Influence of the functional class of Paralympic cross-country sit-skiers on the effectiveness of competitive activity (on the example of the sprint distance)

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Abstract

Purpose: to determine the value of the functional classification and its influence on the result of the competitive activity of Paralympic cross-country sit-skiers.

Material and methods: to solve the problems of the study, the data of 164 Paralympic cross-country sit-skiers were analyzed, including 98 men and 66 women, participants of the Winter Paralympic Games, namely: Sochi 2014 – 47 athletes (24 men and 25 women) PyeongChang 2018 – 61 men and 25 women), Beijing 2022 – 56 athletes (38 men and 18 women) with a functional class LW10-12 and are representatives of the sitting category, performing in the sprint ski race. During the study, the following methods were used: theoretical analysis of scientific and methodological literature and Internet sources, generalization of best practices, analysis of protocols and videos of competitive activity, methods of mathematical statistics.

Results: changes were revealed in relation to representatives of different classes in the final round of the sprint ski race among athletes of the sitting category: Sochi 2014: men – LW10 – 1 and LW12 – 5, women – LW11 – 2 and LW12 – 4; PyeongChang 2018: men – LW11.5 – 1 and LW12 – 5, women – LW11 – 1 and LW12 – 5; Beijing 2022: men LW10 – 2, LW11.5 – 1 and LW12, women – LW10 – 1, LW10.5 – 1, LW11.5 – 1 and LW12 – 3.

Conclusions: it has been proven that one of the topical issues in holding competitions among athletes with disabilities is the classification process aimed at fair competition between athletes, despite their individual functional capabilities; despite this, modern research proves that there are some factors that affect the result of competitive activity, but which are not taken into account by the classification system; the modern classification strategy is aimed at improving this process (percentage system), which helps to increase the competitiveness of representatives of all classes included in the sitting category.

Анотація

Максим Мішин, Людмила Павленко, Miroslawa Cieslicka, Олег Камаєв, Лариса Таран Вплив функціонального класу паралижників категорії сидячи на результативність змагальної діяльності (на прикладі спринтерської дистанції). Мета: визначити значення функціональної класифікації та її вплив на результат змагальної діяльності паралижників категорії сидячи. **Матеріал і методи:** для вирішення завдань дослідження було проаналізовано дані 164 паралижників, серед яких 98 чоловіків та 66 жінок, учасників зимових Паралімпійських ігор, а саме: Sochi 2014 – 47 атлетів (24 чоловік та 25 жінок) PyeongChang 2018 – 61 атлетів (36 чоловіки та 25 жінок), Beijing 2022 – 56 атлетів (38 чоловік та 18 жінок), що мають функціональний клас LW10-12 та є представниками категорії сидячи, які виступали в спринтерських лижних перегонах. Під час проведення дослідження застосовувались наступні методи: теоретичний аналіз науково-методичної літератури та джерел Інтернету, узагальнення передового досвіду, аналіз протоколів і відеозаписів

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змагальної діяльності, методи математичної статистики. **Результати:** виявлено зміни щодо представників різних класів у фінальному раунді спринтерських лижних перегонів серед спортсменів категорії сидячи: Sochi 2014: чоловіки – LW10 – 1 та LW12 – 5, жінки – LW11 – 2 та LW12 – 4; PyeongChang 2018: чоловіки – LW11.5 – 1 та LW12 – 5, жінки – LW11 – 1 та LW12 – 5; Beijing 2022: чоловіки LW10 – 2, LW11.5 – 1 та LW12, жінки – LW10 – 1, LW10.5 – 1, LW11.5 – 1 та LW12 – 3. **Висновки:** доведено, що одним із актуальних питань в проведені змагань серед спортсменів з інвалідністю є процес класифікації, що спрямовано на чесну та справедливу конкуренцію між атлетами, не зважаючи на їх індивідуальні функціональні можливості; попри це, сучасні дослідження доводять що існують деякі чинники, які впливають на результат змагальної діяльності, але які не враховує система класифікації; сучасну класифікаційну стратегію спрямовано на вдосконалення цього процесу (система відсотків), що сприяє підвищенню конкурентоспроможності представників всіх класів, які входять до категорії сидячи.

Introduction

Cross-country skiing as a sport has been part of the official program of the Paralympic Winter Games since the very first, held in 1976 in Ornskoldsvik, Sweden (Gastaldi et al, 2016). For competitions among athletes with disabilities, the rules for cross-country skiing were adapted taking into account their functional capabilities. That is why one of the features of the adapted rules is the use of a functional classification, which is a kind of guarantee of fair and fair competition in Paralympic sports and guarantees the competitiveness of an athlete in his starting group (Briskin et al, 2010, p. 48-49). The main task of the classification is to determine the compliance of the athlete's preserved motor abilities with the minimum criteria for admission to competitions and the distribution of athletes into starting groups for participation in competitions (David et al, 2021).

According to the Classification Code of the International Paralympic Committee (IPC), the classification requirements are the rules of the competition and must be strictly observed and have a great influence on the achievement of sporting results in Paralympic sports (Tweedy et al, 2014; Mishyn, 2017; Grashchenkova et al, 2018)

The distribution into functional classes in each sport is determined by a classification system based on the functional capabilities of athletes to perform the main tasks of competitive activity, which are taken into account regardless of their level of skills or preparedness. In Paralympic skiing, in order to increase competition, a handicap classification is used, which allows combining athletes of different functional classes within the same starting group and provides for assigning a coefficient to a certain functional class that affects the real result of athletes (Kohut et al, 2019, p. 11) . Therefore, in cross-country skiing, there are only three starting groups: competing athletes standing, sitting and athletes with visual impairments.

To implement equal competition between athletes, a certain system of percentages is maintained. These percentages are determined by the results of the World Cup competitions from previous years (Lajunen et al, 2020). The percentage system applied to paralyzers in the sitting category ranges from 86%, the most severe violations, to 100%, the minimum violations. Such a percentage system allows, based on the processing of the actual time, by multiplying by a certain percentage, to correct the finish time of each athlete and determine his overall place in relation to other athletes.

In this regard, the analysis of the classification criteria used in Paralympic cross-country skiing and their influence on the results of competitive activity are of particular relevance.

Material and Methods of the research

Participants: in order to solve the research problems, the results of Paralympic cross-country sit-skiers, who competed in the sprint at the Paralympic Winter Games Sochi 2014, were analyzed – 47 athletes, of which 24 were men: LW10 – 1; LW11 – 3; LW11.5 – 6; LW12 – 14 (www.paralympic.org/sochi-2014/results/cross-country/mens-1-km-sprint-sitting, 21.10.2022) and 23 women: LW10 – 2; LW10.5 – 4; LW11 – 7; LW11.5 – 2; LW12 – 8 (www.paralympic.org/sochi-2014/results/cross-country/womens-1-km-sprint-sitting, 21.10.2022); Paralympic Winter Games PyeongChang 2018 – 61 athletes, of which 36 men: LW10 – 3; LW10.5 – 3; LW11 – 5; LW11.5 – 5; LW12 – 20 (www.paralympic.org/pyeongchang-2018/results/cross-country/mens-11km-sprint-sitting, 21.10.2022) and 25 women: LW10 – 1; LW10.5 – 6; LW11 – 5; LW11.5 – 4; LW12 – 9 (www.paralympic.org/pyeongchang-2018/results/cross-country/womens-11km-sprint-sitting); Paralympic Winter Games Beijing 2022 – 56 athletes, of which 38 men: LW10 – 4; LW10.5 – 2; LW11 – 4; LW11.5 – 7; LW12 – 21 (www.paralympic.org/beijing-2022/results/cross-country/men-s-sprint-sitting, 21.10.2022) and 18 women: LW10 – 2; LW10.5 – 5; LW11 – 2; LW11.5 – 1; LW12 – 8 (www.paralympic.org/beijing-2022/results/cross-country/women-s-sprint-sitting). In total, the results of 164 Paralympic cross-country sit-skiers were analyzed, including 98 men and 66 women..

Methods

During the study, the following methods were used: theoretical analysis of scientific and methodological literature and Internet sources, generalization of best practices, analysis of protocols and videos of competitive activities, methods of mathematical statistics.

Procedure

The research was conducted in several stages. At the first stage, the analysis and generalization of the scientific and methodological literature was carried out, which made it possible to study the state of the problem under study. At the second stage, the protocols and videos of the Winter Paralympic Games were analyzed. At the third stage, a comparative analysis of the obtained data was carried out, the results obtained were summarized, and the conclusions of the study were drawn.

Statistical analysisin

To process the research data, the methods of mathematical statistics of the quantitative analysis of the results obtained were used. The results of the study were processed using the statistical package Excel 2016 (Microsoft, USA).

Results of the research

Data on the use of the percentage system at the Paralympic Winter Games over the past decade is presented in Table 1. An analysis of the classification system for Paralympic cross-country sit-skiers used at the Paralympic Winter Games revealed some changes in recent years. So, at Paralympic Winter Games PyeongChang 2018, compared to Sochi 2014, changes occurred in the LW11.5 class from 97% to 96%. But despite the decrease in the percentage in the competitive sprint discipline (distance length ≈ 1.1 km), the handicap of LW11.5

Application of handicap classification depending on the functional class of athletes of cross-country skiing men's and women's sprint – sitting

Functional class	Gender		Paralympic Winter Games		
			Sochi 2014	PyeongChang 2018	Beijing 2022
LW10	Men's	The current percentages, %	86	86	86
		Time handicap, s	0	0	0
	Women's	The current percentages, %	86	86	86
		Time handicap, s	0	0	0
LW10.5	Men's	The current percentages, %	90	90	87
		Time handicap, s	-	9	2
	Women's	The current percentages, %	90	90	87
		Time handicap, s	8	11	2
LW11	Men's	The current percentages, %	94	94	93
		Time handicap, s	12	18	12
	Women's	The current percentages, %	94	94	93
		Time handicap, s	15	21	14
LW11.5	Men's	The current percentages, %	97	96	96
		Time handicap, s	16	22	16
	Women's	The current percentages, %	97	96	96
		Time handicap, s	-	25	19
LW12	Men's	The current percentages, %	100	100	100
		Time handicap, s	20	29	22
	Women's	The current percentages, %	100	100	100
		Time handicap, s	25	34	26

The number of athletes cross-country skiing men's sprint – sitting

Paralympic Games	Round	Functional classified					Athletes
		LW 10	LW 10.5	LW 11	LW 11.5	LW 12	
Sochi 2014 Paralympic Winter Games	Qualification	1	-	3	6	14	24
	Semi-final	1	-	1	2	8	12
	Final	1	-	-	-	5	6
PyeongChang 2018 Paralympic Winter Games	Qualification	3	3	5	5	20	36
	Semi-final	2	1	1	2	6	12
	Final	-	-	-	1	5	6
Beijing 2022 Paralympic Winter Games	Qualification	4	2	4	7	21	38
	Semi-final	2	1	1	4	4	12
	Final	2	-	-	1	3	6

class athletes increased from 16 s to 22 s to LW10 (0 s) class athletes, who are considered to be the starting point, due to severe functionality impairments.

It is also worth noting that, despite the preservation of percentages in other classes at the Games in Sochi 2014 and PyeongChang 2018, there was an increase in the time handicap in relation to the athletes of the LW10 class. In LW10.5 women, the handicap increased by 3 s, from 8 to 11 s; in LW11 class women from 15 s to 21 s, in LW11 class men from 12 s to 18 s and LW 11.5 from 16 s to 22 s, which was 6 s. The time handicap changed the most in the LW12 class, both for men and women, by 9 s, from 20 s to 29 s and from 25 s to 34 s, respectively.

In comparing the Paralympic Winter Games PyeongChang 2018 and Beijing 2022, the percentage changes occurred in two classes at once: in LW10.5, it was reduced from 90% to 87%, which led to a minimum difference with the LW10 class and amounted to only 1%; in the LW11 class from 94% to 93%. It is these changes that have increased the chances of winning the LW10.5-11 class at the Beijing 2022 Games compared to previous ones. Paraathletes of the LW10.5 class received a significant advantage. Their time handicap was only +2 s over the LW10 class, while women's handicap at PyeongChang 2018 was +11 s, Sochi 2014 was +8 s, and men's at PyeongChang 2018 was +9 s. For LW11 athletes, the time handicap decreased by 6 s, from 18 s to 12 s, exactly the same as it was in Sochi 2014, and for LW11 athletes by 7 s, from 21 s to 14 s, which is also less by 1 s compared with Sochi 2014. At the same time, despite maintaining the percentage at 96%, representatives of the LW11.5 class received a temporary advantage of -6 s compared to previous games. So, for men, the handicap decreased from 22 s to 16 s, and for women from 25 s to 19 s. The same thing happened with the LW12 class athletes. For men, the time behind LW10 athletes decreased by 7 s compared to PyeongChang 2018, and amounted to 22 s, but this is 2 s more than Sochi 2014, and for women the lag was 26 s, which is 8 s less than the handicap 2018 and 1s more than in 2014.

Data on representatives of the functional classes LW10-12, who took part in the Paralympic Winter Games 2014-2022, are presented in Tables 2, 3.

Table 3

The number of athletes cross-country skiing women's sprint – sitting

Paralympic Games	Round	Functional classified					Athletes
		LW 10	LW 10.5	LW 11	LW 11.5	LW 12	
Sochi 2014 Paralympic Winter Games	Qualification	2	4	7	2	8	23
	Semi-final	1	1	4	-	6	12
	Final	-	-	2	-	4	6
PyeongChang 2018 Paralympic Winter Games	Qualification	1	6	5	4	9	25
	Semi-final	1	2	2	1	6	12
	Final	-	-	1	-	5	6
Beijing 2022 Paralympic Winter Games	Qualification	2	5	2	1	8	18
	Semi-final	1	4	2	1	4	12
	Final	1	1	-	1	3	6

Analyzing the Sochi 2014 data, it was found that in the sprint distance, which is held throughout the day and consists of 3 rounds: qualification – all Paralympic cross-country sit-skiers take part; semi-finals – athletes who, according to the results of the qualification, are in the top 12, perform; final – athletes who took 1-3 places in the semi-finals get into, among the athletes of the sitting category, 47 Paralympic cross-country sit-skiers took part.

Thus, among men, 24 athletes competed in the qualifying round, of which representatives of the LW10 class accounted for 4%, LW11 – 13%, LW11.5 – 25% and LW12 – 58%. There were no LW10.5 male athletes in Sochi 2014. According to the results of qualification in the next round of the competition, athletes were represented: LW10 – 8%, LW11 – 8%, LW11.5 – 17% and LW12 – 67%. It was found that according to the results of qualification in the semi-finals, the representation of athletes of the LW10 (8%) and LW12 (67%) classes increased, and at the same time, the representation of athletes of the LW11 (8%) and LW11.5 (17%) classes decreased. This trend was also revealed in the final, where, it is worth noting, only representatives of two classes took part: LW10 and LW12, the percentage of which was 17% and 83%, respectively. At the same time, the winners of the competition were: LW12 – I-II place, LW10 – III place.

When analyzing the ratio of the number of athletes in each round of the competition, it was determined that in men, 100% of the LW10 class athletes, 57% of the LW12 class and 33% of the LW11 and LW11.5 classes (Figure 1) got into the semifinals according to the qualification results.

From the semi-finals, only representatives of two classes LW10 – 100% and LW12 – 63% got to the final stage, and compared to the total number of athletes who took part in the qualification – 100% and 36%, respectively.

Among women of the category sitting at the sprint distance, 23 female Paralympic cross-country sit-skiers participated (Table 3). In qualification, unlike men, there were representatives of all classes: LW10 – 9%, LW10.5 – 17%, LW11 – 30%, LW11.5 – 9% and LW12 – 35%. Skiers of 4 classes entered the second round of the competition, who got into the top 12: LW10 – 8%, LW10.5 – 8%, LW11 – 34%, LW12 – 50%, and the representation of athletes in the LW11 and LW12 classes increased, and LW10 and LW10.5 decreased. In the final, as in men, there were representatives of only 2 classes LW11 (34%) and LW12 (66%). I and III places were won by representatives of the functional class LW12, the second place was taken by a female cross-country sit-skier LW11.

As for the representation of athletes of different classes in competitive rounds, a somewhat similar situation was found here, as in men. Thus, representatives of four classes got into the top 12: LW10 – 50%, LW10.5 – 25%, LW11 – 57% and LW12 – 75%, of which only athletes of two classes got into the top 6: LW11 – 50% and LW12 – 67 %, which of the total number of female cross-country sit-skiers of these classes amounted to 29% and 50%, respectively (Figure 2).

The dominance of higher functional classes was also revealed at the next Paralympic Winter Games PyeongChang 2018. So, in men, 36 athletes took part in the qualifying round of the competition, including representatives of the functional class LW10 and LW10.5 – 8%, LW11 and LW11.5, LW12 – 56% (Table 2). Athletes of all classes got into the semi-finals, and among the top 12 there were 8% of cross-country sit-skiers athletes of the LW10.5 and LW11 classes, 17% of the LW10 and LW11.5 classes each, 50% were athletes of the LW12 class, the percentage of which increased to 83% in the final. the rest were representatives of the LW11.5 class – 17%. It should be
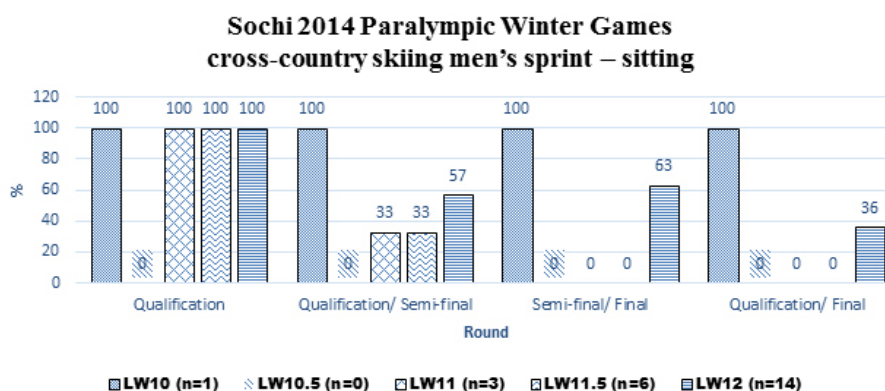

Fig. 1. Percentage of the number of men in each round of the sprint competition at the Paralympic Winter Games Sochi 2014
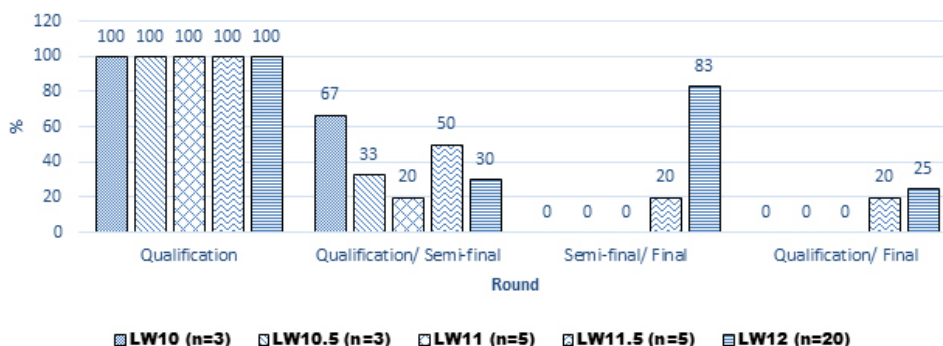
Fig. 2. Percentage of women in each round of the sprint competition at the Paralympic Winter Games Sochi 2014

Fig. 3. Percentage of men in each round of sprint competition at Paralympic Winter Games PyeongChang 2018
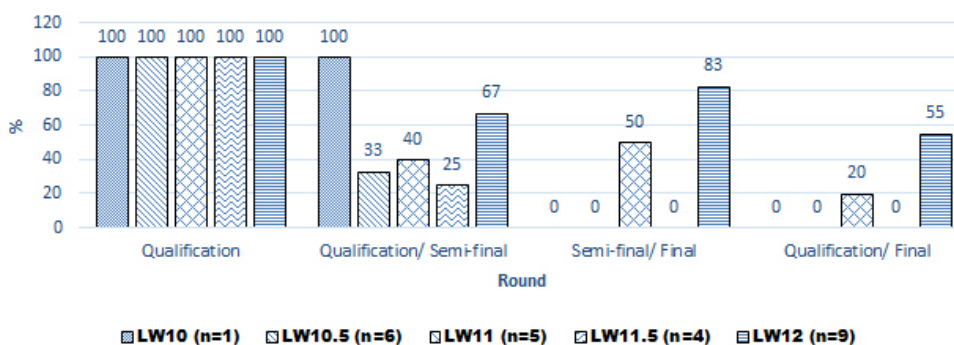

Fig. 4. Percentage of women in each round of sprint competition at Paralympic Winter Games PyeongChang 2018

noted that all prize-winning places were won by athletes of the LW12 class.

Analysis of the percentage of representatives of the same class in the competitive rounds showed that 20% of the representatives of the LW11 class, 30% of the LW12 class athletes, 33% of the LW10.5 class, 50% of the LW11.5 class, 67% of the LW10 class got into the semifinals (Figure 3).

But in the final, as in previous games, there were representatives of only two functional classes. So, 20% of LW11.5 class athletes and 83% of LW12 class athletes got into the top 6 cross-country sit-skiers athletes from the representatives of the

semifinals. As for the representatives of these two classes, out of the total number of athletes participating in the Paralympic Winter Games PyeongChang 2018, 20% of the LW11.5 class athletes remained, and 25% of the LW12 class.

Analysis of data from the 2018 women's PyeongChang sprint cross-country skiing showed a similar pattern for men. According to the qualifying competitions, in which 25 athletes took part: LW10 – 1, LW10.5 – 6, LW11 – 5, LW11.5 – 4, LW12 – 9, which amounted to 4%, 24%, 20%, 16% and 36%, representatives of all functional classes got into the semifinals, the percentage representation of which was: LW10 – 8%,

LW10.5 – 17%, LW11 – 17%, LW11.5 – 8% and LW12 – 50%. According to the results of the semi-finals, only the representatives of LW11 – 17% and LW12 – 83% got to the final (table 3). As in the previous Paralympic Winter Games, I and III places were won by cross-country female sit-skiers of the functional class LW12, the second place was taken by a representative of the LW11 class.

Data on the transition of representatives of each functional class to the next round of the competition is presented in Figure 4.

So, according to the results of the qualification, 100% of LW10 class female athletes, 67% of LW12 class, 40% of LW11 class, 33% of LW10.5 class representatives and 25% of LW11.5 class representatives went to the semifinals. At the same time, according to the results of the semi-finals, only the female athletes of two classes, namely 83% of the LW12 class cross-country female sit-skiers and 50% of the LW11 class, made it to the final. As for the percentage representation of female athletes from the total number of them in the qualification, in the final it was equal to LW11 – 20%, and in the LW12 class – 55%.

At the Paralympic Winter Games Beijing 2022, 38 athletes took part in the sprint distance (Table 2). In the qualifying competitions among men, representatives of the functional classes were represented as follows: LW10 – 11%, LW10.5 – 5%, LW11 – 11%, LW11.5 – 18% and LW12 – 55%. Among the 12 athletes who made it to the semi-finals, representatives of all classes were also identified, namely: LW10 – 18%, LW10.5 – 8%, LW11 – 8%, LW11.5 – 33% and LW12 – 33%. Compared to Paralympic Winter Games Sochi 2014 and PyeongChang

2018, representatives of three classes got into the main final of the competition: 17% – LW11.5, 33% – LW10, 50% – LW12. But it is worth noting that, despite the fact that representatives of the LW12 class made up half of the finals, they all ended up outside the top three. The 1st and 2nd places were won by representatives of the LW10 functional class, the bronze medalist of the Games was the LW11.5 class cross-country sit-skier.

According to the analysis of representatives of different classes in the final rounds of the competition, it was determined that 57% of the LW11.5 class athletes, 50% of the LW10 and LW10.5 class athletes, 29% of the LW11 class and 19% of the LW12 class got into the semifinals (Figure 5).

Among these cross-country sit-skiers, 100% of LW10, 75% of LW12 and 25% of LW11.5 qualified for the finals. As for the representatives of functional classes from the total number of athletes who took part in the competition, 50% of the athletes of the LW10 class and 14% of the LW11.5 and LW12 classes made it to the final.

18 female cross-country sit-skiers took part in the women's competitions at the Paralympic Winter Games Beijing 2022 (Table 3). 11% of the LW10 class, 28% of the LW10.5 class, 11% of the LW11 class, 6% of the LW11.5 class and 44% of the LW12 class were represented in the qualification. According to the results of the qualifying competitions, athletes of all functional classes made it to the semi-finals and were represented by the following composition: 9% of the athletes of the LW10 and LW11.5 classes, 33% of the LW10.5 and LW12 classes and 16% of the LW11 class. Female cross-country sit-skiers of 4 functional classes reached the final: LW10, 10.5, 11.5 and 12,

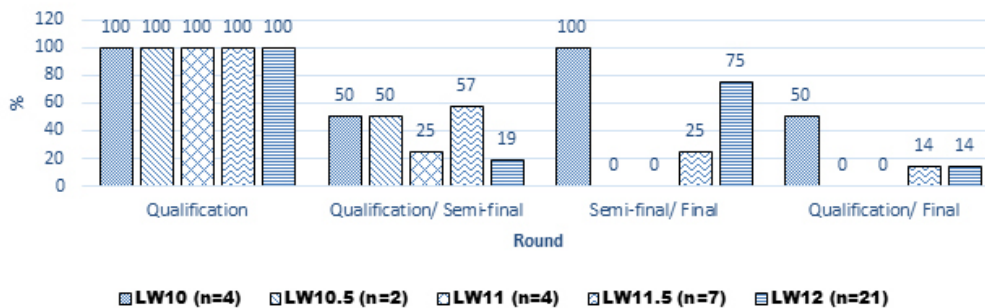**Fig. 5.** Percentage of men in each round of the sprint competition at the Paralympic Winter Games Beijing 2022
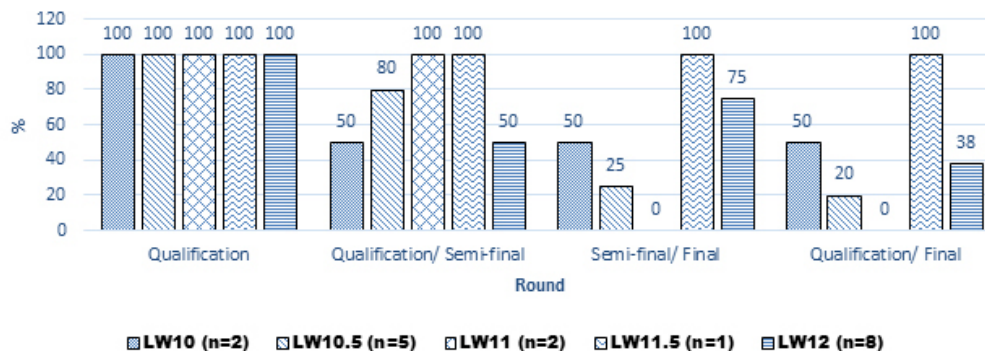

Fig. 6. Percentage of women in each round of the sprint competition at the Paralympic Winter Games Beijing 2022

but the representation of athletes in the LW12 class was 50%. It should be noted that the 1st place was won by an female athlete of the LW10 class, the 2nd place was taken by a representative of the LW12 class, and the 3rd place was taken by an female athlete of the LW10.5 class.

Considering the percentage of athletes who made it to the semi-finals, 50% of the athletes of the functional class LW10 and LW12, 80% of the athletes of the LW10.5 class and 100% of the representatives of the LW11 and LW11.5 classes were determined (Figure 6).

25% of LW10.5 class, 50% of LW10 class, 75% of LW12 class and 100% of LW11.5 class from the semi-finals competed in the final. Of the total number of female athletes who took part in the Paralympic Winter Games Beijing 2022 Cross-country skiing women's sprint – sitting, 20% of the female athletes of the functional class LW10.5, 38% of the functional class LW12, 50% of the female athletes of the LW11.5 class reached the final.

Discussion

This study was aimed at determining the influence of the functional class on the effectiveness of the competitive activity of athletes united in the sitting category, and the objectivity of the classification process at the present stage of development of the Paralympic ski race.

An analysis of modern scientific sources has determined that today, for athletes with disabilities, the problem of classification remains one of the most important and rather ambiguous. Classifiers face difficulties in classifying athletes with several hundred different types and degrees of disability, and sometimes reducing or exaggerating the degree of existing disability during the classification procedure. Despite the evolution of Paralympic Classification systems from early systems based on medical indications to systems currently in use, the classification process has faced objections and protests from both athletes and coaches. Experts note the need for a classification system for specific sports, and the methods used in them must be supported by scientific data developed on the basis of interdisciplinary scientific research, that is, based on evidence and evidence-based data focused on the relationship between the functional impairment of athletes and key factors determining sports results (Connick et al, 2018; Pastor et al, 2019).

Questions about the perfection of the classification process also arise in Paralympic cross-country skiing. The modern classification system distributes athletes included in the sitting category into 5 classes: LW10, LW10.5, LW11, LW11.5, LW12, with lower limb dysfunction, but different ranges of capabilities associated with trunk control (Gastaldi et al, 2016). It was to test the ability to hold the body that the Test-Table-Test was developed. This is a functional test, which is performed in a sitting position and consists of four tasks: 1) torso tilt forward by 45°; 2) torso tilt back by 45°; 3) lifting the ball over your head; 4) the maximum rotation of the body to the right-left, the results of which determine the class among athletes of the sitting category (Pernot, 2012). However, modern researchers draw attention to an additional disadvantage of the classification process, which is associated with the posture in which the athlete sits. Experts identify four sitting postures «normal», «long sit», «kneeing», and «knee-high» (Rapp et al, 2016). Although trunk stability can be improved by strengthening the trunk muscles, athletes with a severe impairment, such as those in the LW10 class, cannot improve balance control while sitting. To overcome weakened muscle control and improve trunk stability,

they adopt a sitting position with knees higher than the hips – «knee-high», which allows for low amplitude and limited trunk movement. In contrast, the «kneeing» position, with the hips above the knees, is commonly used by athletes with good torso control to take advantage of increased torso ranges and control of force direction (Gastaldi et al, 2012; Rosso et al, 2019; Ohlsson et al, 2022). The use of the «knee-high» position by the LW10 class athletes puts them in unequal conditions with the LW12 class, who use the «kneeing» position, which has a performance of 15% or more, and according to the classification system, the percentage of LW12 class athletes is 100%, and LW10 class – 86%, i.e., the difference is 14% (Lajunen, 2020). This is also confirmed by our research. So, according to the results of athletes in the sprint distance at Paralympic Winter Games Sochi 2014 and PyeongChang 2018, among 6 winners in men, 5 were representatives of the LW12 class, and in women 4 representatives of the LW12 class and 2 – LW11.

However, the IPC continuously pursues a classification strategy that promotes fair competition through a clear, transparent and fair sport functional classification process and contributes to the sporting achievement of Paralympic athletes (IPC Athlete Classification Code, 2015). The results of this strategy are that the dominance of LW12 athletes has changed at the Paralympic Winter Games Beijing 2022. So, in the men's final there were 3 representatives of the LW12 class, but the winners were the athletes of the LW10 (2) and LW11.5 classes. For women, 3 representatives of the LW12 class were also represented in the final, but the female athlete of the LW10 class became the champion, representatives of the LW12 and LW10.5 classes, respectively, won II and III places.

In our opinion, we should also note other factors that may affect the results of the competition in different ways, but which are not currently taken into account by the classification system. Cross-country skiing is a sport with variable competition conditions (Taran, 2017). The defining characteristic of the competition is the variability of the profile of tracks and conditions, which puts forward specific requirements for competitive activity, and, consequently, for the preparedness of athletes (Platonov, 2020, p. 19). Athletes of heavier classes (LW10-10.5) are very sensitive to the presence of large elevation changes and the presence of protracted slides on the track, which affects the performance of even the most successful athletes (Bernardi et al, 2012). At the same time, excessive stress experienced by athletes increases the risk of shoulder injury due to subacromial oppression (Sasadai et al, 2022). It should be noted that on the basis of many years of experience, in addition to complex relief segments, it is possible to determine some more factors that affect the final result of competitive activity, such as snowfall, wind, low temperature (Kamaev et al, 2020; Pavlenko et al, 2021). But we clearly understand that it is very, very difficult to take into account these factors in the qualification process. Most participants in the Paralympic competitions believe that no classification system can be perfect, it needs to be understood the basic provisions on which it is based.

Conclusions

The conducted research proved that one of the topical modern issues in holding competitions among athletes with disabilities is the classification process aimed at building fair and fair competition between athletes, despite their individual functional capabilities. The improvement of the classification system is influenced by the IPC improvement strategy and research focused on the relationship between athlete functional

impairment and key determinants of athletic performance.

The main provision of the system of classification of Paralympic cross-country sit-skiers is the stability of the torso. Determining the range of body control possibilities refers the athlete to one of the functional classes: LW10, LW10.5, LW11, LW11.5, LW12. Despite this, modern research proves that there are some factors that affect the result of competitive activity, but which are not taken into account by the classification system.

Data analysis of Paralympic Winter Games Sochi 2014, PyeongChang 2018, Beijing 2022 determined the change in the percentage system in classes LW11.5 from 97% to 96% (2018), LW10.5 from 90% to 87%, LW11 from 94% to 93% (2022), which contributed to an increase in the competitiveness of representatives of these classes.

Analysis of the results of cross-country sit-skiers in the sprint at the Paralympic Winter Games revealed changes in the attitude of representatives of different classes in the final rounds of the competition. So, in Sochi 2014 among men in the finals, classes LW10 – 1 and LW12 – 5 were represented, which amounted to 100% and 36%, respectively, of the total number of athletes in these classes, and for women LW11 – 2 (29%) and LW12 – 4 (50%). In PyeongChang 2018, in the final among men, the classes LW11.5 – 1 (20%) and LW12 – 5 (25%) were represented, among women – LW11 – 1 (20%) and LW12 – 5 (55%). In Beijing 2022, in the final among men, the classes LW10 – 2 (50%), LW11.5 – 1 (14%) and LW12 – 3 (14%) were represented, among women – LW10 – 1 (50%), LW10.5 – 1 (20%), LW11.5 – 1 (100%) and LW12 – 3 (38%).

Author Contributions

Maksym Mishyn – study design/planning, statistical analysis, manuscript preparation;

Liudmyla Pavlenko – data collection, data analysis, data interpretation, fundraising;

Oleg Kamaiev – data analysis, data interpretation;

Larysa Taran - data entry, analysis/literature search.

Conflicts of Interest

The authors declare no conflict of interest.

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