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

Abdul Alim[1], Cerika Rismayanthi[1], Wahyu Dwi Yulianto[1], Yulvia Miftachurochmah[1]

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Abstract **The purpose** of this study is to identify physical factors related to the serve accuracy in Yogyakarta wheelchair tennis 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. (2019), 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 [12]. Good serve accuracy reduces the time for opponents to return the ball to its maximum and increasing 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 engineering component 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 will be prepared.

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 were of 10 participants consisting of 7 men and three women with a height of 167 ± 5.6 cm, a weight of 59.60 ± 6.59 kg, an age of 33.4 ± 1.51 years, exercise duration per week of 9.2 ± 1.1 hours/week, and exercise experience of 8.3 ± 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 ± 1.8 years of playing experience with an average practice time of 9.2 ± 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.   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 [22]–[24].

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 [21] and has been used in WT games [25]. Tests include acceleration and deceleration, as well as turns from both sides.

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) (figure 1). 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.

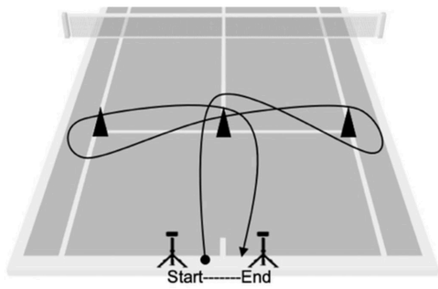

Figure 1. Agility

Source: adapted from [4]

Hewitt service test: the purpose of this serve accuracy test is to measure the placement ability of service accuracy in tennis players [26]. The implementation of this test each athlete performs an 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 field and has been misled, the athlete performs 10 times serve from behind the baseline, as in figure 2.

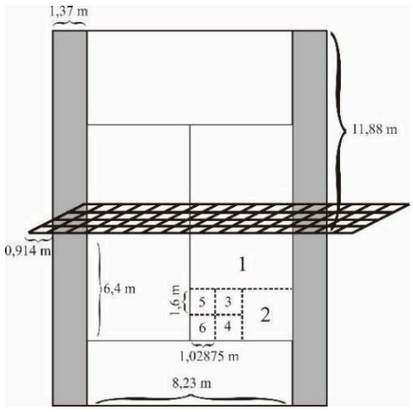

Figure 2. Hewwit

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 [23]. 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.

Upper body strength: Medicine ball tests that simulate forehand, backhand, and serve motions are used to assess explosive strength [27], [28]. 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 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 3. Backhand (a)

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 [24]. 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.

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

Physical variable	Test	Characteristics
		1-Dominan
		2-Non-dominan
Strength		1-Forehand
		2-Backhand
		3-Serve
	Serve accuracy	Average Value of 10 serves
	5m	
Sprint	10m	With and without racket
	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 variables obtained a Shapiro-Wilk value of p > 0.05, so all data is normally distributed. Therefore, the test of inferential data with parametric tests can be carried out.

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. Thus, having a strong relationship with the degree of relationship consistently negative is very good, positive is very good, positive is very good, positive is very good, and positive is very good. 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 (Hewitt test) 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. 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. Thus, having a strong relationship with the degree of relationship consistently negative is very good, positive is very good, positive is very good, positive is very good, and positive is very good. 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 (Hewitt test) 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.

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%, 100%, and 90% (table 6-8).

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 Racket
R: With Racket
MBT: Medicine Ball Throw
F: Forehand
B: Backhand

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

Table 4. 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

Table 5. Hasil Uji Logistic Regression Parameter Fisik terhadap Tingkat Akurasi

Kelompok Variabel Predictor	Variabel Predictor	Omnibus Test (sig.)	Hosmer and Lemeshow Test (sig.)	Nagelkerke R Square	Wald (sig.)
	Grip Strength. Dom				0.527
	Grip strength. No Dom				0.372
	Sprint 5m NR				0.262
	Sprint 10m NR				0.258
	Sprint 20m NR				0.291
	Sprint 5m R				0.275
	Sprint 10m R				0.396
	Sprint 20m R				0.256
	T-Test NR				0.436
	T-Test R				0.665
	MBT F				0.999
	MBT B				0.997
	MBT S				1.000
Endurance	Hit and turn	0.017	0.251	0.582	0.073

Tabel 6. Predicted Model menggunakan kelompok variable predictor sprint without racquet

Classification Table				
		Predicted		
		Kategori Servis		
		Rata-rata, di bawah rata-rata, dan kurang	Baik dan sangat baik	
Kategori Servis	0 = Rata-rata, di bawah rata-rata, dan kurang	4	1	80.0
	1 = Baik dan sangat baik	1	4	80.0
Overall Percentage				80.0

Tabel 7. Predicted Model menggunakan kelompok variable predictor Strength

Classification Table				
		Predicted		
		Kategori Servis		
		Rata-rata, di bawah rata-rata, dan kurang	Baik dan sangat baik	
Kategori Servis	0 = Rata-rata, di bawah rata-rata, dan kurang	5	0	100.0
	1 = Baik dan sangat baik	0	5	100.0
Overall Percentage				100.0

Tabel 8. Predicted Model menggunakan kelompok variable predictor Endurance

Classification Table				
		Predicted		
		Kategori Servis		
		Rata-rata, di bawah rata-rata, dan kurang	Baik dan sangat baik	
Kategori Servis	0 = Rata-rata, di bawah rata-rata, dan kurang	4	1	90.0
	1 = Baik dan sangat baik	0	5	100.0
Overall Percentage				90.0

4. Discussion

Identifying which variables determine as one of the supports for the accuracy of wheelchair tennis services, as well as assisting coaches and physical coaches in designing training programs tailored to technical, psychological, physiological and physical abilities [29]. The purpose of this study is to determine the relationship of physical components that support the serve accuracy Yogyakarta wheelchair tennis players. In general, the medicine ball throw that simulates the forehand, backhand and serve movement blows shows a high correlation, while the service ball throw is the most suitable ($p = 0.001$; $r = 0.874$).

Commented [H1]: was

Commented [H2]: showed

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) [29]. 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 [30] and in tennis players [29].

Tennis services include abdominal muscle activity (rectum and obliques) to flex the bones with rotation [31]. 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 [31] and in body balance to perform propulsion [32].

Implementation of biomechanical servicing through 8 stages (prefix, release, loading, cocking, acceleration, contact, deceleration and finish) [33]. 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.)[34], [35].

It is known that movements that generate energy and make stable in hitting action are components of rotation in the abdominal muscles to increase the accuracy in adjusting direction [36]. 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

[35].

Serve or service is the first strike and involves strength and power of the upper body and shoulder range of motion [33]. 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 [29]. Therefore, the physical and technical trainer 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. The physical component will support in play and technique in play [37], [38].

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 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 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 20m sprint with the racquet, medicine ball throw forehand, medicine ball throw backhand, and medicine ball throw service can affect the accuracy of athletes and are likely to be the determining factors in the accuracy of wheelchair tennis athlete service. 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.

REFERENCES

[1] C. for D. C. and Prevention, "Disability and health overview: Impairments, activity limitations and participation restrictions." US Department of Health and Human Services. https://www. cdc. gov/ncbddd …, 2020.

[2] C. for D. C. and Prevention, "CDC: 1 in 4 US adults live with a disability," *CDC Online Newsroom*, 2018.

[3] S. M. Cooley-Nichols, "Generic special education teacher preparation: Emotional and behavioral disorders," *Emot. Behav. Difficulties*, vol. 9, no. 1, pp. 28–40, 2004.

[4] A. Sánchez-Pay, R. Martínez-Gallego, M. Crespo, and D. Sanz-Rivas, "Key physical factors in the serve velocity of male professional wheelchair tennis players," *Int. J. Environ. Res. Public Health*, vol. 18, no. 4, p. 1944, 2021.

[5] A. Sánchez-Pay, G. Torres-Luque, and D. Sanz-Rivas, "Match activity and physiological load in wheelchair tennis players: a pilot study," *Spinal Cord*, vol. 54, no. 3, pp. 229–233, 2016.

[6] J. R. Gold and M. M. Gold, "Access for all: the rise of the Paralympic Games," *J. R. Soc. Promot. Health*, vol. 127, no. 3, pp. 133–141, 2007.

[7] N. J. Diaper and V. L. Goosey-Tolfrey, "A physiological case study of a paralympic wheelchair tennis player: reflective practise," *J. Sports Sci. Med.*, vol. 8, no. 2, p. 300, 2009.

[8] International Paralympic Committee, "Wheelchair Tennis Classification & Categories," Feb. 2023. https://www.paralympic.org/wheelchair-tennis/classification (accessed Feb. 15, 2023).

[9] ITF Tennis, "Tennis Rules and Regulations ," Feb. 2023. https://www.itftennis.com/en/about-us/governance/rules-and-regulations/?type=classification (accessed Feb. 15, 2023).

[10] R. M. A. Van der Slikke, M. A. M. Berger, D. J. J. Bregman, and H. E. J. Veeger, "From big data to rich data: The key features of athlete wheelchair mobility performance," *J. Biomech.*, vol. 49, no. 14, pp. 3340–3346, 2016.

[11] R. M. A. van der Slikke, M. A. M. Berger, D. J. J. Bregman, and D. H. E. J. Veeger, "Wearable wheelchair mobility performance

measurement in basketball, rugby, and tennis: lessons for classification and training," *Sensors*, vol. 20, no. 12, p. 3518, 2020.

[12] A. Fitzpatrick, J. A. Stone, S. Choppin, and J. Kelley, "Important performance characteristics in elite clay and grass court tennis match-play," *Int. J. Perform. Anal. Sport*, vol. 19, no. 6, pp. 942–952, 2019.

[13] S. Mecheri, F. Rioult, B. Mantel, F. Kauffmann, and N. Benguigui, "The serve impact in tennis: First large-scale study of big Hawk-Eye data," *Stat. Anal. Data Min. ASA Data Sci. J.*, vol. 9, no. 5, pp. 310–325, 2016.

[14] J. Beckmann, L. Fimpel, and V. V. Wergin, "Preventing a loss of accuracy of the tennis serve under pressure," *PLoS One*, vol. 16, no. 7, p. e0255060, 2021.

[15] M. S. Kovacs, "Tennis physiology: training the competitive athlete," *Sport. Med.*, vol. 37, pp. 189–198, 2007.

[16] E. Strecker, E. B. Foster, and D. D. Pascoe, "Test–retest reliability for hitting accuracy tennis test," *J. Strength Cond. Res.*, vol. 25, no. 12, pp. 3501–3505, 2011.

[17] N. S. Kolman, T. Kramer, M. T. Elferink-Gemser, B. C. H. Huijgen, and C. Visscher, "Technical and tactical skills related to performance levels in tennis: A systematic review," *J. Sports Sci.*, vol. 37, no. 1, pp. 108–121, 2019.

[18] T. O. Bompa and C. Buzzichelli, *Periodization: theory and methodology of training*. Human kinetics, 2018.

[19] J. Lambrich and T. Muehlbauer, "Physical fitness and stroke performance in healthy tennis players with different competition levels: A systematic review and meta-analysis," *PLoS One*, vol. 17, no. 6, p. e0269516, 2022.

[20] Á. López-Samanes *et al.*, "Circadian rhythm effect on physical tennis performance in trained male players," *J. Sports Sci.*, vol. 35, no. 21, pp. 2121–2128, 2017.

[21] J. Yanci *et al.*, "Sprint, agility, strength and endurance capacity in wheelchair basketball players," *Biol. Sport*, vol. 32, no. 1, pp. 71–78, 2015.

[22] A. Alim and W. D. Yulianto, "VALIDITY DAN RELIABILITY RANGKAIAN TES FISIK ATLET TENIS KURSI RODA YOGYAKARTA," *Indones. Perform. J.*, vol. 6, no. 1, pp. 21–28, 2022.

[23] C. Granados *et al.*, "Anthropometry and performance in wheelchair basketball," *J. Strength Cond. Res.*, vol. 29, no. 7, pp. 1812–1820, 2015.

[24] A. Ferrauti, V. Kinner, and J. Fernandez-Fernandez, "The Hit & Turn Tennis Test: an acoustically controlled endurance test for tennis players," *J. Sports Sci.*, vol. 29, no. 5, pp. 485–494, 2011.

[25] A. Sánchez-Pay and D. Sanz-Rivas, "Assessment of the physical condition of the high-level wheelchair tennis player according to competitive level and kind of injury," *RICYDE. Rev. Int. Ciencias del Deport. doi 10.5232/ricyde*, vol. 15, no. 57, pp. 235–248, 2019.

[26] J. E. Hewitt, "Hewitt's tennis achievement test, research quarterly, American association for health, physical education and recreation. 37: 2, hlm. 231-240." 2013.

[27] R. J. Negrete *et al.*, "Reliability, minimal detectable change, and normative values for tests of upper extremity function and power," *J. Strength Cond. Res.*, vol. 24, no. 12, pp. 3318–3325, 2010.

[28] E. P. Roetert, T. J. McCormick, S. W. Brown, and T. S. Ellenbecker, "Relationship between isokinetic and functional trunk strength in elite junior tennis players," *Isokinet. Exerc. Sci.*, vol. 6, no. 1, pp. 15–20, 1996.

[29] D. I Lovell, M. Bousson, and C. McLellan, "The Use of Performance Tests for the Physiological Monitoring of Training in Combat Sports: A Case Study of a World Ranked Mixed Martial Arts Fighter," *J. Athl. Enhanc.*, vol. 02, no. 01, pp. 1–6, 2013, doi: 10.4172/2324-9080.1000104.

[30] Y. Ikeda, K. Kijima, K. Kawabata, T. Fuchimoto, and A. Ito, "Relationship between side medicine-ball throw performance and physical ability for male and female athletes," *Eur. J. Appl. Physiol.*, vol. 99, pp. 47–55, 2007.

[31] M. Reid, B. Elliott, and J. Alderson, "Shoulder joint kinetics of the elite wheelchair tennis serve," *Br. J. Sports Med.*, vol. 41, no. 11, pp. 739–744, 2007.

[32] Y.-S. Yang, A. M. Koontz, R. J. Triolo, J. L. Mercer, and M. L. Boninger, "Surface electromyography activity of trunk muscles during wheelchair propulsion," *Clin. Biomech.*, vol. 21, no. 10, pp. 1032–1041, 2006.

[33] M. S. Kovacs and T. S. Ellenbecker, "A performance evaluation of the tennis serve: implications for strength, speed, power, and flexibility training," *Strength Cond. J.*, vol. 33, no. 4, pp. 22–30, 2011.

[34] M. Reid and K. Schneiker, "Strength and conditioning in tennis: current research and practice," *J. Sci. Med. Sport*, vol. 11, no. 3, pp. 248–256, 2008.

[35] M. Reid, B. Elliott, and J. Alderson, "Lower-limb coordination and shoulder joint mechanics in the tennis serve," *Med. Sci. Sport. Exerc.*, vol. 40, no. 2, pp. 308–315, 2008.

[36] R. M. Herring and A. E. Chapman, "Effects of changes in segmental values and timing of both torque and torque reversal in

simulated throws," *J. Biomech.*, vol. 25, no. 10, pp. 1173–1184, 1992.

[37] H. Hernández-Davo, T. Urbán, J. M. Sarabia, C. Juan-Recio, and F. Javier Moreno, "Variable training: effects on velocity and accuracy in the tennis serve," *J. Sports Sci.*, vol. 32, no. 14, pp. 1383–1388, 2014.

[38] R. Antúnez, F. Hernández, J. García, R. Vaíllo, and J. Arroyo, "Relationship between motor variability, accuracy, and ball speed in the tennis serve," *J. Hum. Kinet.*, vol. 33, no. 2012, pp. 45–53, 2012.

Evaluation Report

Evaluation Report	Answers
1. The main weak point of the article is found in the introduction. The introduction should be restructured from the beginning and separated from the literature review. The literature review should be further enriched with relevant research on tennis athletes with and without disabilities. All research hypotheses or research questions of the study should be stated clearly.	The introduction has been revised from the beginning to the end in a more comprehensive way. The introduction begins with an overview to individuals with disabilities, the popularity of wheelchair tennis, and a brief description of wheelchair tennis in Indonesia (NPC DIY). Furthermore, the researchers want to show that wheelchair tennis cannot be equated with conventional tennis because of their physical limitations. Thus, we then elaborate on the importance of service accuracy for wheelchair athletes considering their mobility limitations and some of the current research results. Although service accuracy is very important, the components regarding what makes service accuracy good have yet to be discovered with certainty. Therefore, we propose that an athlete's level of accuracy can be measured or influenced by the underlying physical parameters of service accuracy. Meanwhile, we are trying to determine what physical parameters underlie or affect the accuracy of athlete service. If these parameters are known, then the method of developing service accuracy training can be prepared.
2. The results should emphasize the practical applications of the research and mention at least two proposals for further research. For example, in this type of research, it is usual to make two measurements with an intervention program.	In this study, there was no program intervention in the sample, but we analyzed whether physical parameters (characteristics or physical abilities) will affect the accuracy of athlete service. However, the accuracy of the athlete's service was not influenced by physical parameter factors only but also by cognitive parameter factors. We did not examine these cognitive

	parameters, so that it became a limitation of the research we alluded to in the last discussion section.
3. Figure 1 needs improvement	Figure 1 has been replaced.
4. Similarities in some parts with the study of Sánchez et al. (2021)	The revision of introduction has been carried out comprehensively. All similarities with the study of Sánchez et al. (2021) have been minimized.
5. The sample selection is not presented (e.g., was this a convenience sample, did you use power analysis to estimate the sample size, etc.). Also, the participants are not adequately presented.	The sampling technique used uses purposive sampling by looking at performance and the inclusion-exclusion criteria of the sample. It has been added to the Participation and Procedures section. Furthermore, we have added a more detailed athlete description.
6. The sample size should be increased, and more sophisticated statistical analyses should be implemented.	The sample is a selected sample, so there is little opportunity to increase it (considering the small population). The small sample results in limitations in data analysis techniques. Therefore, we mention this limitation (sample size and analysis techniques) as a limitation of the research.
7. The description of the sample and the tests performed should be more accurate and detailed.	Revisions have been done to the sample description and the explanation of the test procedure in more detail.
8. Regression analysis should be removed. Potentially, only logistic regressions can be performed.	The regression analysis has been replaced with logistic regression, but (because of the small number of samples) there are limitations in interpreting the study results (we have mentioned in the data analysis and results section). It is also a limitation of the research.
9. Table 2 needs captions for the acronyms.	The captions for table 2 of "Mean (M), Standard Deviation (SD) and Confidence Interval (CI) of Physical Test measurements" have been changed to "Description of Physical Test Results."
10. The in-text presentation of the correlation analysis should also include the respective p-values (not only the r values).	The p-value has been added for correlation analysis in the results, discussion, conclusion, and abstract sections.

11. Table 4 (and not Figure 4 as incorrectly mentioned in the text) shows the results of the regression analysis, and not the correlation analysis (these are presented in Table 3).	Table 4 has been removed by adding another table that we have added to the paper.

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Peer Review Report

Notes

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Manuscript Information

Manuscript ID:	**19930690**
Manuscript Title:	**The Main Physical Factors in the Serve Accuracy of Wheelchair Tennis Players**

Evaluation Report

General Comments	This is an interesting paper regarding the identification of physical factors related to the serve accuracy in wheelchair tennis players. Extensive editing of English language and style is required. Fore example the sentence in the 1st paragraph "Today's participation in wheelchair tennis has shown comprehensive progress of athletes and coaches" does not make much sense and has to be revised accordingly. Similar sentences exist throughout the manuscript (e.g., "Validity and reliability were used in this study"; Validity and reliability cannot be used, they can be checked/controlled. The sample size is rather limited, and the statistical analysis implemented are very simplistic (correlations and 1 regression).
Advantage & Disadvantage	**2.1. Participation and Procedures:** The description of the sample and the tests performed should be more accurate and detailed. For example, means and SD of age, body weight, etc. should be presented (also check the "height of 56-167± cm", I think something is missing there). The sample selection is not presented (e.g., was this a convenience sample, did you use power analysis to estimate the sample size, etc.). Also, the participants are not adequately presented. For example, what type of disabilities did they have? What was the level of disabilities? etc. More information is definitely needed. **2.3. Data Analysis** I am not sure that with such a small sample size (10 participants) any inferential statistical analysis can be performed. The selection of Shapiro-Wilk test is adequate; however, regression analysis should be removed. Potentially, only logistic regressions can be performed. **Results** Table 2 needs captions for the acronyms. The in-text presentation of the correlation analysis should also include the respective p-values (not only the r values). Table 4 (and not Figure 4 as incorrectly mentioned in the text) shows the results of the regression analysis, and not the correlation analysis (these are presented in Table 3).

How to improve	The sample size should be increased, and more sophisticated statistical analyses should be implemented.

Please rate the following: (1 = Excellent) (2 = Good) (3 = Fair) (4 = Poor)	
Originality:	2
Contribution to the Field:	**2**
Technical Quality:	**4**
Clarity of Presentation :	**3**
Depth of Research:	**4**

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Manuscript Information

Manuscript ID:	**19930690**
Manuscript Title:	**The Main Physical Factors in the Serve Accuracy of Wheelchair Tennis Players**

Evaluation Report

General Comments	The paper "The Main Physical Factors in the Serve Accuracy of Wheelchair Tennis Players", makes a try to identify physical factors that are related to the serve accuracy in wheelchair tennis players. Quantitative research was conducted using field tests. The work is original and can contribute to the existing literature. In this context, I suggest the following points that the authors should improve so that the paper reaches its published form.
Advantage & Disadvantage	**Advantages:** The originality and significance of the work in the research field are high. It is easy to understand (figures, photos, and tables are very helpful) The abstract provides a precise summary of the paper (including the aim, methods, main results, and relevance of the study) The method is well documented The sample size is satisfactory for field research and selected in an appropriate manner The numbers and tables are clear and the reader can get the gist of them. They explain the main findings of the research and are well structured The interpretations provided by the authors are supported by the findings obtained in the study All the references in the list are used in the document The number, relevance, and 'timeliness' of references are appropriate **Disadvantages** The introduction does not identify the paper's purpose or hypotheses and does not place the paper within the broader research perspective The introduction does not put the rest of the paper into perspective (doesn't explain the structure of the paper) The introduction and literature review are both in one section Research questions are not explained in detail Lack of suggestions for further research The paper should be checked for linguistic clarity and accuracy. Pay attention to prepositions

	and highlighted sentences and words.
How to improve	The main weak point of the article is found in the introduction. The introduction should be restructured from the beginning and separated from the literature review. The literature review should be further enriched with relevant research on tennis athletes with and without disabilities. All research hypotheses or research questions of the study should be stated clearly. The results should emphasize the practical applications of the research and mention at least two proposals for further research. For example, in this type of research, it is usual to make two measurements with an intervention program. Professional editing is needed.

Please rate the following: (1 = Excellent) (2 = Good) (3 = Fair) (4 = Poor)

Originality:	1
Contribution to the Field:	**2**
Technical Quality:	**3**
Clarity of Presentation :	**2**
Depth of Research:	**2**

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

Abstract **The purpose** of this study is to identify physical factors related to the serve accuracy in Yogyakarta wheelchair tennis 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 ($r = 0.923$), forehand ($r = 0.807$) and backhand ($r = 0.790$) medicine ball throw showed a positive correlation with serve accuracy. A regression analysis identified a single model with throw medicine ball as the main predictor of serve accuracy ($r2 = 0.836$, $p < 0.001$). 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 a person's limited ability to perform certain roles and tasks. Therefore, physical disability is the third most common after mental retardation and autism [1]. Wheelchair tennis is one of the disciplines of paralympics conducted by tennis athletes with disabilities, especially people with physical disabilities [2][3]. Today's participation in wheelchair tennis has shown comprehensive progress of athletes and coaches [2][3].

Wheelchair tennis (WT) is a sport adapted from conventional tennis (CT) [4]. This sport has increased rapidly and become a competitive sport and encourages professional players [5]. To assist WT players in improving performance and professionalism, creating special training situations that simulate the reality of the competition has been indicated as a key factor in session design [6]. For this reason it is very important for coaches and physical trainers to better understand these factors to influence WT performance and achieve the best results.

The WT competition is divided into two categories: Open and Quad. In the Open category, there are two classes: women and men [4]. In this category players have a wide variety of disabilities, including spinal cord injury, single amputation, double amputation or spina bifida. In the Quad category, men and women play together and they also have limb disabilities and upper body bees as well [7].

Most of the studies conducted on the analysis of WT matches focus on the open category. Those studies concluded that the length of the WT rally proved to last between six to ten seconds, with three to four shots per rally [8][9]. Serve and return of serve seem to be the most important blows in a WT match. In conventional tennis (CT) serve has been described as the most potentially dominant hit in modern times games [10][11], although in WT it does not seem to have the same positive influence as in TC [5][12]. Serve accuracy is undoubtedly one of the determining factors for standing players [13] and its relationship with other factors related to the player's physical condition has been widely studied. Several studies have used different isometric tests, such as wrist, elbow or shoulder flexion-extension [14], while other studies have used dynamic strength tests such as isokinetic shoulder tests [15] to find the relationship between physical condition and serve accuracy. On the other hand, research has also used functional field tests related to medicine ball throw as a factor of serve accuracy

[16][17].

Several studies conducted by national tennis associations have used physical battery tests to determine the ability of their athletes [18][19], as well as to establish relationships between components [20][21][22]. In general, anthropometric measurements, strength, speed, agility, endurance and flexibility are usually included in such tests.

From a biomechanical perspective, serve movements are usually divided into three phases (preparation, acceleration and follow-through) including eight stages (starting, releasing, loading, cocking, acceleration, contact, deceleration and finish) [23]. The loading stage of the lower body has been described as the 'loaded position' adopted by the dominant elbow in its lowest vertical position, coinciding with maximum knee flexion [23] and occurring at the end of the eccentric movement phase. In the case of WT, the players have a lower punch field compared to the standing players, as well as a lower starting power than the standing players due to the production deficit of lower body styles [24]. In addition, the functional limitations of WT players explain that players in the Quad category, who have more functional limitations, impact the ball closer to the body and result in lower hit power compared to the non-quad category [25].

Good serve accuracy reduces the time for opponents to return the ball to its maximum and increasing the likelihood of the server dominating in the rally or directly winning direct points [26]. Because there are studies in TC that show a relationship between physical parameters and serve accuracy [20][17], and that serve techniques will be aligned with one of the physical components, our hypothesis states that there is a relationship between some physical parameters and serve accuracy in WT players. Nevertheless, to the author's knowledge there has been no research on how the relationship of serve accuracy with WT physical parameters, field tests have become a reliable option for establishing athlete performance [27]. Therefore, the purpose of this study is to identify physical factors related to the accuracy serve in WT players using a variety of reliable and valid tests that have been tested in the study.

2. Materials and Methods

2.1. Participation and Procedures

This research is a quantitative study using correlation analysis carried out by field tests. The population in this study were 10 participants consisting of 7 men and 3 women with a height of 56-167± cm, body weight of 50-70± kg aged 31-35 years. The player has 12± 6 years of experience playing and practicing on average 7±10 hours per week. experienced as a national and international athlete, has won the championship at the Asean Paragames 2022 competition in Solo and the national competition 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: (a1) the athlete is not willing to carry out a structured test, (b2) the athlete is not in good health. The study was approved by NPC DIY members and wheelchair tennis athletes.

Athletes were called at alternating times to perform tests [35]. First, a standard 10-minute directed warm-up was performed consisting of joint mobility, linear movement with a chair, circular and turn movements that simulated blows, and low-intensity acceleration and deceleration [28] . Tests were conducted on two consecutive days in the following order: Day 1: Sprint test (5, 10 and 20 m), agility test (T-test), accuracy test of service (Hewitt), and medicine ball throw test (forehand, backhand and serve); Day 2: Incremental resistance test (Hit and Turn Tennis Test) and manual strength handgrip. Scores from various tests were collected during their development by the researchers. All tests are carried out on the outdoor hard tennis court.

2.2. Measurements Collected

Validity and reliability were used in this study. The characteristics of each test are as follows [27][28][29].

Sprint test: four lines at 0.5.10 and 20m were used to measure the speed of the WT athlete. The subject started from the back of the first line. Each athlete performed the test three times without a racket and three times using a racket. 2 minutes break between each repetition. The best score of the three experiments was recorded. Time is calculated in seconds(s).

Agility test (T-Test): This Agility test is adapted for wheelchair tennis [30] and has been used in WT games [31]. Tests include accelluals and desalination, as well as turns from both sides.

Participants start at the center mark in the baseline, they must move to the intersection of the single line with the service line, always approaching the center area of the field (T) until they return to the starting area (figure 1). Each participant performed the test three times using a racket and three times without a racket, with a break of 2 minutes between each repetition. The best scores of all three experiments were recorded. Time is measured using a stopwatch.

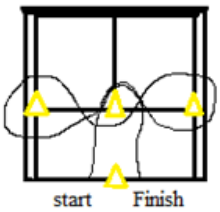

Figure 1. Agility

Hewitt service test: the purpose of this serve accuracy test is to measure the placement ability of service accuracy in tennis players [32]. The implementation of this test each athlete performs an 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 field and has been misled, the athlete performs 10 times serve from behind the baseline, as in figure

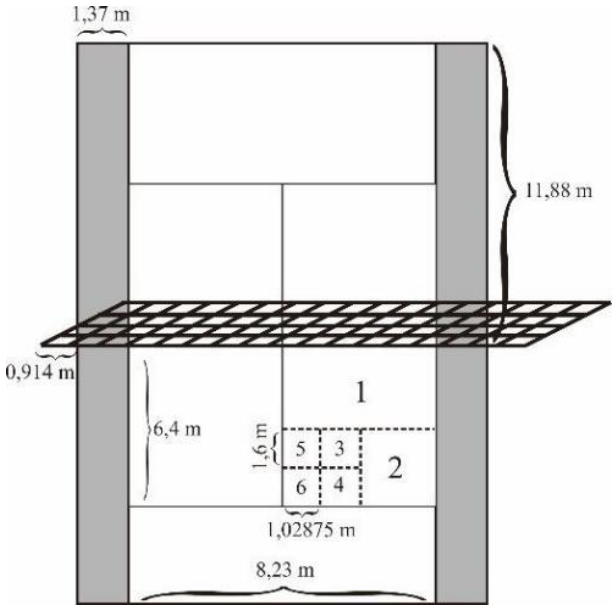

Figure 2. Hewwit

Isometric handgrip strength: a hand dynamometer test is performed to assess the maximum isometric strength in the finger flexor with the Hand Dynamometer. The test was carried out in a wheelchair in a seated position with the arms outstretched and taped to the wheel without actually being concerned [28]. Each athlete performs with 3 repetitions maximum with each hand after the adaptation phase with the isometric research instrument handgrip strength. The remaining time between each repetition is 2 minutes. The best scores of the three trials will be recorded.

Upper body strength: Explosive strength is measured through tests that use medicine ball through test, simulating forehand, backhand and serve movements [33][34]. 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 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 3. Backhand (a)

Figure 4. Forehand (b)

Figure 5. Serve (c)

Anaerobic endurance test (hit and turn tennis test): this test is an adaptation of a standing tennis development to evaluate the player's specific anaerobic endurance through the level reached [29]. The test consists of simulating a punch in a designated place located on the doubles line with the baseline line, according to the existing signal. After the hit, the player simulates another hit on the opposite side and so on until the end of the session. In the punch adaptation must be done close to the mark located in doubles line with the baseline line. End of the test when the athlete cannot take a hit when the sound signal goes off. The results of each athlete were recorded according to where he was unable to simulate a hit.

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

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

2.3. Data Analysis

Because the samples used were small, the Shapiro-Wilk and Levene Test tests were used to test the homogeneity of the variance for each variable (sprint, agility, strength and anaerobic durability). All variables obtained a value of $p > 0.05$, except for the dynamometer variable with the dominant arm. Pearson correlation analysis (Kendall's Tau-b for dominant dynamometer) was performed to identify variables related to service accuracy. The values are classified as 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) [42]. Furthermore, many linear (phased) regression analyses were performed to identify the parameters with the greatest influence on SV. SV is used as a dependent variable, while the rest of the variables that previously showed significance operate as independent variables. Meaning was established at $p < 0.05$.All data were analyzed with IBM SPSS 25.0 statistics.

3. Result

Table 2 shows a descriptive analysis of test measurements in wheelchair tennis players.

Table 3 shows the correlation coefficients of the physical tests performed with service accuracy.

Figure 4 shows that there is a significant statistical relationship between the variables and the accuracy of the service. A higher correlation that was more significant was obtained from medicine ball throw for service ($r = 0.923$), forehand ($r = 0.807$) and backhand ($r = 0.790$) showed a positive correlation. The 20-meter sprint test using a racket showed significance ($p = 0.010$) and a negative correlation with serve accuracy ($r = -0.794$).

Table 2. Mean (M), Standard Deviation (SD) and Confidence Interval (CI) of Physical Test measurements

Test	Mean (M)	Standard Deviation (SD)	Confidence Interval (CI)
Grip Strength. Dom	44.21	4.10	41.11;47.24
Grip strength. No Dom	32.44	5.89	28.34;37.49
Serve Accuracy	89.55	8.98	82.33;96.23
Sprint 5m NR	3.43	0.39	3.23;3.68
Sprint 10m NR	5.34	0.56	4.96;5.87
Sprint 20m NR	11.54	0,87	10.89;12.24
Sprint 5m R	4.43	0.46	4.12;4.78
Sprint 10m R	8.34	0.54	7.98;8.76
Sprint 20m R	12.63	0.98	11.64;13.47
T-Test NR	14.57	1.12	13.54;15.56
T-Test R	15.90	1.26	14.94;16.94
MBT F	5.88	1.90	4.97;6.65
MBT B	5.34	1.67	4.85;6.12
MBT S	7.23	1.55	5.96;8.67
Hit and turn	15.34	3.45	11.96;18.68

Table 3. Correlation Coefficient of Physical Test with Serve Accuracy

Test	r	P
Grip Strength. Dom	0.572	0.098
Grip strength. No Dom	0.284	0.423
Sprint 5m NR	-0.610	0.070
Sprint 10m NR	-.0514	0.147
Sprint 20m NR	-0.533	0.139
Sprint 5m R	-0.519	0.160
Sprint 10m R	-0.612	0.090
Sprint 20m R	-0.794	0.010
T-Test NR	-0.612	0.068
T-Test R	-0.582	0.090
MBT F	0.807	0.007
MBT B	0.790	0.012
MBT S	0.923	<0.001
Hit and turn	0.610	0.083

Dom: Dominant
No Dom: Not dominant
NR: Without Racket
R: With Racket
MBT: Medicine Ball Throw
F: Forehand
B: Backhand

Table 4 shows the results of multiple regression analysis. Medicine ball throw simulation shows that there is a positive relationship to serve accuracy ($r2 = 0.836$, $p < 0.001$).

Table 4. Correlation Coefficient of Physical Test with Serve Accuracy

	R	R^2	R^2 adjust	F	Sig E	Regression Equation
Model	0.923	0.836	0.813	37.483	<0.001	
			Beta	T	Sig T.	y = 69.348 + 6.382 x MBT S
MBTS			0.923	5.986	<0.001	

MBT: Medicine Ball Throw
S: Serve

4. Discussion

Identifying which variables determine as one of the supports for the accuracy of wheelchair tennis services, as well as assisting coaches and physical coaches in designing training programs tailored to technical, psychological, physiological and physical abilities [36]. The purpose of this study is to determine the relationship of physical components that support the serve accuracy Yogyakarta wheelchair tennis players. In general, the medicine ball throw that simulates the forehand, backhand and serve movement blows shows a high correlation, while the service ball throw is the most suitable.

Technical and physical coaches often use tests to evaluate athletes' development according to components (related to speed, agility, maximum strength or functional movement) to make athletes' abilities improve [36]. The pitch of the medicine ball forehand and backhand showed a good and statistically significant correlation with service accuracy (Table 3). This throw is useful for testing the rotational power of athlete trunks [37] and in tennis players [36].

Tennis services include abdominal muscle activity (rectum and obliques) to flex the bones with rotation [24]. In addition, medicine ball throw forehand has a higher correlation with tennis service accuracy than medicine ball throw backhand ($r = 0.807$ vs $r = 0.790$). The implementation of medicine ball throw encompasses body rotation to the dominant side of servicing, which can explain the greater correlation between the two. In addition, the 20m sprint showed a negative correlation with service accuracy ($r = -0.794$). In this elaboration, a greater throw distance is associated with a higher displacement speed (less time) for long distances (20m). Abdominal muscles have a large role in producing service

accuracy [24] and in body balance to perform propulsion [38].

Implementation of biomechanical servicing through 8 stages (prefix, release, loading, cocking, acceleration, contact, deceleration and finish) [23]. Because in wheelchair tennis, the lower part of the body has drawbacks, so in the kinetic chain servicing produces little power. It can be indicated that from the loading phase (semi-side position, elbow of the racket arm at its lowest position, free arm stretched up, etc.) the upper body movement when performing wheelchair servicing has a similarity to when a tennis player stands sitting on a chair. This can explain that the pitch of the medicine ball that simulates the service is the main variable that supports the accuracy of the service (Table 4) showing a high 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.) [39][40].

It is known that movements that generate energy and make stable in hitting action are components of rotation in the abdominal muscles to increase the accuracy in adjusting direction [41]. This action is very clear in the forehand and backhand blows, but also has a very relevant role in the servicing movement. In this study, it has been observed that from a kinematic point of view, actions that resemble forehand, backhand, and service blow have a high correlation with service accuracy. From a kinematic point of view, medicine ball throw service reproduces service movements in the setup and advance-impact phases. 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 [39].

Serve or service is the first strike and involves strength and power of the upper body and shoulder range of motion [23]. 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 [36]. Therefore, the physical and technical trainer 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 have an effect on service accuracy. The physical component will support in play and technique in play [20][14].

5. Conclusions

Forehand, backhand and service simulation movements using Medicine ball throw showed a high correlation to serve accuracy in WT. 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.

REFERENCES

[1] Cooley-Nichols, S. Generic special education teacher preparation: emotional and behavioural disorders. Emotional and Behavioural Disabilities 9, no. 1: 28–40. 2004.

[2] Sánchez-Pay, A., Martínez-Gallego, R., Crespo, M., & Sanz-Rivas, D. Key Physical Factors in the Serve Velocity of Male Professional Wheelchair Tennis Players. International Journal of Environmental Research and Public Health, 18(4), 1944. 2021. https://doi. org/10.3390/ijerph18041944

[3] Sánchez-Pay, A., Torres-Luque, G., & Sanz-Rivas, D. Match activity and physiological load in wheel chair tennis players: a pilot study. Spinal Cord, 54(3), 229-233. https://doi.org/10.1038/sc.2015.107

[4] International Tennis Federation. Rules of Tennis; International Tennis Federation: London, UK, 2020.

[5] Sánchez-Pay, A. Analysis of scientific production in wt [Análisis de la producción científica sobre el tenis en silla de ruedas]. Rev. Iberoam. Cienc. Act. Física Deport, 8, 13–25. 2019. [CrossRef]

[6] Reid, M.; Morgan, S.; Whiteside, D. Matchplay characteristics of Grand Slam tennis: Implications for training and conditioning. J. Sport. Sci, 34, 1791–1798. 2016. [CrossRef]

[7] Sánchez-Pay, A.; Sanz-Rivas, D. Wt, from health to competitive analysis: A narrative review. J. Hum. Sport Exerc, in press. 2020. [CrossRef]

[8] Mason, B.S.; van der Slikke, R.M.A.; Hutchinson, M.J.; Goosey-Tolfrey, V.L. Division, result and score margin alter the physical and technical performance of elite wt players. J. Sports Sci, 38, 937–944. 2020. [CrossRef]

[9] Sánchez-Pay, A.; Palao, J.M.; Torres-Luque, G.; Sanz-Rivas, D. Differences in set statistics between wheelchair and conventional tennis on different types of surfaces and by gender. Int. J. Perform. Anal. Sport, 15, 1177–1188. 2015. [CrossRef]

[10] O'Donoghue, P.; Brown, E. The importance of service in Grand Slam singles tennis. Int. J. Perform. Anal. Sport, 8, 70–78. 2008. [CrossRef]

[11] Fitzpatrick, A.; Stone, J.A.; Choppin, S.; Kelley, J. Important performance characteristics in elite clay and grass court tennis match-play. Int. J. Perform. Anal. Sport, 19, 942–952. 2 0 1 9 . [CrossRef]

[12] Sánchez-Pay, A.; Sanz-Rivas, D.; Torres-Luque, G. Match analysis in a wt tournament. Int. J. Perform. Anal. Sport, 15, 540–550. 2015. [CrossRef]

[13] Ayala, F., Moreno-Pérez, V., Vera-Garcia, F. J., Moya, M., Sanz-Rivas, D., & Fernandez-Fernandez, J. Acute and time-course effects of traditional and dynamic warm-up routines in young elite junior tennis players. PloS one, 11(4), e0152790. 2016.

[14] Antúnez, RM, Hernández, FJM, García, JPF, Vaíllo, RR, & Arroyo, JSD. Correlation of motor variability, accuracy and ball speed in tennis serve. Journal of Human Kinetics, 33, 45. 2012.

[15] Baiget, E.; Corbi, F.; Fuentes, J.P.; Fernández-Fernández, J. The relationship between maximum isometric strength and ball velocity in the tennis serve. J. Hum. Kinet, 53, 63–71. 2016. [CrossRef]

[16] Hernández-Davó, J.L.; Moreno, F.J.; Sanz-Rivas, D.; Hernández-Davó, H.; Coves, Á.; Caballero, C. Variations in kinematic variables and performance in the tennis serve according to age and skill level. Int. J. Perform. Anal. Sport, 19, 749–762. 2019. [CrossRef]

[17] Atkinson, G., & Speirs, L. Diurnal variation in tennis service. Perceptual and motor skills, 86(3_suppl), 1335-1338. 1998.

[18] Kramer, T.; Huijgen, B.C.H.; Elferink-Gemser, M.T.; Visscher, C. A longitudinal study of physical fitness in elite junior tennis players. Pediatr. Exerc. Sci, 28, 553–564. 2016. [CrossRef]

[19] Yulianto, W. D., & Yudhistira, D. Content Validity of Circuit Training Program and Its Effects on The Aerobic Endurance of Wt Athletes. International Journal of Kinesiology and Sports Science, 9(3), 60-65. 2021

[20] Hernández-Davo, H., Urbán, T., Sarabia, J. M., Juan-Recio, C., & Javier Moreno, F. Variable training: effects on velocity and accuracy in the tennis serve. Journal of sports sciences, 32(14), 1383-1388. 2014.

[21] Fernandez-Fernandez, J.; Nakamura, F.Y.; Moreno-Perez, V.; Lopez-Valenciano, A.; Del Coso, J.; Gallo-Salazar, C.; Barbado, D.; Ruiz-Perez, I.; Sanz-Rivas, D. Age and sex-related upper body performance differences in competitive young tennis players. PLoS ONE, 14. 2019. [CrossRef] [PubMed]

[22] Ulbricht, A.; Fernandez-Fernandez, J.; Mendez-Villanueva, A.; Ferrauti, A. Impact of fitness characteristics on tennis performance in elite junior tennis players. J. Strength Cond. Res, 30, 989–998. 2016. [CrossRef]

[23] Kovacs, M.S.; Ellenbecker, T.S. A performance evaluation of the tennis serve: Implications for strength, speed, power, and flexibility training. Strength Cond. J, 33, 22–30. 2011. [CrossRef]

[24] Reid, M.; Elliott, B.C.; Alderson, J. Shoulder joint kinetics of the elite wt serve. Br. J. Sports Med. 41, 739–744. 2007. [CrossRef] [PubMed]

[25] Cavedon, V.; Zancanaro, C.; Milanese, C. Kinematic analysis of the wt serve: Implications for classification. Scand.

[26] Whiteside, D.; Reid, M. Spatial characteristics of professional tennis serves with implications for serving aces: A machine learning approach. J. Sports Sci, 35, 648–654. 2017. [CrossRef]

[27] Alim, A., & Yulianto, W. D. Validity Dan Reliability Rangkaian Tes Fisik Atlet Tenis Kursi Roda Yogyakarta. Indonesia Performance Journal, 6(1), 21-28. 2022.

[28] Granados, C.; Yanci, J.; Badiola, A.; Iturricastillo, A.; Otero, M.; Olasagasti, J.; Bidaurrazaga-Letona, I.; Gil, S.M. Anthropometry and performance in wheelchair basketball. J. Strength Cond. Res, 29, 1812–1820. 2015. [CrossRef] [PubMed]

[29] Ferrauti, A.; Kinner, V.; Fernandez-Fernandez, J. The Hit & Turn Tennis Test: An acoustically controlled endurance test for tennis players. J. Sports Sci, 29, 485–494. 2011.

[30] Yanci, J.; Granados, C.; Otero, M.; Badiola, A.; Olasagasti, J.; Bidaurrazaga-Letona, I.; Iturricastillo, A.; Gil, S.M. Sprint, agility, strength and endurance capacity in wheelchair basketball players. Biol. Sport, 32, 71–78. 2015. [CrossRef]

[31] Sánchez-Pay, A.; Sanz-Rivas, D. Assessment of the physical condition of the high-level wt player according to competitive level and kind of injury. RICYDE Rev. Int. Ciencias del Deport, 57, 235–248. 2019. [CrossRef]

[32] Hewitt, J. E. Hewitt's tennis achievement test. Research Quarterly. American Association for Health, Physical Education and Recreation, 37(2), 231-240. 1966.

[33] Negrete, R.J.; Hanney, W.J.; Kolber, M.J.; Davies, G.J.; Ansley, M.K.; Mcbride, A.B.; Overstreet, A.L. Reliability, minimal

detectable change, and normative values for tests of upper extremity function and power. J. Strength Cond. Res, 24, 3318–3325. 2010. [CrossRef]

[34] Roetert, E.P.; McCormick, T.J.; Brown, S.W.; Ellenbecker, T.S. Relationship between isokinetic and functional trunk strength in elite junior tennis players. Isokinet. Exerc. Sci, 6, 15–20. 1996. [CrossRef]

[35] López-Samanes, Á.; Moreno-Pérez, D.; Maté-Muñoz, J.L.; Domínguez, R.; Pallarés, J.G.; Mora-Rodriguez, R.; Ortega, J.F. Circadian rhythm effect on physical tennis performance in trained male players. J. Sports Sci, 35, 2121–2128. 2017. [CrossRef] [PubMed]

[36] Lovell, D. I., Bousson, M., & McLellan, C. The use of performance tests for the physiological monitoring of training in combat sports: A case study of a world ranked mixed martial arts fighter. J Athl Enhancement, 2(1), 2-6. 2013. https://doi.org/10.4172/2324-9080.1000104

[37] Ikeda, Y.; Kijima, K.; Kawabata, K.; Fuchimoto, T.; Ito, A. Relationship between side medicine-ball throw performance and physical ability for male and female athletes. Eur. J. Appl. Physiol, 99, 47–55. 2007. [CrossRef]

[38] Yang, Y.-S.; Koontz, A.M.; Triolo, R.J.; Mercer, J.L.; Boninger, M.L. Surface electromyography activity of trunk muscles during wheelchair propulsion. Clin. Biomech, 21, 1032–1041. 2006. [CrossRef]

[39] Reid, M.; Elliot, B.; Alderson, J. Lower-limb coordination and shoulder joint mechanics in the tennis serve. Med. Sci. Sports Exerc, 40, 308–315. 2008. [CrossRef]

[40] Reid, M.; Schneiker, K. Strength and conditioning in tennis: Current research and practice. J. Sci. Med. Sport, 11, 248–256. 2008. [CrossRef]

[41] Herring, R.M.; Chapman, A.E. Effects of changes in segmental values and timing of both torque and torque reversal in simulated throws. J. Biomech, 25, 1173–1184. 1992. [CrossRef]

[42] Hopkins, W.G. Measures of reliability in sports medicine and science. Sport. Med, 30, 1–15. 2000. [CrossRef]

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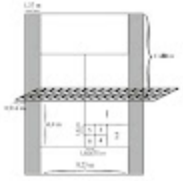

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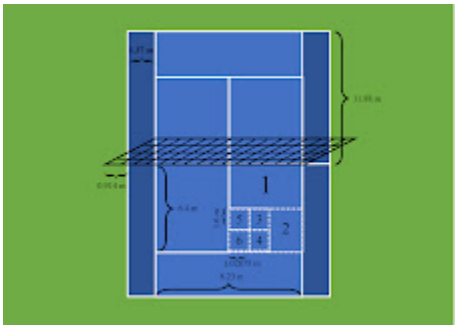

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DESCRIPTION OF ETHICAL APPROVAL
"ETHICAL APPROVAL"

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Surat keterangan ini menyatakan bahwa Komisi Etik Lembaga Penelitian dan Pengabdian pada Masyarakat Universitas Negeri Yogyakarta telah melakukan telaah terhadap riset:

This statement is to inform that the ethics committee at Institute of Research and Community Service Universitas Negeri Yogyakarta has approved a study:

Judul *Title*	:	Analisis Faktor Fisik Dominan dalam Akurasi Servis Atlet Tenis Kursi Roda *The Main Physical Factors in the Serve Accuracy of Wheelchair Tennis Players*
Nama Peneliti *Name of Investigator(s)*	:	(1) Dr. Abdul Alim, M.Or. (2) Dr. Cerika Rismayathi, M. Or (3) Wahyu Dwi Yulianto, M.Pd (4) Yulvia Miftachurochmah, M.Pd
Nama Institusi *Name of Institution*	:	Universitas Negeri Yogyakarta

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Declared to be ethically appropriate in accordance to 7 (seven) WHO 2011 Standards, 1) Social Values, 2) Scientific Values, 3) Equitable Assessment and Benefits, 4) Risks, 5) Persuasion/Exploitation, 6) Confidentiality and Privacy, and 7) Informed Concent, referring to the 2016 CIOMS Guidelines.

Pernyataan Layak Etik ini berlaku selama 1 Agustus 2022 sampai tanggal 30 Oktober 2022.

This declaration of ethics applies during the period August 1, 2022– October 30, 2022

Yogyakarta, 29 July 2022
Professor and Chairperson,

Prof. Dr. Dra. Endang Rini Sukamti, M.S.

FINAL CHECK MIFTA

by fitriakamelias@gmail.com kamelia

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

Abstract **The purpose** of this study is to identify physical factors related to the serve accuracy in Yogyakarta wheelchair tennis 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. (2019), 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 [12]. Good serve accuracy reduces the time for opponents to return the ball to its maximum and increasing 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 engineering component 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 will be prepared.

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 were of 10 participants consisting of 7 men and three women with a height of 167 ± 5.6 cm, a weight of 59.60 ± 6.59 kg, an age of 33.4 ± 1.51 years, exercise duration per week of 9.2 ± 1.1 hours/week, and exercise experience of 8.3 ± 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 ± 1.8 years of playing experience with an average practice time of 9.2 ± 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.   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 [22]–[24].

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 [21] and has been used in WT games [25]. Tests include acceleration and deceleration, as well as turns from both sides.

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) (figure 1). 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.

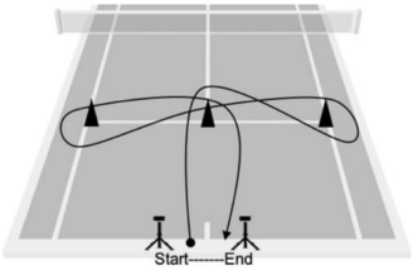

Figure 1. Agility

Source: adapted from [4]

Hewitt service test: the purpose of this serve accuracy test is to measure the placement ability of service accuracy in tennis players [26]. The implementation of this test each athlete performs an 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 field and has been misled, the athlete performs 10 times serve from behind the baseline, as in figure 2.

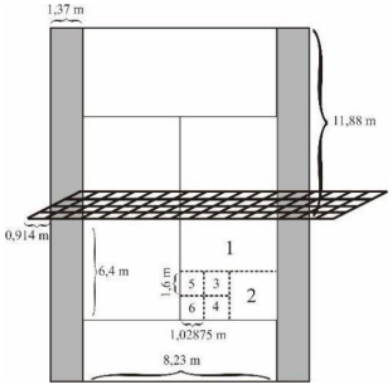

Figure 2. Hewwit

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 [23]. 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.

Upper body strength: Medicine ball tests that simulate forehand, backhand, and serve motions are used to assess explosive strength [27], [28]. 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 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 3. Backhand (a)

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 [24]. 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.

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

Physical variable	Test	Characteristics
	Grip strength	1-Dominan
		2-Non-dominan
Strength	Medicine ball	1-Forehand
		2-Backhand
		3-Serve
	Serve accuracy	Average Value of 10 serves
	5m	
Sprint	10m	With and without racket
	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 variables obtained a Shapiro-Wilk value of $p > 0.05$, so all data is normally distributed. Therefore, the test of inferential data with parametric tests can be carried out.

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. Thus, having a strong relationship with the degree of relationship consistently negative is very good, positive is very good, positive is very good, positive is very good, and positive is very good. 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 (Hewitt test) 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. 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. Thus, having a strong relationship with the degree of relationship consistently negative is very good, positive is very good, positive is very good, positive is very good, and positive is very good. 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 (Hewitt test) 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.

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%, 100%, and 90% (table 6-8).

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 Racket
R: With Racket
MBT: Medicine Ball Throw
F: Forehand
B: Backhand

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

Table 4. 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

Table 5. Hasil Uji Logistic Regression Parameter Fisik terhadap Tingkat Akurasi

Kelompok Variabel Predictor	Variabel Predictor	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

Tabel 6. Predicted Model menggunakan kelompok variable predictor sprint without racquet

Classification Table				
		Predicted		
		Kategori Servis		Percentage Correct
		Rata-rata, di bawah rata-rata, dan kurang	Baik dan sangat baik	
Kategori Servis	0 = Rata-rata, di bawah rata-rata, dan kurang	4	1	80.0
	1 = Baik dan sangat baik	1	4	80.0
Overall Percentage				80.0

Tabel 7. Predicted Model menggunakan kelompok variable predictor Strength

Classification Table				
		Predicted		
		Kategori Servis		Percentage Correct
		Rata-rata, di bawah rata-rata, dan kurang	Baik dan sangat baik	
Kategori Servis	0 = Rata-rata, di bawah rata-rata, dan kurang	5	0	100.0
	1 = Baik dan sangat baik	0	5	100.0
Overall Percentage				100.0

Tabel 8. Predicted Model menggunakan kelompok variable predictor Endurance

Classification Table				
		Predicted		
		Kategori Servis		Percentage Correct
		Rata-rata, di bawah rata-rata, dan kurang	Baik dan sangat baik	
Kategori Servis	0 = Rata-rata, di bawah rata-rata, dan kurang	4	1	90.0
	1 = Baik dan sangat baik	0	5	100.0
Overall Percentage				90.0

4. Discussion

Identifying which variables determine as one of the supports for the accuracy of wheelchair tennis services, as well as assisting coaches and physical coaches in designing training programs tailored to technical, psychological, physiological and physical abilities [29]. The purpose of this study is to determine the relationship of physical components that support the serve accuracy Yogyakarta wheelchair tennis players. In general, the medicine ball throw that simulates the forehand, backhand and serve movement blows shows 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) [29]. 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 [30] and in tennis players [29].

Tennis services include abdominal muscle activity (rectum and obliques) to flex the bones with rotation [31]. 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 [31] and in body balance to perform propulsion [32].

Implementation of biomechanical servicing through 8 stages (prefix, release, loading, cocking, acceleration, contact, deceleration and finish) [33]. 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.)[34], [35].

It is known that movements that generate energy and make stable in hitting action are components of rotation in the abdominal muscles to increase the accuracy in adjusting direction [36]. 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

Commented [H1]: was

Commented [H2]: showed

[35].

Serve or service is the first strike and involves strength and power of the upper body and shoulder range of motion [33]. 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 [29]. Therefore, the physical and technical trainer 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. The physical component will support in play and technique in play [37], [38].

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 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 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 20m sprint with the racquet, medicine ball throw forehand, medicine ball throw backhand, and medicine ball throw service can affect the accuracy of athletes and are likely to be the determining factors in the accuracy of wheelchair tennis athlete service. 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.

REFERENCES

[1] C. for D. C. and Prevention, "Disability and health overview: Impairments, activity limitations and participation restrictions." US Department of Health and Human Services. https://www. cdc. gov/ncbddd …, 2020.

[2] C. for D. C. and Prevention, "CDC: 1 in 4 US adults live with a disability," *CDC Online Newsroom*, 2018.

[3] S. M. Cooley-Nichols, "Generic special education teacher preparation: Emotional and behavioral disorders," *Emot. Behav. Difficulties*, vol. 9, no. 1, pp. 28–40, 2004.

[4] A. Sánchez-Pay, R. Martínez-Gallego, M. Crespo, and D. Sanz-Rivas, "Key physical factors in the serve velocity of male professional wheelchair tennis players," *Int. J. Environ. Res. Public Health*, vol. 18, no. 4, p. 1944, 2021.

[5] A. Sánchez-Pay, G. Torres-Luque, and D. Sanz-Rivas, "Match activity and physiological load in wheelchair tennis players: a pilot study," *Spinal Cord*, vol. 54, no. 3, pp. 229–233, 2016.

[6] J. R. Gold and M. M. Gold, "Access for all: the rise of the Paralympic Games," *J. R. Soc. Promot. Health*, vol. 127, no. 3, pp. 133–141, 2007.

[7] N. J. Diaper and V. L. Goosey-Tolfrey, "A physiological case study of a paralympic wheelchair tennis player: reflective practise," *J. Sports Sci. Med.*, vol. 8, no. 2, p. 300, 2009.

[8] International Paralympic Committee, "Wheelchair Tennis Classification & Categories," Feb. 2023. https://www.paralympic.org/wheelchair-tennis/classification (accessed Feb. 15, 2023).

[9] ITF Tennis, "Tennis Rules and Regulations ," Feb. 2023. https://www.itftennis.com/en/about-us/governance/rules-and-regulations/?type=classification (accessed Feb. 15, 2023).

[10] R. M. A. Van der Slikke, M. A. M. Berger, D. J. J. Bregman, and H. E. J. Veeger, "From big data to rich data: The key features of athlete wheelchair mobility performance," *J. Biomech.*, vol. 49, no. 14, pp. 3340–3346, 2016.

[11] R. M. A. van der Slikke, M. A. M. Berger, D. J. J. Bregman, and D. H. E. J. Veeger, "Wearable wheelchair mobility performance

measurement in basketball, rugby, and tennis: lessons for classification and training," *Sensors*, vol. 20, no. 12, p. 3518, 2020.

[12] A. Fitzpatrick, J. A. Stone, S. Choppin, and J. Kelley, "Important performance characteristics in elite clay and grass court tennis match-play," *Int. J. Perform. Anal. Sport*, vol. 19, no. 6, pp. 942–952, 2019.

[13] S. Mecheri, F. Rioult, B. Mantel, F. Kauffmann, and N. Benguigui, "The serve impact in tennis: First large-scale study of big Hawk-Eye data," *Stat. Anal. Data Min. ASA Data Sci. J.*, vol. 9, no. 5, pp. 310–325, 2016.

[14] J. Beckmann, L. Fimpel, and V. V. Wergin, "Preventing a loss of accuracy of the tennis serve under pressure," *PLoS One*, vol. 16, no. 7, p. e0255060, 2021.

[15] M. S. Kovacs, "Tennis physiology: training the competitive athlete," *Sport. Med.*, vol. 37, pp. 189–198, 2007.

[16] E. Strecker, E. B. Foster, and D. D. Pascoe, "Test–retest reliability for hitting accuracy tennis test," *J. Strength Cond. Res.*, vol. 25, no. 12, pp. 3501–3505, 2011.

[17] N. S. Kolman, T. Kramer, M. T. Elferink-Gemser, B. C. H. Huijgen, and C. Visscher, "Technical and tactical skills related to performance levels in tennis: A systematic review," *J. Sports Sci.*, vol. 37, no. 1, pp. 108–121, 2019.

[18] T. O. Bompa and C. Buzzichelli, *Periodization: theory and methodology of training*. Human kinetics, 2018.

[19] J. Lambrich and T. Muehlbauer, "Physical fitness and stroke performance in healthy tennis players with different competition levels: A systematic review and meta-analysis," *PLoS One*, vol. 17, no. 6, p. e0269516, 2022.

[20] Á. López-Samanes *et al.*, "Circadian rhythm effect on physical tennis performance in trained male players," *J. Sports Sci.*, vol. 35, no. 21, pp. 2121–2128, 2017.

[21] J. Yanci *et al.*, "Sprint, agility, strength and endurance capacity in wheelchair basketball players," *Biol. Sport*, vol. 32, no. 1, pp. 71–78, 2015.

[22] A. Alim and W. D. Yulianto, "VALIDITY DAN RELIABILITY RANGKAIAN TES FISIK ATLET TENIS KURSI RODA YOGYAKARTA," *Indones. Perform. J.*, vol. 6, no. 1, pp. 21–28, 2022.

[23] C. Granados *et al.*, "Anthropometry and performance in wheelchair basketball," *J. Strength Cond. Res.*, vol. 29, no. 7, pp. 1812–1820, 2015.

[24] A. Ferrauti, V. Kinner, and J. Fernandez-Fernandez, "The Hit & Turn Tennis Test: an acoustically controlled endurance test for tennis players," *J. Sports Sci.*, vol. 29, no. 5, pp. 485–494, 2011.

[25] A. Sánchez-Pay and D. Sanz-Rivas, "Assessment of the physical condition of the high-level wheelchair tennis player according to competitive level and kind of injury," *RICYDE. Rev. Int. Ciencias del Deport. doi 10.5232/ricyde*, vol. 15, no. 57, pp. 235–248, 2019.

[26] J. E. Hewitt, "Hewitt's tennis achievement test, research quarterly, American association for health, physical education and recreation. 37: 2, hlm. 231-240." 2013.

[27] R. J. Negrete *et al.*, "Reliability, minimal detectable change, and normative values for tests of upper extremity function and power," *J. Strength Cond. Res.*, vol. 24, no. 12, pp. 3318–3325, 2010.

[28] E. P. Roetert, T. J. McCormick, S. W. Brown, and T. S. Ellenbecker, "Relationship between isokinetic and functional trunk strength in elite junior tennis players," *Isokinet. Exerc. Sci.*, vol. 6, no. 1, pp. 15–20, 1996.

[29] D. I Lovell, M. Bousson, and C. McLellan, "The Use of Performance Tests for the Physiological Monitoring of Training in Combat Sports: A Case Study of a World Ranked Mixed Martial Arts Fighter," *J. Athl. Enhanc.*, vol. 02, no. 01, pp. 1–6, 2013, doi: 10.4172/2324-9080.1000104.

[30] Y. Ikeda, K. Kijima, K. Kawabata, T. Fuchimoto, and A. Ito, "Relationship between side medicine-ball throw performance and physical ability for male and female athletes," *Eur. J. Appl. Physiol.*, vol. 99, pp. 47–55, 2007.

[31] M. Reid, B. Elliott, and J. Alderson, "Shoulder joint kinetics of the elite wheelchair tennis serve," *Br. J. Sports Med.*, vol. 41, no. 11, pp. 739–744, 2007.

[32] Y.-S. Yang, A. M. Koontz, R. J. Triolo, J. L. Mercer, and M. L. Boninger, "Surface electromyography activity of trunk muscles during wheelchair propulsion," *Clin. Biomech.*, vol. 21, no. 10, pp. 1032–1041, 2006.

[33] M. S. Kovacs and T. S. Ellenbecker, "A performance evaluation of the tennis serve: implications for strength, speed, power, and flexibility training," *Strength Cond. J.*, vol. 33, no. 4, pp. 22–30, 2011.

[34] M. Reid and K. Schneiker, "Strength and conditioning in tennis: current research and practice," *J. Sci. Med. Sport*, vol. 11, no. 3, pp. 248–256, 2008.

[35] M. Reid, B. Elliott, and J. Alderson, "Lower-limb coordination and shoulder joint mechanics in the tennis serve," *Med. Sci. Sport. Exerc.*, vol. 40, no. 2, pp. 308–315, 2008.

[36] R. M. Herring and A. E. Chapman, "Effects of changes in segmental values and timing of both torque and torque reversal in

simulated throws," *J. Biomech.*, vol. 25, no. 10, pp. 1173–1184, 1992.

[37] H. Hernández-Davo, T. Urbán, J. M. Sarabia, C. Juan-Recio, and F. Javier Moreno, "Variable training: effects on velocity and accuracy in the tennis serve," *J. Sports Sci.*, vol. 32, no. 14, pp. 1383–1388, 2014.

[38] R. Antúnez, F. Hernández, J. García, R. Vaíllo, and J. Arroyo, "Relationship between motor variability, accuracy, and ball speed in the tennis serve," *J. Hum. Kinet.*, vol. 33, no. 2012, pp. 45–53, 2012.

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