



Analysis of the Table Tennis Specific Test in Classification for Players with an Intellectual Disability



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Abstract

Elite table tennis (TT) players with intellectual disabilities (ID) have been included at the Paralympic programs since 2012. However, no research study has examined the credibility of the current TT specific classification system for players with ID in order to maintain the fairness of competition. The purpose of this exploratory study was to analyze the performance of the TT-specific test for players with ID. Data of 87 international TT players with ID were collected at the major TT championships. Three parts of TT testing results (i.e., service, return service, and basic TT skills and control) in classification and training information of players were analyzed. Results showed that 73 players with ID were clearly classified as eligible players just through the TT-specific test using the cut-off points proposed in the current International Table Tennis Federation classification manual. Fourteen players needed to attend the advanced test in order to confirm their classification. However, 6 players were borderline and 2 players were not eligible after the confirmation of the advanced test and observation during competition. Based on the findings of this exploratory investigation, the current classification system for most players with ID was generally valid and effective because most players with ID can be clearly classified without difficulties. However, the TT-specific test may need to be fine-tuned in the future, especially in the slight adjustment of the cut-off points for borderline players. It is essential that the longitudinal monitoring for borderline TT players is needed and so the TT classification system for players with ID can be evaluated with more evidence-based support.

Keywords: Intellectual disability; Para table tennis; 3S & 3C principles; Evidence-based classification

Introduction

Table tennis (TT) is an interactive and popular sport in the world. Many people enjoy playing TT for fun, health, recreation, or competition. It is also widely used for rehabilitation, recreation, exercise or competition for people with disabilities [1]. Since 2010, athletes with an intellectual disability (ID) have been proposed to be integrated into the Paralympic Family. TT has been one of three sports joining with athletics and swimming to announce the inclusion of players with ID into the 2012 London Paralympic Games [2-4]. This tremendous step encourages the development of sports for athletes with ID around the world. Through the 2012 London, 2016 Rio and 2020 Tokyo Paralympic Games, elite TT players with ID have shown their high standard of performance [1,5].

The TT classification system for players with ID has been developed in 2010 and has been approved to apply it in international championships since September 2010. Although the International Table Tennis Federation (ITTF) is the first sport to develop the TT-specific classification system for athletes with ID, its credibility and validity has not been examined in any actual championships [2]. In particular, the TT classification system for players with ID based on the framework of 3S (speed, spin and spot) and 3C (control, consistency and change) principles included a series of testing parts (i.e., service, return service, basic TT skills and control test, short match, and/or advanced test) and observation during competition [1,2,6]. During the classification process, most coaches and technical staff recognized

and supported the contents of the system and testing items because they were sport-specific evaluations. Limited studies have examined the TT abilities and performances in players with ID [7]. Van Biesen and colleagues identified that TT players with ID in returning service were significantly poorer than the able-bodied players [7]. However, so far, no study has analyzed whether the classification system used for TT players with ID is effective since it has been applied in the international para-TT world, and so the classification system is challenged by a few researchers due to a lack of scientific evidence [8,9]. Therefore, the purposes of this exploratory study were to investigate the credibility of the classification system in TT for players with ID, and to compare the difference between male and female players in the TT-specific tests. The outcomes of this investigation may be a useful reference for further clarification of the system and help the revision of the first international edition of the TT classification system for players with ID.

Methods

Participants

Data of 87 international TT players with ID were collected and analyzed, 56 male and 31 female players. All of them were classified in France and Poland, the European Championships in Croatia, the Pan-American Championships in Mexico and the Asian Championships in Hong Kong by international senior classifiers respectively. Players with ID were from 5 continents and 23 countries. All of the players had registered in VIRTUS: World Intellectual Impairment Sport before they had reached the primary eligible criteria as athletes with ID [10]. Each player had signed the classification consent form and promised to fully cooperate with classifiers during the classification process. After the explanation of the classification procedures to players and coaches, they attended the classification tests step by step. ITTF approved the data collection and analysis of this study.

Data collection

The data collected included names, genders, ages, countries, training years, training hours per week, and three parts of classification testing results (i.e., service, return service, and basic TT skills and control) of 87 players with ID. The detailed contents of the testing items in the TT-specific test are presented in Table 1. In addition, the classification results also included the calculation of the total service and return service scores and total testing scores (adding the scores on service, return service, and basic TT skills and control).

Statistical analysis

Statistical analysis was performed using SPSS version 20.0 for Windows. The descriptive statistics for general information and testing results of players were provided. Independent t-test was used to compare male and female results in basic information and classification tests, and to compare players at high and low

score groups. The high score group is defined as top 27% of all participants i.e., above 83 points in total testing score and on the other hand the low score group is defined as low 27% of all participants i.e., less than 63 points in total testing score. In this study, p value less than 0.05 was set as the minimal threshold for statistical significance.

Results & Discussion

Using the classification criteria proposed by the ITTF classification system in the edition of March 2011 [2], six players with ID who performed well in the tests of service and return service, and basic TT skills and control, based on the 3S and 3C principles, those players should participate in the advanced test. However, when the old cut-off points were used for application, there were 10 out of 87 players (11.5%) that needed to attend the advanced test. Clearly, four players had obvious restrictions in TT skills during a short match and so they did not need to participate in the advanced test. Thus, an objective criterion based on statistical analysis should be proposed to revise the old cut-off points in the classification system and criteria. Table 2 provides the recommended cut-off points for two main components after the data analysis and confirmation of players' abilities in a short match during the classification process. If the testing results of players are over cut-off points in service and return service points and basic skills and control points, players must participate in the advanced test. If a player who has one component over cut-off points and the other component close to the cut-off points, he or she should attend the advanced test. This may be a practical approach for classifiers to objectively decide who should attend the advanced test for further clarification of eligibility in competition.

The basic information and testing results of players with ID are presented in Table 3. Testing results in male and female players are compared to identify the gender differences. No significant difference between male and female players in all basic information and in service and return service results was found. Male players performed better in the basic TT skills and control and total testing scores ($p < .05$).

When the new cut-off points and criteria (Table 2) were used to decide whether players with ID should participate in the advanced test, the results showed that 14 out of 87 players (16.1%) must participate in the advanced test and 8 out of 87 players (9.2%) may be in the borderline status, in terms of "being eligible for competition" (see Table 4). Thus, these eight players in borderline situations should be carefully classified in the advanced test, a short match, and observation during competition. All of the recommended procedures should be video recorded in order to confirm the players' abilities, to ensure the consistency of players' performances in classification and competition and prevent intentional misrepresentation of classification by players. When classifiers have more information for determining

the eligible status of the borderline players, the fairness and credibility of competition for players with ID could be maintained appropriately. Actually, two players were identified not-eligibility after the whole classification process (Table 4).

Table 1: Testing items in TT-specific test.

Testing Items in Service	Test Instruction	Scoring
Long Back Spin to Backhand	Each service item is conducted three times. Players are informed to do the correct skill and allowed to practise once.	0: wrong service and wrong location of the ball or missed the service; 1: poor control in service or poor location of the ball; 2: good control in service and good location of the ball.
Long Back Spin to Forehand		
Short Back Spin to Backhand		
Long No Spin to Body		
Fast Ball to Forehand		
Long Side Spin to Backhand		
Testing Items in Return Service	Test Instruction	Scoring
Long Back Spin to Backhand	Each return service item is conducted three times. Players are informed to do the correct skill and allowed to practise once.	0: wrong control in stroke and miss the ball; 1: poor control in stroke or poor location of the ball; 2: good control in stroke and good location of the ball.
Long Back Spin to Forehand		
Short No Spin to Forehand		
Long Top Spin to Forehand		
Fast Ball to Backhand		
Long Side Spin to Backhand		
Basic Skills & Control Items	Test Instruction	Scoring
Forehand Stroke & Rally	A technical classifier asks the ID player to play using certain types of TT skills a few times and to try to make a consistent rally. The player's coach demonstrates a trial and classifiers clearly explain the testing skill to the ID player.	None (N): wrong stroke and cannot control the ball on the table; Poor (P): poor stroke and/or may not consistently control the ball on the table; Reasonable (R): may do the stroke and/or reasonable control of the ball on the table; Good (G): good stroke and good control of the ball on the table.
Backhand Stroke & Rally		
Forehand Top Spin & Rally		
Backhand Top Spin & Rally		
Forehand Back Spin & Rally		
Backhand Back Spin & Rally		
Forehand Side Spin & Rally		
Forehand and Backhand Stroke & Rally		
Forehand and Backhand Back Spin & Rally		
Forehand Top Spin around 2/3 Table & Rally		
Service and Attack & Leg Movements		
High Ball Attack & Leg Movements		
Note: When the ranks of "None, Poor, Reasonable, and Good" are transferred to scores for further calculation, they are 0, 1, 2, and 3 points, respectively.		

Table 2: Main cut-off points in two components of TT tests.

Component	Maximal Scores	Cut-Off Scores
Service & Return Service	72	≥60
Basic Skills and Control	12 items is good (i.e. 36 points)	≥8 items is good & ≥3 items is reasonable (i.e. ≥30 points)

Table 3: Comparison of basic information and TT testing results.

	Total (N=87)	Male (N=56)	Female (N=31)
Age (years)	26.9 ± 8.1	27.1 ± 8.3	26.5 ± 7.8
	(13-48)	(16-45)	(13-48)
Training years	11.8 ± 7.3	12.5 ± 7.5	10.5 ± 6.8
	(1-35)	(1-35)	(1-28)
Training hours per week	10.4 ± 6.9	10.8 ± 7.2	9.8 ± 6.3
	(1-30)	(1-30)	(1-23)
Service score	23.5 ± 6.0	23.5 ± 6.1	23.4 ± 5.9
	(6-34)	(8-34)	(6-31)
Return score	24.8 ± 5.8	25.6 ± 5.3	23.2 ± 6.4
	(11-34)	(12-34)	(11-34)
Service & Return score	48.2 ± 10.1	49.1 ± 9.9	46.6 ± 10.5
	(18-64)	(23-64)	(18-63)
Basic skills and control score *	24.4 ± 7.8	26.1 ± 6.9	21.3 ± 8.6
	(3-36)	(11-36)	(3-35)
Total testing score *	71.5 ± 17.1	74.2 ± 16.0	66.7 ± 18.2
	(30-98)	(32-97)	(30-98)

Note 1. Values are Mean ± SD (minimum-maximum)
 Note 2. * Significant difference between male and female players ($p < .05$).

Table 4: Summary of the possibilities for male and female players after the test.

		Male (N=56)	Female (N=31)	Total (N=87)
Need Advanced test	Yes	13 (23.2%)	1 (3.2%)	14 (16.1%)
	No	43 (76.8%)	30 (96.8%)	73 (83.9%)
Borderline	No	49 (87.5%)	30 (96.8%)	79 (90.8%)
	Yes	7 (12.5%)	1 (3.2%)	8 (9.2%)
Eligibility	Yes	55 (98.2%)	30 (96.8%)	85 (97.7%)
	No	1 (1.8%)	1 (3.2%)	2 (2.7%)

Note 1. Players who need to attend the advanced test to be sure “eligibility for competition” through the advanced test, short match, and observation during competition.
 Note 2. A few players need to be checked to make sure their credibility as a TT player (because some players score far too low).

Table 5: Comparison of basic information and TT testing results in high and low score groups.

	High group (N=23)	Low group (N=23)
Age (years)	29.0 ± 7.3	25.7 ± 9.0
Training years*	15.7 ± 7.9	7.9 ± 7.1
Training hours per week	12.0 ± 7.4	10.1 ± 8.0
Service score **	28.5 ± 3.4	17.5 ± 6.2
Return score **	30.2 ± 2.8	19.2 ± 5.4
Service & Return score **	58.7 ± 3.7	36.7 ± 9.5
Basic skills and control score **	31.9 ± 3.3	16.5 ± 7.3
Total testing score **	90.6 ± 4.9	48.8 ± 11.8

Note 1. Values are Mean ± SD (minimum-maximum)
 Note 2. * Significant difference between high and low score groups ($p < .01$); ** Significant difference between high and low score groups ($p < .001$).

In this study, we found that the mean total score of the TT tests was 71.5 points and the ranges of the total score were from 30 to 98 points. When one standard deviation is added to the mean score to represent the general cut-off point for the advanced test, it may be a useful score for classifiers to apply it. When the total score of a player is over 90 points, he or she should participate in the advanced test. If this recommended criterion is used in this study, 16 out of 87 players (16.1%) should attend the advanced test. It seems to be one of the essential cut-off points for a reasonable consideration of classifiers in the classification process. However, classifiers should not directly use the total score to decide whether a player is eligible or not-eligible for para TT competition. Classifiers should observe the quality of abilities in 3S and 3C and the short match to decide the further actions such as following the instruction of the classification system and ITTF classification rule to conduct further tests.

We compared the testing results in high and low score groups to confirm the validity of the tests. Results showed that the high score group was significantly higher than the low score group in training years, service score, return score, service & return score, basic skills and control score, and total testing score (Table 5). When each testing item was further compared between those two groups, all testing items showed significant difference ($p < .01$) except the service item- fast ball to forehand. This means that the abilities of the high score group can be distinguished in most testing items. If the TT-specific test needs to be revised, few items may be removed or adjusted. However, in the current stage, more players with ID need to be evaluated before the system is fine-tuned.

One of the important issues in the current sport development for players with ID is how to prevent intentional misrepresentation in classification and prevent “able-bodied players” participating in international TT competition. Although detailed processes and classification procedures were proposed and used in the current competition, this issue should always be noticed by ITTF, classifiers, participating countries, coaches, and players. Particularly, the definition of “intellectual disability” may be slightly different among different countries, even the American Association on Intellectual and Developmental Disabilities (AAIDD) have written the information of including people with ID [11]. The eligible issue of athletes with real ID for fair competition has been debated for several years, even VIRTUS has generally developed the primary criteria [10]. Therefore, a long-term evaluation for monitoring borderline players with ID should be done in order to identify main elements for revision of the future classification, and observation during competition.

The International Paralympic Committee (IPC) developed a touch screen test called “Sport Cognition Test Battery” to identify four components in memory and learning, executive functioning, visual perception & fluid intelligence, and processing speed & attention-concentration tests of athletes with ID in 2010 [12]. However, this test has been argued because it may have three

main problems. First, the test may not prevent cheating during the test. For example, able-bodied athletes may perform poor scores during the test if they do not intend to perform well. Thus, the testing results may become meaningless and cannot be used to identify whether people are eligible in ID sports. Second, the reliability and validity of the test has not been scientifically proven enough. Third, some of the testing results have been found incorrectly. For example, data of visual perception and reaction times in many athletes were clearly too slow. Thus, while IPC may use arguable data to decide the cut-off points to confirm athletes with or without ID, the testing results seem to be challenged. In other words, the general touch screen test may not be suitable for TT classification. If the above three problems can be solved appropriately, the touch screen test may be used as an important part of evaluation for borderline players in para TT. In this study, it may be proposed that eight players should need to attend the touch screen test to have further analysis in cognitive functions. Because TT is a reciprocal and interactive sport, we suggest that the items and cut-off points of the touch screen test may need to be adjusted for TT players.

In this study, it is particularly essential to consider the issue of intentional misrepresentation in classification for players with or without ID [1]. This is because borderline players or able-bodied players may be misclassified to be eligible if the classification procedures or system are not stable and solid. Experienced classifiers using the sport-specific classification in TT may easily identify who may cheat if the whole classification process including basic test, advanced test, a real short match, and observation during competition is completed. Because TT is an open-loop and interactive sport, experienced classifiers may substantially observe the movement patterns and playing styles of eligible players with ID, under the principle of 3S and 3C. If players without ID try to cheat in classification, they may demonstrate different playing styles between classification processes and the competition events. On the other hand, the touch screen test may not be useful for clear identification of borderline players and prevent cheating during the test, even if the testing data are provided in classification. Therefore, the final decision for eligibility of players made by classifiers may depend on the sport-specific test and its related procedures, and also combination of the results of touch screen tests due to the impact of sport intelligence on TT performance and tactics [2,13,14].

Although this exploratory study is to analyze TT-specific and classification for players with ID, there are still several limitations. First, this study only evaluated the data of service, return service, and basic TT skills and control. The comments in the advanced test and a short match were not considered for data analysis in any greater depth. Thus, we may just focus on identifying the testing results in the first classification stage without reviewing the whole pictures of classification such as the qualitative information in other tests and discussion among classifiers during short matches and competition. Second, limited numbers of players with ID

were analyzed in this study although the current players who had been classified by ITTF classifiers were all included in this study. Some continents have only a few TT players with ID at the moment. Therefore, future study may follow the similar research method to include more ID athletes from different countries and longitudinally examine the effectiveness of the classification system in further depth. Third, the reliability of testing results may be challenged because different classification teams conducted the classification of 87 players. Therefore, the issues of quality of classifiers and the reliability of tests should be further examined in the future study.

Conclusion

Based on the findings of this exploratory investigation, the current TT classification system for players with ID was generally valid and effective because most players with ID can be clearly classified without difficulties and problems. Using the classification system, the testing results in male and female players were not significantly different. In addition, about 16% of players with ID needed to participate in the advanced test. Most standard players with ID could be identified as eligible players through the basic TT test and short match.

After the statistical analysis of the basic TT test in this study, however, the classification system may need to be fine-tuned in the future, especially in the slight adjustment of the cut-off points in two main components of the TT tests and in reduction of a few testing items. The testing components are highly correlated between the tests of service and return service, basic TT skills and control tests, and total testing scores. We also identified that the TT testing items for most players with ID were valid. Particularly, the testing items in the TT classification system developed through using the framework of 3S and 3C principles and the context of TT games were confirmed. It is recommended that more research on players with ID and TT classification is needed. The similar approach may be used to longitudinally monitor the borderline players and so the classification system for players with ID can be evaluated with more scientific evidence.

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