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Formation of wheelchair handling technique in players with disabilities by means of preparatory exercises

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation.

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Abstract

Background and Study Aim. Wheelchair basketball is a leading tool for promoting social rehabilitation and integration for individuals with disabilities. This sport is characterized by high intensity and frequent changes in direction, requiring players not only to develop physical fitness but also to master specific technical skills for effectively handling a sports wheelchair during gameplay. The purpose of the study: to investigate the dynamics of basketball wheelchair handling skills under the influence of a set of preparatory exercises.

Material and methods. Fourteen athletes representing various functional classes participated in the study on a voluntary basis and in accordance with the ethical principles of the Declaration of Helsinki. A proprietary set of preparatory exercises was applied three times a week for eight weeks as part of a dedicated warm-up during the preparatory phase of the training session. The exercises were structured to gradually increase in difficulty, avoiding overload and adapting the load to the athletes' fitness level.

Results. Changes in the T-test results over the course of the study indicate a statistically significant difference ($t=2,63$; $p<0,05$). Despite the relatively small improvement in the average time to complete the control exercise (from 25,16 s to 25,09 s), statistical significance indicates that the changes reflect a stable positive effect of the proposed preparatory exercise program. At the same time, an increase in the standard error at the end of the study (from ±1,63 to ±1,69) indicates a variable impact of the proposed program on players of different functional classes, which requires further research.

Conclusions. The systematic use of preparatory exercises contributes to the development of wheelchair basketball technique, agility, movement precision, and functional autonomy in athletes. This approach not only improves performance but also reduces the risk of injury, enhances motivation, and expands opportunities for competitive participation. The acquired basic technical elements can be further integrated into ball-handling exercises, forming the foundation for comprehensive training programs for athletes of various functional classes.

Keywords: Adaptive sports, Paralympic sports, wheelchair basketball, technical training, functional mobility, training process.

Анотація

Формування техніки керування інвалідним візком у гравців з інвалідністю засобами підготовчих вправ

Передумови та мета дослідження. Баскетбол на кріслах колісних є одним із провідних засобів, який сприяє соціальній реабілітації та інтеграції осіб з інвалідністю. Характерними рисами цього виду спорту є висока інтенсивність та часті зміни напрямку руху, що вимагає від гравців не лише розвитку фізичних якостей, а і належного розвитку специфічних технічних навичок, які спрямовано на ефективне використання спортивного крісла колісного щодо виконання ігрових дій. Мета дослідження: дослідити динаміку рівня володіння баскетбольним кріслом колісним під впливом застосування комплексу підготовчих вправ.

Матеріал і методи. У дослідженні, яке проводилось на добровільних засадах відповідно до етичних принципів «Гельсінської Декларації», прийняли участь 14 спортсменів, що представляли різні функціональні класи. Авторський комплекс підготовчих вправ застосовувався протягом восьми тижнів тричі на тиждень

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у рамках спеціальної розминки в підготовчій частині тренувального заняття. Вправи були структуровані за принципом поступового ускладнення, що дозволяло уникати перевантаження та адаптувати навантаження відповідно до рівня підготовленості спортсменів.

Результати. Зміни результатів «Т-тесту» протягом дослідження свідчать про їх статистично достовірну різницю ($t = 2,63$; $p < 0,05$). Незважаючи на відносно невелике покращення середнього часу виконання контрольної вправи (з 25,16 с до 25,09 с), статистична значущість вказує на те, що зміни які відбулися відображають стабільний позитивний ефект запропонованого комплексу підвідних вправ. Водночас, збільшення стандартної похибки наприкінці дослідження (з ±1,63 до ±1,69) свідчить про варіативний вплив запропонованого комплексу на гравців різних функціональних класів, що потребує додаткових досліджень.

Висновки. Систематичне застосування підготовчих вправ сприяє формуванню техніки володіння баскетбольним кріслом колісним, розвитку маневреності, точності рухів та функціональної автономії спортсменів. Такий підхід не лише підвищує ефективність гри, але й знижує ризик травматизму, посилює мотивацію та розширює можливості участі у змагальній діяльності. Засвоєні базові елементи техніки можуть бути в подальшому інтегровані у вправи з м'ячем, що створює основу для комплексних програм підготовки спортсменів різних функціональних класів.

Ключові слова: адаптивний спорт, паралімійський спорт, баскетбол на кріслах колісних, технічна підготовка, функціональна мобільність, тренувальний процес.

Introduction

The popularity of wheelchair basketball worldwide makes it one of the leading means of social rehabilitation and The worldwide popularity of wheelchair basketball makes it one of the leading means of social rehabilitation and integration for individuals with disabilities related to musculoskeletal disorders [1]. High intensity, frequent changes in direction, accelerations and stops, and alternating aerobic and anaerobic loads are characteristic of this Paralympic sport [2].

A unique aspect of wheelchair basketball is that athletes compete while seated in specialized wheelchairs. This necessitates the development of specific technical skills [3]. As noted by Ferreira da Silva C.M.A. et al. [4] and Yüksel M.F. [5], an athlete's performance depends not only on their level of physical development (speed, strength, endurance, agility) but also on how proficiently the player handles a sports wheelchair to perform game actions such as pushing, turning, passing, dribbling, catching the ball, and shooting baskets.

According to scientific data, wheelchair mobility and interaction between players significantly impact game performance [6]. Ultimate success in competition depends on both the development of fundamental motor skills and the degree of mastery of specific wheelchair control skills, which are developed through targeted training [7].

It should be noted that considering the individual functional capabilities of each athlete is crucial in wheelchair basketball training [8, 9]. Our preliminary research has determined that differences in trunk control, strength, and coordination abilities require a differentiated approach to developing wheelchair technique, enabling the maximal realization of each player's motor potential [10].

The relevance of this topic stems from the need for scientifically based programs and training methods for athletes with musculoskeletal disorders that account for the specifics of wheelchair use as an integral element of basketball skill. The development and implementation of effective preparatory exercises aimed at enhancing players' technical preparedness is an important step toward improving the quality of the training process, athletic self-realization, and social integration of individuals with disabilities.

The purpose of the study was to investigate the dynamics of basketball wheelchair handling skills under the influence of a set of preparatory exercises.

Material and methods

Participants

Fourteen athletes participated in the study: five players from the Basketball Club of Wheelchair Disabled KHARKIV-BASKET and nine players from the Sports Club TITANY-LVIV. Five of these athletes represented the following functional classes: 1.0-1.5 - five; two in the 2.0-2.5 group two; in the 3.0-3.5 group; and five in the 4.0-4.5 group. The average age of the players was 37,8±11.0 years.

The study was conducted on a voluntary basis in accordance with the ethical principles of the Declaration of Helsinki, and the athletes provided verbal consent.

Procedure

To develop basketball wheelchair technique, a proprietary preparatory exercise routine was developed (Table 1). It was used during a dedicated warm-up in the preparatory portion of training sessions three times a week for eight weeks.

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The developed preparatory exercise routine is structured from simple to complex, avoiding overloading the players and adapting the load to their fitness level. The exercises promote precise force application, develop movement rhythm and braking skills, with special attention paid to hand coordination and core stabilization, the foundation for effective wheelchair use in gameplay. Combinations involving backward movements, direction changes, and turns simulate in-game maneuvers and prepare players for the rapid adjustments required during play.

To determine the dynamics of the development of basketball wheelchair technique, control measurements were carried out at the beginning and end of the study using the "T-test" (Figure 1) [11].

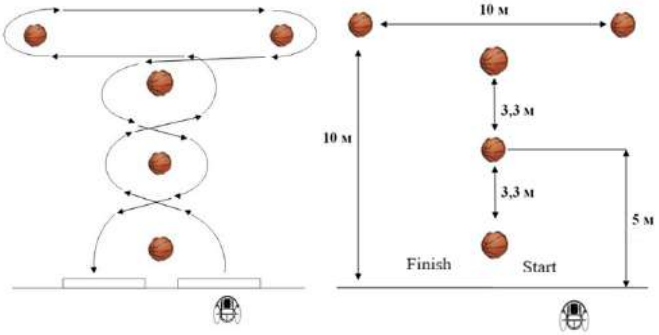

Figure 1. Graphical representation of the "T-test" to determine the level of technique in a basketball wheelchair.

Statistical analysis

Statistical data processing methods were used to process the research results using Micro-

Table 1. A set of preparatory exercises to develop the technique of using a basketball wheelchair.

№	Exercise name	Purpose	Implementation methodology
1	Push–Stop	Mastering Starting and Braking	One push forward with both hands, a stop with both hands
2	Two Pushes–Stop	Controlling Movement and Braking	Two pushes forward, a stop with both hands
3	Two Pushes–Stop–90°Left Turn–90°Right Turn	Mastering Turns from a Stop	After a stop, two turns alternately left and right
4	Two Pushes–Stop–90°Right Turn–90°Left Turn	Mastering Turns from a Stop	After a stop, two turns alternately right and left
5	Two Pushes–Stop–180°Left Turn–180°Right Turn	Mastering Sequential Turns	After a stop, two full turns left and right
6	Two Pushes–Stop–180°Right Turn–180°Left Turn	Mastering Sequential Turns	After a stop, two full turns right and left
7	Two Pushes–90°Left Turn–Stop–90°Right Turn	Combined actions based on turns with locking	While driving, turn left, then stop and turn right.
8	Two Pushes–90°Right Turn–Stop–90°Left Turn	Combined actions based on turns with locking	While driving, turn right, then stop and turn left.
9	Two Pushes–180°Left Turn–Stop–180°Right Turn	Symmetrical maneuvering with a complete change of direction	Turn when moving left, stop, opposite the turn
10	Two Pushes–180°Right Turn–Stop–180°Left Turn	Symmetrical maneuvering with a complete change of direction	Turn when moving to the right, stop, opposite the turn
11	Two Pushes–Stop–360°Left Turn	Dynamic turn with locking	Stop, then turn completely left in place.
12	Two Pushes–Stop–360°Right Turn	Dynamic rotation with fixation	Stop, then turn completely in place to the right
13	Three Pushes–360°Left Turn	Non-stop maneuverability	Three thrusts, then turn completely to the left without stopping
14	Three Pushes–360°Right Turn	Non-stop maneuverability	Three thrusts, then turn completely to the right without stopping
15	Two Pushes Forward–Stop–One Push Backward–Stop	Direction control	Two thrusts forward, stop, move backward, stop
16	Three Pushes Forward–Stop–One Push Backward–Stop	Rhythmic change in direction of movement	Three thrusts forward, stop, move backward, stop
17	Three Pushes Forward–Stop–One Push Backward–Stop–180°Left Turn–Stop–180°Right Turn	Combined mobility with inverse symmetry	Sequence of movements and turns with a stop
18	Three Pushes Forward–Stop–One Push Backward–Stop–180°Right Turn–Stop–180°Left Turn	Combined mobility with inverse symmetry	Sequence of movements and turns with a stop
19	Three Pushes Forward–Stop–One Push Backward–180°Left Turn–Stop–180°Right Turn	Variability of movement with continuous change of direction	Sequence of movements and turns without stopping when moving backward
20	Three Pushes Forward–Stop– One Push Backward–180°Right Turn–Stop–180°Left Turn	Variability of movement with continuous change of direction	Sequence of movements and turns without stopping when moving backward

soft Excel software, allowing for the monitoring of data dynamics and percentages. To compare the obtained test results, an even-numbered two-sample Student's t-test was used for means. When evaluating statistical hypotheses, a 5% probability level was used, ensuring the necessary accuracy in pedagogical research.

Results

Table 2 presents the results of the basketball wheelchair skill test. The primary evaluation metric is the time in seconds achieved by the players at the beginning and end of the study, as well as the percentage improvement in performance. Including players from all functional classes (1.0-4.5) ensures a representative sample for analyzing the effectiveness of the training interventions.

Thus, the performance gains for players in the 1.0-1.5 functional class ranged from -0,1% to +0,5%. These minimal changes indicate limited adaptability in this group of athletes due to their low physical capabilities related to the severity of their injury.

For players in the 2.0-2.5 functional class, performance remained more stable throughout the study, without significant improvement (from -0,3% to +0,1%).

For players in the 3.0-3.5 functional class, performance improvements ranged from +0.3% to +0.6%, demonstrating the positive impact of the proposed preparatory exercise program.

Players in the 4.0-4.5 functional class, with minimal functional impairments compared to other classes, showed the greatest improvement in performance (from +0,4% to +1,0%). However, one player experienced a slight decrease in performance by -0,2%.

Overall, most players showed positive changes, although the gains were small (0,1-1,0%). The greatest improvement was observed among athletes in the 4.5 functional class, demonstrating the high effectiveness of training programs in this category. Minimal or negative changes were typical for athletes in the lower classes (1.0-2.5), indicating the need for specialized training methods adapted to their physical capabilities.

Table 3 presents an analysis of the dynamics of wheelchair basketball technique for 14 players after the implementation of a set of preparatory exercises.

Table 2. Results of the T-test at the beginning and end of the study, (n=14)

№	Player Functional Class	Player's age	Test results, s		Increase in results, %
			to the study	after the study	
1	1.0	53	26,77	26,70	0,3
2	1.0	48	27,96	27,94	0,1
3	1.0	60	27,24	27,28	-0,1
4	1.5	35	25,40	25,27	0,5
5	2.0	30	25,57	25,59	-0,1
6	2.5	33	25,10	25,07	0,1
7	2.5	35	25,54	25,62	-0,3
8	3.0	34	24,25	24,11	0,6
9	3.5	31	26,02	25,95	0,3
10	4.0	26	25,17	25,08	0,4
11	4.5	50	22,45	22,29	0,7
12	4.5	42	22,35	22,13	1,0
13	4.5	25	23,61	23,45	0,7
14	4.5	27	24,79	24,84	-0,2

Table 3. Analysis of the dynamics of the level of technique in a basketball wheelchair, (n=14)

Testing	$\bar{x}$ ± m		t	p
	before the study, s	after the study, s		
T-test	25,16±1,63	25,09±1,69	2,63	<0,05

Notes: t_{cr} = 2,16 when p=0,05

Changes in the T-test results over the study indicate a statistically significant difference (t=2,63; p<0,05). Despite the relatively small improvement in the average time to complete the control exercise (from 25,16 s to 25,09 s), the statistical significance indicates that these changes reflect a stable positive effect of the proposed set of preparatory exercises. Simultaneously, the increase in standard error by the end of the study (from ±1,63 to ±1,69) indicates a variable impact of the proposed set on players of different functional classes, warranting further research.

Discussion

The purpose of the study was to determine the effectiveness of using a set of preparatory exercises during the preparatory portion of a training session as part of a specialized warm-up aimed at developing wheelchair basketball technique. It was hypothesized that the systematic use of such exercises would create favorable conditions for improving the training process, developing functional mobility, and enhancing the playing effectiveness of athletes with musculoskeletal disorders.

The results of our study complement the data of modern studies by Glattke K.E. et al. [12] and Haycraft J.A.Z. et al. [13] and confirm that trunk control is a determining factor in functional mobility in adaptive sports. Da Veeger T.T. et al. [14] and De Freitas G.R. et al. [15] emphasize the importance of balance and trunk control exercises for the development of players' agility and mobility. At the same time, the authors note that the ergonomic characteristics of a sports wheelchair (frame, wheels, backrest, anti-tip mechanism) have a significant impact on performance and should take into account the level of impairment of each player.

Our previous studies have proven that the ability to maintain balance in static and dynamic positions is a basic condition for mastering game technique and developing physical capabilities [16], and exercises for balance and stabilization of the torso contribute to the development of the ability to maintain an upright posture and coordinate movements, which is consistent with the conclusions of specialists who emphasize the role of coordination abilities in the technical training of athletes [17]. At the same time, it should be noted that the specific nature of wheelchair basketball requires the development of dexterous rotational movements to change direction [18].

It should be noted that improperly organized training can lead to the reinforcement of faulty techniques [19] and overuse and injury, particularly to the upper extremities [20]. Therefore, our study demonstrates that the use of preparatory exercises in the preparatory phase is crucial for developing correct motor patterns. Furthermore, they serve not only a training but also a preventative function, as they create optimal conditions for the gradual preparation of players, activating the neuromuscular system and preparing them for more complex technical actions. Their use should be considered a key component of a modern system for training wheelchair basketball players.

The analysis of scientific works determined that in addition to physical aspects, the psychological component is important, since participation in adaptive sports reduces the level of anxiety and depressive symptoms, forms motivation for classes [21], and athletes who play basketball in wheelchairs are mostly focused on completing training tasks, and not on external stimuli [22]. This emphasizes the importance of a properly organized training system that combines physical, technical and motivational factors.

The obtained results confirm that a set of preparatory exercises integrated into a specific warm-up has a positive effect on basic basketball skills [23]. This allows us to recommend the inclusion of a set of preparatory exercises in the training process as a mandatory element ensuring improved athletic performance and social integration of athletes with disabilities.

Conclusions

In the context of developing adaptive sports, particularly wheelchair basketball, mastering wheelchair control technique is especially important as a key component of game effectiveness. Maneuverability, precision, the ability to quickly change direction, and spatial control determine an athlete's performance and safety. For players with disabilities, developing wheelchair basketball control technique is not only a skill but also an element of functional autonomy.

Using a set of preparatory exercises in the training process allows for the gradual development of essential motor skills, tailoring the load to the athlete's individual capabilities, and ensuring steady technical improvement. This approach helps increase motivation, reduce injury risk, and expand opportunities for competitive participation.

Analysis of the study's results confirms that targeted training interventions improve the technical skill of wheelchair basketball players. Even minor, statistically confirmed improvements in the time to complete the control exercise highlight the importance of systematically using preparatory exercises to develop the technical skill of wheelchair basketball players.

The acquired basic elements of wheelchair basketball technique can later be integrated into ball-handling exercises (dribbling, passing, shooting) and used in developing targeted programs

and techniques for players of different functional classes. This ensures comprehensive development of game skills and the formation of a holistic athletic model corresponding to the specifics of wheelchair basketball.

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Supplementary Information

Article details

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Ethical statement
The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Participation in the research was voluntary. All athletes were informed about the purpose, procedures, and conditions of the study and provided informed consent prior to participation. All applied procedures were non-invasive and adapted to the functional capabilities of the participants, ensuring their safety and well-being throughout the study.

Conflict of interest
The authors declare no conflict of interest.

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