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The Main Physical Factors in the Serve Accuracy of Wheelchair Tennis Players

Abdul Alim*, Cerika Rismayanthi, Wahyu Dwi Yulianto, Yulvia Miftachurochmah

Faculty of Sport Science, Universitas Negeri Yogyakarta, Colombo Street No.1, Yogyakarta 55281, Indonesia

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Abstract **The purpose** of this study is to identify physical factors related to the serve accuracy in Yogyakarta wheelchairtennis players (WT). **Method:** This research is a quantitative study using correlation analysis conducted by field test. The participants were the best wheelchair tennis athletes with seven men and three women 156-167± cm, weight 50-70± kg, age 31-35. Each athlete performed neuromuscular tests consisting of: isometric handgrip strength; serve accuracy (Hewitt test); sprint tests 5m, 10m and 20m (using and not using rackets); agility (using and not using rackets); medicine ball throw (serve, forehand and backhand movement); and endurance test specific to WT. **Results:** The highest correlation was found from medicine ball throw serve ($p = 0.001$; $r = 0.874$), forehand ($p = 0.004$; $r = 0.811$) and backhand ($p = 0.013$; $r = 0.747$), medicine ball throw showed a positive correlation with serve accuracy. The physical parameters of the medicine ball throw can explain 100% of the service accuracy level (Nagelkerke R Square = 1.00) and have a percentage of being correct 100% through the logistic regression test classification table. **Conclusion:** It is recommended that coaches and physical trainers incorporate medical ball throwing exercises into the training program of WT players due to benefits of transferring serve accuracy.

Keywords Tennis, Wheelchair, Biomechanics, Serve

1. Introduction

Disability is any condition of the body or mind that makes individuals have difficulty carrying out certain activities and interactions with the world around them [1]. It is known that disability has a strong impact (major) on daily activities. In this case, the most common disability is a disability with a type of mobility (physical impairment) [2]. In children, physical disability caused by cerebral palsy becomes the third most common physical impairment disability after Intellectual Disability (ID) and Autism Spectrum Disorder (ASD) [3]. Today, however, individuals with disabilities do not restrict from participating in health, recreational, or competitive sports.

Wheelchair tennis is one of the Paralympic sports followed by tennis athletes with disabilities, especially those with physical disabilities or physical impairment [4], [5]. Since its first appearance at the Paralympic Games in 1992, wheelchair tennis has developed into one of the favorite Paralympic sports for people with disabilities [6]. The popularity of wheelchair tennis is dominant in groups of people with leg amputations, spinal cord injuries, or cerebral palsy. However, wheelchair sports are in the top four most popular Paralympic sports [7]. In Indonesia, especially the National Paralympic Committee of Yogyakarta Special Region (NPC DIY), athletes who have joined the sport of wheelchair tennis generally have physical impairment disabilities. Some athletes with disabilities have participated in national (PON/National Sports Week) and international (Asean Games) competitions.

According to the requirements or eligibility of the race with disability, individuals based on their disability can be distinguished or categorized into open or quad categories.

Open is a wheelchair tennis category for players with disabilities who permanently have impairments in one leg or both. Meanwhile, Quad is a wheelchair tennis category for players with additional disabilities besides footwork, such as hands and others that affect racquet grip or the ability to control a wheelchair. Athletes with the following conditions, such as Impaired muscular power, Athetosis, Impaired passive range of motion, Hypertonia, Limb deficit, Ataxia, and Leg length discrepancy, may also compete [8], [9]. Athletes' limitations in each of these categories distinguish the performance of wheelchair tennis athletes from conventional tennis when competing. Despite its limitations, wheelchair tennis athletes will struggle to improve their competitive performance to achieve their desired achievements.

In achieving high achievements in competitive sports, competitive performance becomes one of the determinants of athlete success. When viewed as a whole, the performance of wheelchair tennis athletes on the court is determined by the mobility performance of athletes [10]. Meanwhile, the level of athlete mobility performance is determined by the variation in athlete disability [11]. In addition to the athlete's ability or mobility performance, there is also the ability to control the ball. Wheelchair control skills (mobility performance) and ball skills determine athlete performance when competing. According to Fitzpatrick et al. [12], technical skills or the ability to control the ball, such as service accuracy and service return, is important in wheelchair tennis matches, given athletes' mobility limitations. Good serve accuracy reduces the time for opponents to return the ball to its maximum and increases the likelihood of the server dominating in the rally or directly winning direct points. It is undeniable that such accuracy can determine the win or loss of a match. Good accuracy, coupled with the ability of power to produce fastballs, is the key to tennis athletes' success in this modern era [13], [14].

In short, the mastery of accurate tennis batting techniques along with tactical skills became a determining factor in tennis athletes' victory. The problem in Indonesia is that trainers, especially NPC DIY trainers, have difficulty finding appropriate programs to improve the accuracy of their athletes. Meanwhile, the scientific literature on exercise methodology for developing wheelchair tennis players' punch accuracy skills has not been much or inadequate. Understanding the factors that affect accuracy must first be known to develop accuracy.

In competitive tennis, a physical or biomotor component is a factor that determines athlete performance, such as speed, strength, flexibility, agility, and endurance [15]. In addition to the physical components, technical and tactical components affect athlete performance. Therefore, the process of improving the athlete's performance must include the development of all of these components (physical, technical, and tactical) [16], [17]. Achievement of a high level of tactical ability must be delivered using a good technical ability, and good technical ability (accuracy) must be based on good physical ability [17]. The better the athlete's physical foundation, the higher the athlete can develop his technical, tactical, and physiological skills to the next level [18], [19]. These skills are all interconnected and cannot be isolated from one another. Given that serve approaches will be in line with one of the physical components and that studies in TC have shown a link between physical parameters and serve accuracy [20], [17], our hypothesis is that there is a link between certain physical factors and serve accuracy in WT players.

Accuracy is part of the technical ability and is a determining component of the performance of wheelchair tennis athletes. An understanding of the factors influencing accuracy is required to prepare an accuracy training methodology. Consequently, the goal of this research is to identify the physical variables that influence service accuracy in open wheelchair tennis players and quad athletes who perform well in NPC DIY's with accurate strokes. It is hoped that by measuring the physical parameters of elite athletes, an understanding of the factors determining the accuracy of wheelchair tennis athletes can be known, and appropriate exercise programs can be made.

2. Materials and Methods

Participation and Procedures

This research is a quantitative study using correlation analysis carried out by field tests. The population in this study was 10 participants consisting of seven men and three women with a height of 167 $\pm$ 5.6 cm, a weight of 59.60 $\pm$ 6.59 kg, an age of 33.4 $\pm$ 1.51 years, exercise duration per week of 9.2 $\pm$ 1.1 hours/week, and exercise experience of 8.3 $\pm$ 1.8 years. All of the population were wheelchair tennis athletes with a disability category. The details of the athlete's disability are polio disability (n=6), amputation (n=1), spinal cord injury (n=2), and impaired muscle power for the hands and feet (n=1). Thus, as many as nine athletes were included in the open category, and one athlete was in the quad category. The wheelchair tennis athlete has 8.3 $\pm$ 1.8 years of playing experience with an average practice time of 9.2 $\pm$ 1.1 hours per week.

To determine the factors that affect service accuracy in wheelchair tennis, the researchers believe that more valid results are obtained by measuring physical parameters in high-achieving athletes. Therefore, the sampling technique using purposive sampling, athletes are professional athletes with high skills, evidenced by having participated in national and international events, even winning the 2022 ASEAN Paragames competition in Solo and several national competitions in 2021. The inclusion criteria are as follows: (1) the athlete is willing to carry out a structured test, (2) the athlete is in good health, while the patient meets the following criteria: (a) the athlete is not willing to carry out a structured test, (b) the athlete is not in good health. This study was approved by members of the National Paralympic Committee of Yogyakarta Special Region (NPC DIY) as the governing body for the development and training of sports with disabilities and for improving the achievement and welfare of athletes with disabilities.

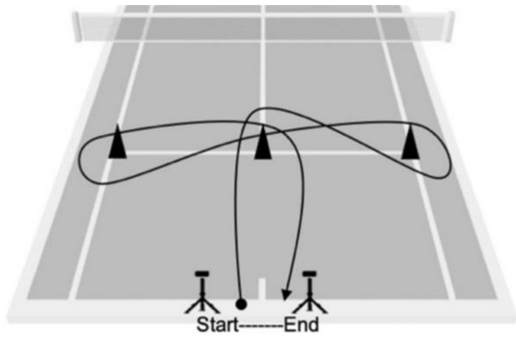
Athletes are called alternately to perform physical parameter tests. Before performing the test, each athlete will be briefed or informed about the procedure for carrying out each test item [20]. There are no set procedures for administering the test items in this research. First Prose, a typical 10-minute directional heating exercise that consists of joint mobility, linear movement with the seat, circular movement, and twists that promote punching, acceleration, and deceleration with low intensity [21]. The following tests were carried out on two consecutive days: Day 1: Sprint (5, 10, and 20 m), agility (T-test), service accuracy (Hewitt), and medicine ball toss (forehand, backhand, and service); Day 2: Increasing resistance (Hit and Turn Tennis Test) and manual strength handgrip. & nbsp; Scores from numerous tests were obtained throughout its development by the researchers. All experiments were carried out on outdoor hard tennis courts.

Measurements Collected

The following information was gathered based on the features of each test [20]–[22].

Sprint test: the WT athlete's speed was measured using four lines at 0.5.10 and 20m. The first line's last word was where the topic began. Each athlete completed the test three times without a racket and three times with one. A two-minute pause follows each repeat. The experiment with the highest score out of the three was noted. The unit of time is the second (s).

Agility test (T-Test): This Agility test is adapted for wheelchair tennis [23] and has been used in WT games [24]. Tests include acceleration and deceleration, as well as turns from both sides as shown in figure 1.



Source: adapted from [4]

Figure 1. Agility Field Test

Participants must go from the baseline's center mark to the single line's junction with the service line before returning to the starting area, constantly towards the field's center (T)w. During a 2-minute interval in between each repeat, each subject completed the test three times with a racket and three times without one. The top results from each experiment were noted. A stopwatch is used to measure time.

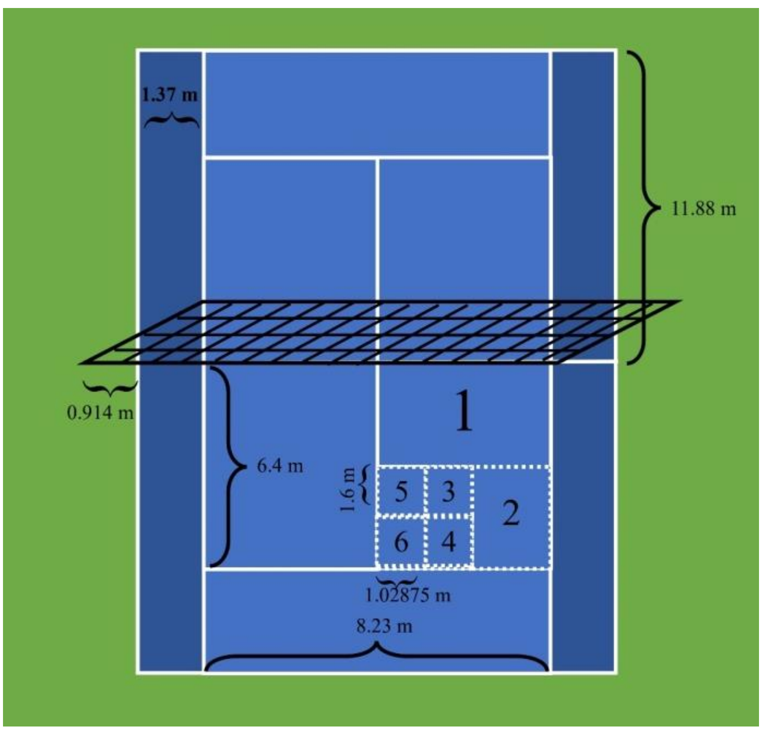


Figure 2. Hewitt's Tennis Achievement Field Test

Hewitt service test: the purpose of this serve accuracy test is to measure the placement ability of service accuracy in tennis players [25]. The implementation of this test each athlete performs abstinence first for 10 minutes, after heating, the athlete is ready to perform an accuracy test serve and stand behind the baseline. Every athlete gets a chance to try 2 times before the test. The ball that hits the net and falls in the serve area must be repeated. The value is recorded when hit in the correct fieldand has been misled, the athlete performs 10 times serve from behind the baseline, as in figure 2.

Isometric handgrip strength is measured with a hand dynamometer test, which measures the maximal isometric strength in the finger flexor. Without truly being worried, the test was performed in a wheelchair while the subject was sitting with their arms extended and taped to the wheel [21]. During the adaptation period with the isometric research instrument handgrip strength, each athlete executes a maximum of 3 times with each hand. There are 2 minutes left between each repeat. The top results from the three trials will be kept.

Figure 3. Backhand (a)

Upper body strength: Medicine ball tests that simulate forehand, backhand, and serve motions are used to assess explosive strength [26], [27]. Participants stand behind the throw line. The length of the gauge reaches 15 meters in the field perpendicular to the throw line, the result is measured from the fall of the ball to the starting throw position. A 2 kg ball of medicine was used for the test. Each participant gets a chance three times, with a break of 2 minutes between each repetition. Players must throw the ball simulated backhand (figure 3), forehand (figure 4), and serve (figure 5) movements.

Figure 4. Forehand (b)

Figure 5. Serve (c)

Test of anaerobic endurance (hit-and-turn tennis): This test is a modification of a standing tennis development to assess the player's particular anaerobic endurance via the level attained [22]. According to the current signal, the test entails simulating a punch at a certain location that is on the doubles line with the baseline line. The player simulates a second hit on the other side after the first one, and so on until the session is over. Close to the mark on the punch adaption that is in the doubles line with the baseline line is required. When the sound signal sounds and the athlete is unable to take a hit, the test is over. Each athlete's findings were tabulated based on the areas in which he was unable to simulate a hit. The sum of physical variables test used in this study can be shown in table 1.

Table 1. The physical variables measured as well as the different tests used

Physical variable	Test	Characteristics
Strength	Grip strength	1-Dominan
		2-Non-dominan
	Medicine ball	1-Forehand
		2-Backhand
		3-Serve
	Serve accuracy	Average Value of 10 serves
Sprint	5m	With and without racket
	10m	
	20m	
Agility	t-test	With and without racket
Endurance	Hit and run tennis test	With racket

Data Analysis

The Shapiro-Wilk test was performed to determine if each variable was normally distributed since the samples used were small (n=10) (grip strength, sprint, agility, strength, endurance, and accuracy). The Hewitt test results that indicate athletes' accuracy are employed as a dependent variable, while the other variables that previously displayed results for physical parameter measurements are used as independent variables. The correlation test using Pearson Correlation Coefficient was carried out to determine the relationship between each physical parameter variable to accuracy. Decision-making is taken based on the significance value or p-value. If the Pearson Correlation Coefficient results in a p-value < 0.05, there is a relationship between the independent and dependent variables. Meanwhile, the r values are classified into less (0-0.1), small (0.1-0.3), medium (0.3-0.5), good (0.5-0.7), very good (0.7-0.9), almost perfect (0.9), and perfect (1.0). Furthermore, the Binary Logistics Regression test is carried out to predict whether the dichotomous variable service accuracy level (0/average, below average, less; 1/good and very well influenced or has a relationship to each physical parameter. The entire analysis process in this study was analyzed using IBM SPSS 25.00 statistics.

3. Result

Normality Test

All data variables (details in table 2) obtained a Shapiro-Wilk value of $p > 0.05$, so all data is normally distributed as shown in table 3. Therefore, the test of inferential data with parametric tests can be carried out.

Table 2. Description of Physical Test Results

Physical Test	Mean (M)	Standard Deviation (SD)	Confidence Interval (CI)
Grip Strength. Dom	44.02	4.08	41.09;46.94
Grip strength. No Dom	32.22	5.66	28.16;36.27
Serve Accuracy	32.30	7.00	27.28;37.31
Sprint 5m NR	3.43	0.39	3.15;3.71
Sprint 10m NR	5.34	0.53	4.95;5.72
Sprint 20m NR	11.85	0.97	11.15;12.54
Sprint 5m R	4.45	0.43	4.13;4.76
Sprint 10m R	8.11	0.56	7.71;8.52
Sprint 20m R	11.40	0.81	10.82;11.98
T-Test NR	14.57	1.12	13.76;15.37
T-Test R	15.99	1.11	15.19;16.79
MBT F	5.74	1.60	4.60;6.89
MBT B	5.37	1.61	4.21;6.52
MBT S	7.11	1.33	6.15;8.07
Hit and turn	15.42	2.92	13.32;17.51

*Dom: Dominant; No Dom: Not dominant; NR: Without Racquet; R: With Racquet; MBT: Medicine Ball Throw; F: Forehand; B: Backhand; S: Serve

Table 3. Shapiro Wilk Test of Normality

Physical Test	Statistic	df	Sig.
Grip Strength. Dom	0.855	10	0.067
Grip strength. No Dom	0.856	10	0.068
Serve Accuracy	0.935	10	0.500
Sprint 5m NR	0.966	10	0.847
Sprint 10m NR	0.992	10	0.999
Sprint 20m NR	0.933	10	0.482
Sprint 5m R	0.865	10	0.088
Sprint 10m R	0.953	10	0.704
Sprint 20m R	0.927	10	0.417
T-Test NR	0.881	10	0.133
T-Test R	0.980	10	0.964
MBT F	0.961	10	0.794
MBT B	0.926	10	0.414
MBT S	0.917	10	0.331
Hit and turn	0.876	10	0.119

Correlation Test

The correlation results using Pearson correlation coefficients showed that the physical parameter variables sprint 20m ($p = 0.019$; $r = -0.718$), medicine ball throw forehand ($p = 0.004$; $r = 0.811$), medicine ball throw backhand ($p = 0.013$; $r = 0.747$), and medicine ball throw service ($p = 0.001$; $r = 0.874$) have a p-value of < 0.05 as shown in table 4. Thus, having a strong relationship with the degree of relationship, consecutively, very good negative, very good positive, very good positive, very good positive, and very good positive. Meanwhile, the physical parameters of grip strength (dominant and non-dominant), sprint without a racquet (5m, 10m, and 20m), sprint with a racquet (5m and 10m), T-test (with and without racquet), and endurance (Hit and Turn) have a p-value > 0.05 so that it means that the physical parameters do not have a significant relationship to the accuracy of athlete service.

Table 4. Pearson Correlation Coefficient of Physical Test with Serve Accuracy

Physical Test	r	p
Grip Strength. Dom	0.566	0.088
Grip strength. No Dom	0.239	0.506
Sprint 5m NR	-0.566	0.088
Sprint 10m NR	-0.476	0.165
Sprint 20m NR	-0.505	0.136
Sprint 5m R	-0.480	0.160
Sprint 10m R	-0.561	0.091
Sprint 20m R	-0.718	0.019
T-Test NR	-0.589	0.073
T-Test R	-0.568	0.087
MBT F	0.811	0.004
MBT B	0.747	0.013
MBT S	0.874	0.001
Hit and turn	0.579	0.080

Logistic Regression Test

Due to the small number of samples, the dependent variable or in this case, the athlete's accuracy dichotomy category, 1) good and excellent, and 2) average, poor, and very poor can only be predicted by one of the predictor variables groups that share the same characteristics, namely 1) Dominant and Non-Dominant Strength Grip, 2) Sprint without racquet/sprint 5m, 10m, and 20m, 3) Sprint with racquet 5m, 10m, and 20m, 4) T-Test with or without a racquet, 5) Strength/medicine ball throw forehand, backhand, and service, and 6) Endurance/Hit and Turn.

It is known that the significance value of omnibus tests of model coefficients (table 5) variable predictor sprint without racquet (5m, 10m, 20m), medicine ball throw (forehand, backhand, service), and hit and turn has a value of < 0.05 so that the model coefficients can be said to be compatible with null models. In addition, the significance value of omnibus tests < 0.05 can also be interpreted that each variable predictor sprint without racquet (5m, 10m, 20m), medicine ball throw (forehand, backhand, service), and hit and turn (in the same predictor variable group) stimulative have a significant effect on the accuracy of athlete service or dependent variables. Meanwhile, the variable predictor group of grip strength, sprint with the racquet, and agility did not show the model's compatibility with the null model because the value was > 0.05. Meanwhile, the group of variable predictor grip strength, sprint with the racquet, and agility (within the same predictor variable group) stimulative did not affect service accuracy. The group of predictor variables that do not pass the match to the null model can be said to have a chance to get the wrong prediction results.

Furthermore, when viewed from the results of the Hosmer and Lemeshow Test analysis (table 5), all predictor variable groups (grip Strength, sprint with racquet, sprint without racquet, agility strength, and endurance) have a significance value of > 0.05 so that the prediction model can be said to match the observation model and hypothesis test can be carried out.

Through the results of the Nagelkerke R Square test analysis (table 5), it is known that the predictor variable group grip strength, sprint with the racquet, sprint without a racquet, agility, strength, and endurance can consistently 29.3%, 82.7%, 22.2%, 30.2% 100%, 25.1% in explaining the dependent variable or athlete accuracy. Then the sprint variables without racquet, strength, and endurance have a percentage probability of being consistently correct by 90% (table 6), 100% (table 7), and 90% (table 8).

Table 5. Physical Parameter Logistic Regression Test Results with Accuracy Level

Predictor Variable Groups	Predictor Variabels	Omnibus Test (sig.)	Hosmer and Lemeshow Test (sig.)	Nagelkerke R Square	Wald (sig.)
Strength	Grip Strength. Dom	0.614	0.293	0.124	0.527
	Grip strength. No Dom				0.372
Sprint Without Racquet	Sprint 5m NR	0.036	0.827	0.766	0.262
	Sprint 10m NR				0.258
	Sprint 20m NR				0.291
Sprint With Racquet	Sprint 5m R	0.300	0.222	0.409	0.275
	Sprint 10m R				0.396
	Sprint 20m R				0.256
Agility	T-Test NR	0.425	0.302	0.210	0.436
	T-Test R				0.665
Strength	MBT F	0.003	1.000	1.000	0.999
	MBT B				0.997
	MBT S				1.000
Endurance	Hit and turn	0.017	0.251	0.582	0.073

Table 6. Predicted Model using Predictor Variable Sprint without Racquet Group

Classification Table				
		Predicted		
		Serve Category		Percentage Correct
		Average, Below Average, and Poor	Good and Excellent	
Serve Category	0 = Average, Below Average, and Poor	4	1	80.0
	1 = Good and Excellent	1	4	80.0
Overall Percentage				80.0

Table 7. Predicted Model using Predictor Variable Strength Group

Classification Table				
		Predicted		
		Serve Category		Percentage Correct
		Average, Below Average, and Poor	Good and Excellent	
Serve Category	0 = Average, Below Average, and Poor	5	0	100.0
	1 = Good and Excellent	0	5	100.0
Overall Percentage				100.0

Table 8. Predicted Model using Predictor Variable Endurance Group

Classification Table				
		Predicted		
		Serve Category		Percentage Correct
		Average, Below Average, and Poor	Good and Excellent	
Serve Category	0 = Average, Below Average, and Poor	4	1	90.0
	1 = Good and Excellent	0	5	100.0
Overall Percentage				90.0

4. Discussion

Identifying the dominant physical components that support accuracy in wheelchair tennis is very important because it helps coaches and physical coaches designing training programs that are adapted to the unique combination of physiological, psychological, technical and physical abilities [28]. The purpose of this study was to determine the relationship of physical components that support the serve accuracy of Yogyakarta wheelchair tennis players. In general, the medicine ball throw that simulates the forehand, backhand and serve movement blows showed a high correlation, while the service ball throw is the most suitable ($p = 0.001$; $r = 0.874$).

Technical and physical coaches often provide tests to athletes to gauge their progress in relation to several components (connected to speed, agility, maximal strength, or functional movement) [28]. The pitch of the medicine ball forehand and backhand showed a good and statistically significant correlation with service accuracy (Table 4).This throw is useful for testing the rotational power of athlete trunks [29] and in tennis players [28].

Tennis services include abdominal muscle activity (rectum and obliques) to flex the bones with rotation [30]. In addition, medicine ball throw forehand has a higher correlation with tennis service accuracy than medicine ball throw backhand ($p = 0.004$; $r = 0.811$ vs $p = 0.013$; $r = 0.747$). The use of the medicine ball involves turning the body to the serving side, which may account for the stronger association between the two. Moreover, there was a poor association between serve accuracy and the 20-meter sprint ($p = 0.019$; $r = -0.718$). In this explanation, it is shown that at long distances, a larger throw distance corresponds to a faster displacement speed (less time) (20m). Abdominal muscles have a large role in producing service accuracy [30] and in body balance to perform propulsion [31].

Implementation of biomechanical servicing through 8 stages (prefix, release, loading, cocking, acceleration, contact, deceleration and finish) [32]. Because in wheelchair tennis, the lower part of the body has drawbacks, so in the kinetic chain servicing produces little power. It is apparent that the upper body movement while conducting wheelchair service is similar to when a tennis player stands while seated on a chair during the loading phase (semi-side posture, elbow of the racket arm in its lowest position, free arm extended up, etc.). This explains why the pitch of the medicine ball that replicates the serve is the key variable that supports the service's accuracy (Table 4), demonstrating a strong correlation. In addition, the loading position on this punch has special biomechanical implications that do not occur on the forehand and backhand of the MBT (shoulder work over shoulder, free-arm action-reaction, line of force direction, asynchronous movement between the two arms, etc.) [33], [34].

It is known that movements that generate energy and make stability in hitting action are components of rotation in the abdominal muscles to increase the accuracy in adjusting direction [35]. This movement plays a crucial part in the service movement and is quite obvious in the forehand and backhand hits. In this research, it was shown that moves that mimic forehand, backhand, and service blow have a strong link with service accuracy from a kinematic point of view. Medicine ball throw service replicates service actions in the setup and advance-impact phases from a kinematic perspective. In fact, wheelchair tennis players who have spinal injuries and functional deficits in the muscles of the body, can use their non-dominant hand as a support in the act of hitting, in the same way as happens with the service movement of standing players [34].

Serve or service is the first strike and involves strength and power of the upper body and shoulder range of motion [32]. Without considering the component kinetic chain of servicing in the lower body, it can be concluded that serve determines in the WT game. In accordance with the results obtained, the strength-specific coaching program that simulates servicing movements with medicine ball can help to achieve an increase in accuracy performance in servicing. Trainers design programs in a structured manner to achieve specific goals [28]. Therefore, the physical and technical trainers design the training program according to the needs during the match.

The results obtained in this study present a series of findings that physical components may have an effect on service accuracy. Good technique and play can be achieved with the support of the physical component [36], [37].

In this study, we realized that this study could not be separated from its shortcomings. At least the study's limitations can be mentioned in four important points. First, the study's sample size needs to be bigger to be researched, so research with a larger sample size needs to be done to make the study results more accurate. Second, logistic regression analysis cannot be interpreted optimally because of the limitations of the number of research samples. Third, this study was only conducted on a hard field, so the study's results may be different from athletes accustomed to competing on clay or grass courts. Fourth, the shortcoming of this study is that researchers cannot explain how much the contribution of physical parameters affects the accuracy of service along with the amount of contribution of the athlete's cognitive level. It is because service accuracy can be influenced by cognitive parameters, while there are no cognitive level parameters involved in this study.

5. Conclusions

Based on the results of analysis and discussion in this study, the physical parameter variables of sprint 20m with a racquet ($p = 0.019$; $r = -0.718$), medicine ball throw forehand ($p = 0.004$; $r = 0.811$), medicine ball throw backhand ($p = 0.013$; $r = 0.747$), and medicine ball throw service ($p = 0.001$; $r = 0.874$) have a good and very good relationship with athlete accuracy. The effect of these physical parameters on the accuracy of athlete service has a percentage of being correct of 90%, 100%, and 90% through logistic regression test. If interpreted into one, it can be interpreted that the physical parameters of the Sprint 20m R, MBTF, MBTB, and MBTS can affect the accuracy of athletes and are likely to be the determining factors in the accuracy of wheelchair tennis athlete service. An appropriate program to adjust movements that resemble the original game is recommended to include medicine ball throwing exercises as a service transfer exercise in the WT player training program. In this case, the researchers recommend doing a medicine ball throw to further develop the athlete's accuracy.

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