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Combining Wheelchair Table Tennis Classes 4 and 5: A Performance-Based Perspective on Classification

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Abstract

The debate surrounding the amalgamation of wheelchair table tennis classes 4 and 5 has persisted for two decades, yet it remains clouded by a dearth of scientific evidence. This paper aims to address this gap by conducting a review of existing literature and scrutinizing global player rankings within wheelchair classes, specifically through the performance perspective. While conventional wisdom suggests a positive correlation between higher wheelchair classes and enhanced table tennis proficiency, current world rankings present a counterintuitive scenario. Surprisingly, athletes in class 4 demonstrate performance levels comparable to, if not exceeding, their counterparts in class 5. Notably, within the top 10, 20, and 50 rankings, the representation of both male and female players in class 4 surpasses that of class 5. These empirical insights prompt consideration for the consolidation of classes 4 and 5 into a unified class 4. However, such a merger necessitates meticulous adjustments to criteria, including the establishment of minimum impairment thresholds and the refinement of the boundary between classes 3 and 4. To ensure the ongoing fairness and integrity of competition, it is imperative that further research be conducted on this contentious issue.

Keywords: Wheelchair table tennis; Classification; Performance; Fairness

Introduction

In the current world, many people with physical impairments (PI) enjoy playing table tennis (TT) for fun, health, recreation, or competition. TT has been widely used for rehabilitation, recreation, social integration, exercise, or competition for people with PI since the 1950s. At the 2020 Tokyo Paralympic Games, para table tennis (PTT) ranked in the top 3 in the number of participating players and in the top 4 in medal counts. However, evidence-based classification (EBC) for eligible wheelchair TT players and objective testing with technological support during classification have never been examined properly [1]. In the 2021 international VISTA conference organized by the International Paralympic Committee (IPC), urgent requests for EBC and practices were made, and the core concept of scientific evidence was promoted for future sport-specific classification [2]. Principally, classification in disability sports means that athletes with similar impairments, severities, and functions should compete with each other [3]. Classification in para sports is essential and cannot be avoided for the fairness of competition. Since the Paralympic Games began internationally in 1960, classification has been recognized as one of the most important aspects: without solid classification processes and outcomes, fair competition in the Paralympic Games is not possible [4-6].

The current TT classification system for wheelchair players has never been examined in depth, although the system has combined the medical and functional approaches [5]. However, EBC has been mentioned by the IPC for several years, but the progression has been slow. Only limited examinations on a few sports have been published, such as in wheelchair basketball, wheelchair rugby, athletics, swimming, etc. Regarding the classification system for PTT players, fairness of competition and classification outcomes have never been mentioned in the recent 10 years [7]. On the other hand, the old medical-based classification system for standing TT players has been criticized through proof of performance analysis [8]. In 2002, the functional approach was used to revise the old

system, based on considering the TT-specific functions of PTT players instead of traditional medical diagnosis and impairments. The functional-based classification system for PTT was quite successful based on empirical studies conducted at the 2004 Paralympic Games and 2006 World PTT Championships. Even though the functional approach was accepted by most coaches and players, objective measurements on players' functions and abilities related to TT skills and performances have never been mentioned until 2016 [7]. Although TT-related functions and 3S principles are the main framework for fair classification among different classes of players with PI, few empirical examinations have been reported [9], and so EBC in PTT was almost nonexistent. Wu and colleagues compared the players in classes 4 and 5 regarding their hitting abilities. In their findings, the successful hitting percentage of elite players in classes 4 and 5 was not significantly different [9]. However, the study design was too simple, and thus the basic ability of players may not have been measured properly, even though players in class 4 had less trunk functions compared with class 5 players. Similar findings also appeared in the wheelchair racing classification study [10]. They found that international wheelchair racers with partial trunk functions or with normal trunk did not show a significant difference in acceleration and racing time. Thus, the reduction in wheelchair TT classes should be considered carefully, just based on the limited evidence. In this study, the functional and performance perspectives were used to discuss the issue of combination of wheelchair TT classes to maintain fairness and enhance the level of competition.

Evidenced-Based Classification in PTT

Research on wheelchair TT and classification has been limited. Most studies have examined the fairness of wheelchair classification through the performance perspective. Recently, technology and sports science applied in many elite able-bodied sports have become popular [2]. No studies have been applied in PTT and its classification, except the first preliminary study conducted by Wu and his colleagues [6,11]. They used the intelligent TT racket (ITTR) to quantify the speed, acceleration, and X-Y-Z axes of swing patterns of the forehand stroke for the able-bodied players and to reveal the potential to evaluate the TT skills and abilities between elite and amateur able-bodied players. Theoretically, the ITTR can be considered as the possible technological approach to distinguish skillful abilities and functions among different classes. Wu and colleagues used the ITTR to evaluate a few elite PTT players to prove its effectiveness and differentiate the functional TT abilities in different classes of players [11]. Based on the preliminary data and case studies, they proposed that elite wheelchair players in classes 4 and 5 did not appear to show significant differences in terms of the swing pattern and efficiency [12]. This indicates the possible direction of combining classes 4 and 5 because they may have similar TT-related abilities.

Although no further study has applied the ITTR in wheelchair players, we know that the higher the wheelchair classes, the better the functional abilities, especially in TT-related skills such as forehand swing and smash. The main characteristics of wheelchair players in classes 1 to 5 have been summarized in Table 1 [13]. However, no empirical and scientific studies have proved the relationships between classes and functions in PTT. In disability swimming, wheelchair racing, wheelchair basketball, wheelchair rugby, this kind of data analysis has proven that the higher the classes, the better the performances in specific sports [10,14-17,19]. Thus, we believe that if the sport-specific classification is fair, the classification outcomes should reveal the theoretical assumptions through proper measurements of functions and abilities of players with PI (Table 1).

Table 1: Main Characteristics of Wheelchair TT Players in Classes 1 to 5.

Class	Standard impairments	Functional abilities	3S principle
1	SCI C6 or comparable impairments	Poor control in playing arm and non-playing arm, no trunk function	Slow speed, poor spin, narrow spot
2	SCI C7 or comparable impairments	Reasonable control in playing arm and non-playing, no trunk function	Slow to moderate speed, poor spin, narrow spot
3	SCI C8-T8 or comparable impairments	Normal playing arm, no to poor trunk function, no dynamic trunk balance	Moderate speed, moderate spin, moderate spot
4	SCI T9-L1/2, double AK amputation, or comparable impairments	Normal playing arm, moderate trunk function, some dynamic trunk balance	Moderate to fast speed, good spin, moderate to wide spot
5	SCI L2/3-S1/2, single AK amputation, or comparable impairments	Normal playing arm, good to normal trunk function, good to normal dynamic trunk balance	Fast speed, good spin, wide spot

Note: SCI means spinal cord injury, AK amputation means above knee amputation.

Resources from the ITTF classification system [13] and classification seminar. The authors summarized the relevant contents. When Sheu et al. developed the ITTR with current technology, one inertial measurement unit (IMU) sensor was set on the inner handle space without significantly changing the weight of the ITTR. A force-sensitive resistor (FSR) sensor was embedded between the wood and plastic rubber of the racket to sense the position of the hitting point on the racket. The IMU sensor includes a 3-axis accelerometer, a 3-axis gyroscope, and a 3-axis magnetometer, which are MEMS (Micro Electro Mechanical

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Systems) sensors [18]. The IMU and FSR sensor data are gathered into a low power consumption microcomputer (Cortex-M3 series), and all data are sent to the computer by a high-speed 2.4G RF module (Taiwan patent I713890, 2020). ITTR has been proven to detect the posture of TT hitting movements [19]. The breakthrough TT equipment for able-bodied TT and PTT may enhance the levels of training and increase the precise measurements in players' performances. ITTR is recognized as a useful and objective tool for PTT classification. However, the related testing methods and database have never been developed, and the evaluation has been used for a few players with PI [11,12]. Nevertheless, this exploratory method connects technological support (i.e., ITTR) and sport science concepts (testing and measurements in PTT) for wheelchair players and classification, which is the appropriate direction for objective and longitudinal measurement.

In addition, during the classification processes in wheelchair classes, EBC is the core element. Classifiers need to conduct physical evaluations, technical evaluations related to TT skills, and observations during competition to confirm the class of a player. For most honest players, the above processes can provide the right and fair classes for them. However, how can the right procedures be introduced to avoid cheating or intentional misrepresentation (IM)? Also, how do classifiers more objectively classify borderline players to avoid making wrong decisions? These issues need to be identified clearly to maintain the fairness of competition [12]. Therefore, it is essential to develop valid testing methods with proper scientific equipment to measure sport-specific functions and abilities of players with PI in order to conduct EBC in PTT.

Performance Approach to Analyze the Wheelchair World Ranking

In the previous ITTF meeting, a few countries and many classifiers recognized the controversial issue: Does ITTF need 5 wheelchair classes instead of 4 classes? In Table 1, players in classes 1 and 2 show weaknesses in their playing and non-playing arms. Obviously, they are much weaker players in terms of the severity of PI. Players in classes 3 to 5 may have normal playing arms, but their main differences lie in trunk functions and reaching abilities during play. Limited trunk functions may affect their playing speed and the area covered in reaching, such as playing wide or short balls among classes 3, 4, and 5. If the classification is valid, players in different classes should demonstrate different abilities and skills. Thus, we may assume that players in class 5 should outperform those in class 4.

We used the current PTT ranking data in March 2024 to test a simple concept: the higher the wheelchair classes, the better the world ranking. Data retrieved from https:// www.ipttc.org/rating/2024-03-01/ To avoid biases, we only analyzed the numbers and percentage of wheelchair classes 1 to 5 in the world ranking's top 10, 20, 50, and 100. The summarized data for male and female wheelchair players are shown in Tables 2 and 3. After basic descriptive analysis, due to the limited number of female players, we focused on the analysis of elite wheelchair players in the top 20 and top 50 to observe general patterns of male and female players in classes 1 to 5 (Figures 1 and 2).

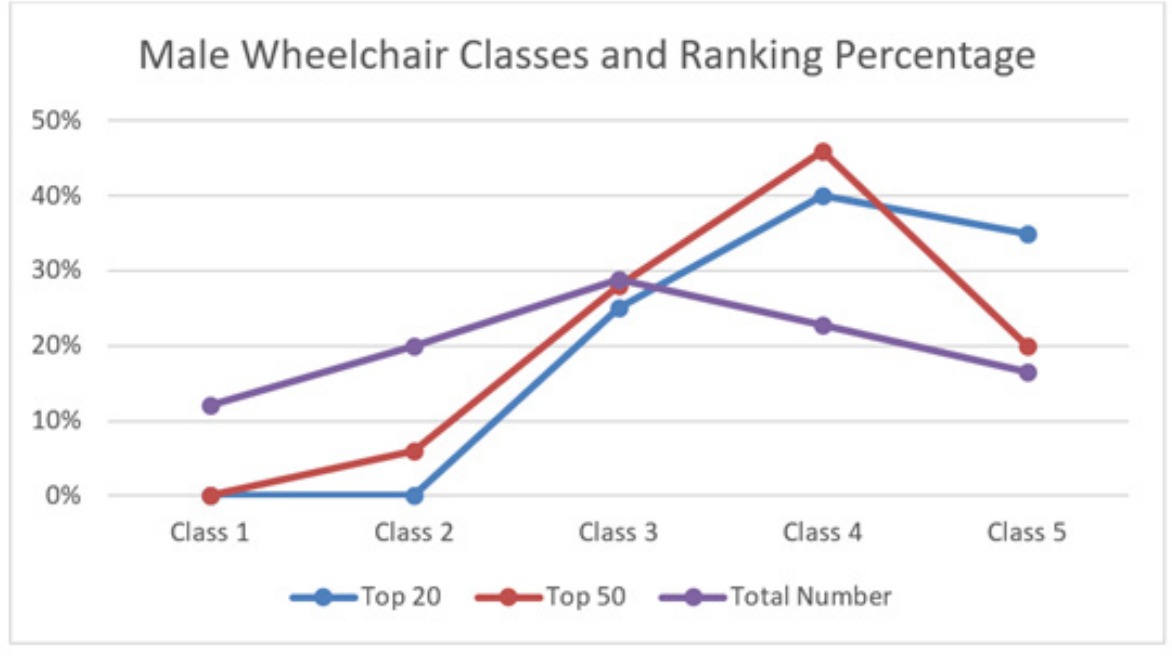

Figure 1: Percentage of Male Classes 1 to 5 in World Raking Top 20 and 50.

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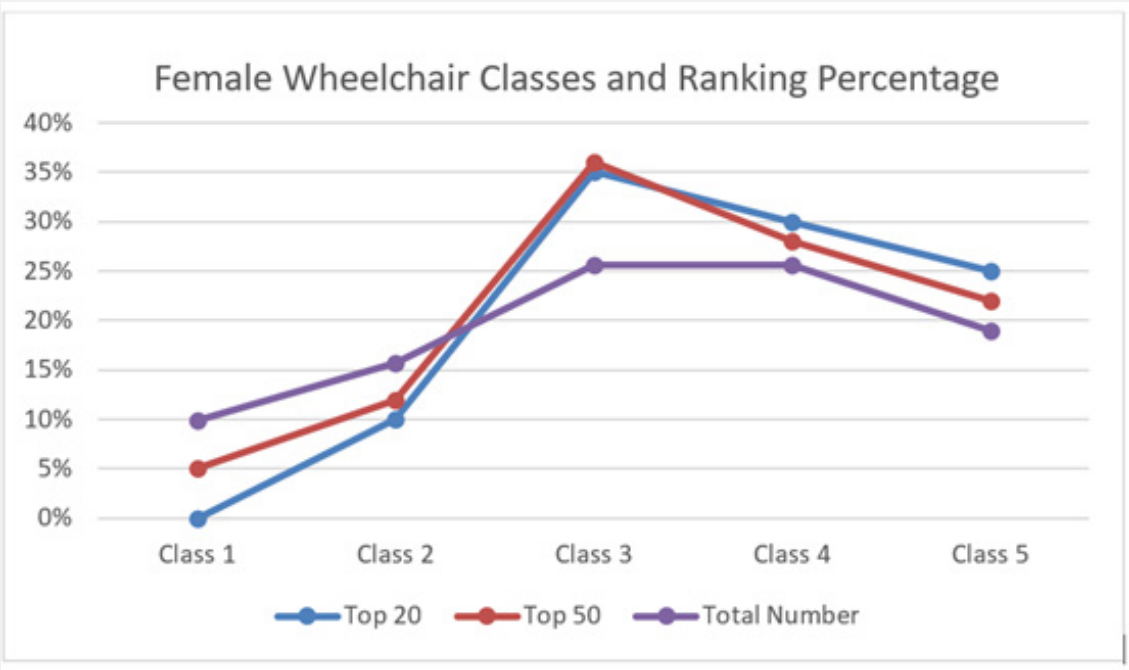

Figure 2: Percentage of Female Classes 1 to 5 in World Raking Top 20 and 50.

Based on Tables 2 and 3, as well as Figures 1 and 2, we found that male players in classes 4 and 5 had similar numbers in the top 20, but this pattern was not shown in female players. Among the top 50 male players, 23 players in class 4 outnumbered those in classes 3 and 5 which were only 14 and 10 respectively. Findings from the performance approach, it is possible to consider the combination of classes 4 and 5. However, the above patterns were not observed in female players, even though we understand that there are far fewer female players in wheelchair classes compared to male players. We did not find that female class 5 players performed better than class 4.

Table 2: Numbers from classes 1 to 5 in Male Wheelchair Players (N=316).

	Class 1	Class 2	Class 3	Class 4	Class 5
Top 10	0	0	3	5	2
Top 20	0	0	5	8	7
Top 50	0	3	14	23	10
Top 100	5	18	26	26	23
Total number	38	63	91	72	52

Table 3: Numbers from classes 1 to 5 in Female wheelchair players (N=121).

	Class 1	Class 2	Class 3	Class 4	Class 5
Top 10	0	0	3	5	2
Top 20	0	2	7	6	5
Top 50	1	6	18	14	11
Top 100	6	12	27	34	21
Total number	12	19	31	36	23

Estimation of Combination and Adjustment of Classes 4 and 5

Regarding the functional abilities and medical conditions, players in class 5 should perform better than those in class 4 and class 3 (Table 1), even though all of them have both normal playing and non-playing arms. However, this theoretical concept was not supported by the performance approach considering the analysis of the top world ranking. We did not find that players in class 5

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outperformed players in class 4. In this empirical data, players in class 4 achieved better ranking results in the top 10, 20, and 50 than players in class 5.

In actual practice, a few female players in class 4 would like to be in class 5 because they think it may be easier to win a medal in class 5. This is an unusual circumstance, but it occurs. When considering the combination of classes 4 and 5 and making a few adjustments to the criteria of these classes, this may be an essential process. Surely, objective criteria cannot be offered in this study. Further evidence is needed to clarify the revised criteria if the combination of classes 4 and 5 is considered. However, we may propose that the low abilities of players in class 4 should be checked as class 3, and the high abilities of players in class 5 should be evaluated to see if they fit the MIC. We estimate that 5% of players in the current class 4 may move to class 3, and 10% of players in the current class 5 may not be eligible to reach MIC for wheelchair classification. In this case, the estimated numbers of players in 4 classes may be reported in Table 4. However, this needs further evaluation and evidence to prove it.

Table 4: Estimation of Possible Numbers of Players in Wheelchair Classes.

	Class 1	Class 2	New Class 3	New Class 4
Male	38	63	95	115
Female	12	19	34	48

Note: 5% of current class 4 moves to class 3 and 10% of current class 5 is not eligible for wheelchair classification.

On the one hand, if a wheelchair class is reduced, the competition level in the new class 4 can be enhanced, and fairness can also be maintained by including eligible players in the ITTF classification system and excluding non-eligible players. ITTF may consider the testing findings and evidence in this study to develop the objective minimal impairment criteria (MIC) for wheelchair players in greater depth. On the other hand, the cancellation of two events in male and female singles may result in the reduction of 8 medals in those events. From a political perspective, most countries and players may not support it. Thus, experts in ITTF should consider available evidence to make a final decision.

Trunk functions significantly affect performances in several wheelchair sports, such as wheelchair basketball [16], wheelchair racing [10,17], wheelchair rugby [20], and wheelchair TT [9]. Researchers agree that precise measurements of trunk functions are difficult and inconsistent [20]. Currently, different para sports have their own specific trunk functional tests. For example, TT includes the observation of trunk forward/backward, rotation, and side bending movements. Three classes have been assigned for wheelchair TT players based on trunk-related functions (no balance, partial, and almost normal functions). However, no quantitative data have been recorded. On the other hand, wheelchair racing requires explosive power in acceleration. However, only two classes (no or limited trunk balance vs partial to normal trunk function) are assigned to athletes. The decision in wheelchair racing is more based on EBC and scientific evidence. Thus, trunk functional tests with unambiguous evidence are essentially needed for wheelchair TT because of their impact on three classes in PTT.

The other critical issue in wheelchair classes is the main minimal impairment criteria (MIC) for including players with PI. In the past 20 years, classifiers have found it difficult to evaluate players to define MIC objectively. More often than not, classifiers rely on their experience and subjective judgments to decide whether players may compete in wheelchair classes. The rationale behind these decisions may not be persuasive, leading to discussions and challenges to the credibility and validity of the wheelchair classification system by players and coaches. Through the use of the ITTR for measurement, we believe this is an objective way to identify players' functions and abilities. Generally, wheelchair players in higher classes should have better sport performances. In PTT, we may interpret this theoretical assumption more extensively: wheelchair players in class 5 should have stronger playing styles, strength, power, speed, reaching abilities, and tactics than players in class 4. If scientific data cannot identify the main differences in the above testing results, theoretically, it may be fair to combine those two classes and create a new class to increase competitiveness. From the classifiers' perspective, the clear dividing criteria for players in classes 4 and 5 are ambiguous because the borderline area between classes 4 and 5 is always in doubt. Practical ways to classify wheelchair players without arm problems can be more easily evaluated and classified. In addition, from coaches' and players' perspectives, what is the main difference between elite class 4 and class 5 players in terms of TT skills and functional abilities? Thus, researchers and classifiers need to find solutions to deal with the problems in the MIC in wheelchair players and also consider possible approaches to combine wheelchair classes fairly based on scientific evidence.

Conclusion

Based on the current evidence and performance perspectives on the issue of combining wheelchair classes 4 and 5, it is possible to support this direction. However, research on wheelchair TT is quite limited, and thus the significant discussion on the issue of combining or adjusting classes may not be conclusive. In particular, the new criteria for the new classes 3 and 4 need to be checked and evaluated carefully if the combination of classes 4 and 5 is

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approved by ITTF. The introduction of ITTR and measurement in PTT classification is urgently needed to have more objective data for analysis. This is an essential task in the evaluation process before a final decision is made to address the controversial issue.

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