. Methods to develop balance and coordination are performed to improve equilibrium and orientation in space, and efficient movement.

Based on the results of the theoretical analysis, a structural and logical model of the initial stages of preparation for sport climbing was developed, which shows the interconnection of the main blocks of preparation. On the theoretical basis of a systemic approach, the unity of technical and physical preparation is assumed, where physical qualities are the foundation, and technique training is the connecting element. In this model, the priority is given to coordination, which ensures the effective technique of movement and adaptation to the conditions of climbing. It is considered that the development of coordination is the most important condition for effective grip strength and endurance training, as well as technical preparation. The model is based on the principles of progression and variability, which provide for a step-by-step change of the tasks and adaptation of the load to the characteristics of athletes. A key condition of the formation of motor actions is the sequential process from simple techniques to complex ones. The proposed model includes the training tasks, physical qualities, types of exercises, motor techniques and load management. All the elements of the structure, in one way or another, play a special role and are oriented towards the achievement of the initial level of training readiness. The interrelationship of structural and logical model components creates an integrated process. Implementation of the model leads to the effective training of the necessary motor skills and basic physical qualities, and provides for a lack of overload in training. It has been established that a close functional relationship exists between physical qualities and technical preparation in novice athletes. In the future, there is a perspective to study the effectiveness of the proposed model in the course of the experimental study, to improve the methodology of training coordination, grip strength and endurance of novice athletes.

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Conflict of Interest

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Особливості етапу початкової підготовки спортсменів у спортивному скелелазінні

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Анотація. Мета дослідження полягала в теоретичному обґрунтуванні особливостей фізичної та технічної підготовки спортсменів на початковому етапі тренувального процесу у спортивному скелелазінні. Дослідження виконано в межах теоретико-методичного підходу із застосуванням теоретичного аналізу наукових джерел та логіко-структурного моделювання. Результати дослідження засвідчили, що підготовка спортсменів-початківців має комплексний характер і базується на інтеграції фізичних якостей та технічних умінь, серед яких визначальними постає сила хвата, координаційні здібності та витривалість. Встановлено, що сила хвата забезпечує можливість утримання положень і виконання переходів, а її розвиток потребує поступовості та врахування індивідуальних можливостей спортсменів. Визначено, що координаційні здібності виконують системоутворюючу функцію, оскільки саме вони забезпечують ефективність засвоєння технічних елементів, точність рухів і адаптацію до умов траси. Узагальнення наукових джерел дозволило визначити ефективні засоби підготовки, зокрема вправи на висах і утриманнях, лазіння по простих трасах, балансувальні та координаційні вправи, а також тривалі й інтервальні навантаження адаптивного характеру. Обґрунтовано, що ефективність підготовки має забезпечуватися інтегрованим використанням зазначених засобів, варіативністю умов виконання та поступовим ускладненням рухових завдань. Розроблена структурно-логічна модель відобразила взаємозв'язок між фізичними якостями та технічною підготовкою, визначила пріоритетність розвитку координаційних здібностей і передбачала поетапне формування рухових дій. Встановлено, що раціональне дозування навантаження сприятиме безпечному розвитку спортсменів і запобіганню перевантаження. Практичне значення дослідження полягає у можливості застосування його результатів тренерами зі спортивного скелелазіння, викладачами фізичної культури та фахівцями дитячо-юнацьких спортивних шкіл для оптимізації тренувального процесу та забезпечення безпечного розвитку фізичних і технічних якостей

Ключові слова: фізичні якості; сила хвата; витривалість; тренувальний процес; ефективність засвоєння технічних дій