

PERFORMANCE MODEL IN SITTING VOLLEYBALL: THE RIO 2016 PARALYMPIC GAMES CASE

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ABSTRACT. Objectives. Sitting Volleyball has been a Paralympic discipline recognized by the IPC since 2004 and has been part of the FIPAV sports disciplines since 2013, under the aegis of CONI and CIP. **Material and Methods.** This research aims to identify the Performance Model in Sitting Volleyball and define the correlations between gestures or phases of the game and victory. The sample includes the eight male and the eight female finalists of the competition for the gold medal of Rio 2016 Olympics Games. **Results.** The results confirm Sitting Volleyball as an attacking sport in both the male and female sectors. **Conclusions.** The efficiency of the attack turns out to be correlated to the victory of single sets. In the female sector, the serve is a winning tactical weapon; the block is more consistent in the male one. Ultimately, the quality of the side-out and breakpoint phases is correlated to the victory of the single set.

Keywords: *sitting volleyball, Paralympics, adapted sport, performance, model.*

Introduction

Sitting Volleyball has been a Paralympic discipline since 1980 but its history has distant roots in time. It was in the wake of the Stoke Mandeville International Games, when Sitting Volleyball was introduced in 1956 in the Netherlands, by Tammo Van de Scheer and Anton Albers, as a new sport that could bring together the characteristics of traditional volleyball and Sitzball.

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The aim was to allow wounded or amputated soldiers of the Second World War to practice sports. The bet was that constant physical activity could have improved social relationships and the physical recovery of injured people. Sport proved to be a fantastic catalyst for increasing people's physical well-being, both from a physiological (endorphin) and emotional (Matthews, Sukeik, Haddad, 2014) (Interaction with others) point of views (Bragaru, Dekker, Geertzenm Dijkstra, 2011). Thousands of war veterans needed to get out of their homes, to socialize.

In the same period, there were several attempts to practice volleyball while sitting on a wheelchair, but it wasn't successful, perhaps due to the excessive static nature of the game. Also, in England, Standing Volleyball was being developed: a game played by amputated athletes while standing. The two disciplines under the aegis of the ISOD (International Sport Organization of the Disabled) were performed as exhibition disciplines, only for the men's tournament of the 1976 Toronto Paralympic Games, but later included as official disciplines in 1980 in Arnhem, Netherlands.

Until the 2000 Sydney Games, the two sports had a parallel development. However, in 2004, Standing Volley was removed from the Paralympics to make room for women's Sitting Volleyball. Today, Sitting Volleyball is known all over the world and played not only in Europe, but also in America, Africa, Asia and Oceania, coordinated in each continent by the relevant organizations: ECVD (European Committee Volleyball for Disabled), PACVD (Pan -American Committee Volleyball for Disabled), ACVD (African Committee Volleyball for Disabled), AOCVD (Asia Oceania Committee Volleyball for Disabled); organizations that respond to the WOVD (World Organization Volleyball for Disabled) and the I.P.C. (International Paralympic Committee).

Sitting Volleyball is a sport in which disabled and able-bodied people can play together at a very high technical level and it represents an opportunity for cooperation and integration. As numerous scientific studies suggest, sports activities involving children with disabilities can reduce negative attitudes towards disability in able-body children.

This discipline is widespread internationally. Now, the most important worldwide representatives are Italy, Brazil, Iran, USA, Russia and Serbia. In these countries, for various socio-cultural reasons, there is a very strong and significant movement involved in the Paralympic disciplines, attributable to the sports, military and public health heritage of these contexts.

Research objectives and hypotheses

The aim of this paper is to define Performance Model in Sitting Volleyball and useful parameters for the achievement of victory. Sitting Volleyball is still in a pioneering phase and it lacks many performance analysis tools. Furthermore, the performance model is not well defined and formalized yet. Fortunately, volleyball, from which it has borrowed many aspects of the game, is on the contrary at a very advanced stage in terms of match analysis and definition of the performance model.

Match analysis in volleyball has become standardized worldwide and it is a fundamental engine of teams. It allows to monitor the game informing the players about their performance, through an objective tool.

"Until these operations were entrusted to the sensations of the coaches, the interventions were conflicting and above all not very convincing, because they lacked the fundamental requirement of objectivity" (Lombardozzi et al., 2000).

Many parameters are available to Sitting Volleyball. In detail, this research aims to identify:

- The parameters to establish a Performance Model in Sitting Volleyball in terms of effectiveness and efficiency of technical gestures, ball change and breakpoint systems.
- Specific sport correlations between the aforementioned gestures or systems and victory / defeat.

Material & methods

The match analysis focused on the matches played during the 2016 Paralympic Sitting Volleyball Games. The 6 final matches of women's competition were analyzed. Data Volley was the software used to build the performance analysis in Sitting Volleyball; it is normally used in volleyball and beach volleyball. This software is set on the volleyball rules; it was therefore necessary to create some customized parameters (so-called "customizations") to comply with some different rules (e.g. the block on the serve).

A very important process for the construction of a Performance Model in Sitting Volleyball has been the construction of "universal" parameters that can be adopted as valid indicators of the performance. For this reason, during the research, interviews with privileged witnesses were used, such as coaches, players, referees from the world of Sitting Volleyball, both at national and international level. From these elements, it was possible to build a first set of tools useful to highlight the main characteristics of Sitting Volleyball and to underline the most critical points with the statistical analysis software.

Results

The serve and its directions

The serve represents the beginning of the game and therefore assumes a strategic importance. The study did not reveal, in line with what was hoped, a particular direction of the serve, but a very varied range both of the starting point and of the arrival point emerged. The most used serve in the competition is the float, followed by the "hybrid" and lastly the "spin". These serves differ greatly from each other:

- Float: this effect literally makes the ball float in the air, making its oscillatory trajectory difficult to receive. It is often used as a tactical weapon.
- Spin: this effect, typical of a powerful hit, makes the ball spin from top to bottom with a powerful wrist movement.
- Hybrid: serve that starts with one of the two effects and ends in the other; often used to hide real intentions to the opponent.

Hybrid serve is interesting in women. Players pretend to throw the "float" ball, stationary, without rotation, and then perform a spin, often top-spin (ball rotation from top to bottom). Other times, more rarely, the opposite happens. This much greater use, compared to volleyball or beach volleyball, is probably due to the extreme speed of the game and the small size of the field that make it essential to use a lot of feints to hide intentions from the opponent.

The low presence of spin serves, widely used in volleyball especially by men, is probably due to the constant presence of the opponent's block. This type of serve is effective if it passes close to the upper belt of the net. The block forces the player to raise serve parable. In the following graph, you can see the uses in women's teams of the serve. Only two national teams use the "spin", confirming what was said previously.

The quality of the serve is measured according to the canonical standards of volleyball evaluation. The management of this aspect shows numerous similarities with the serve of other similar sports. Errors represent an important part of the performance especially for women. Furthermore, it is very interesting to notice that women take more risks (more errors) but then score more points (indeed, there is a higher efficiency). With men, however, the lower efficiency stands out probably due to the presence of the block.

Serve-block correlation

Another very important part of the performance is the serve-block correlation, which, in the case of Sitting Volleyball, is a unique feature among the return sports. In these sports the serve is usually performed without

obstacles; the ball passes over the net into the other court and the opponent often intercepts it at considerable distances from the net. This prevents the attack construction or makes it more difficult to approach the net. In Sitting Volleyball, the server must take into consideration the presence of the block and its organization. From the data collected it emerges that in women about one block out of six (16%) is made after the opponent's serve. This is a significant data considering the usual comparison with other sports. With men the percentage lowers but we must not forget that the number of attacks is almost double (n male attacks = 1909; n female attacks = 1095) with the number of serve that instead remains with similar values (male = 1125; female = 844). However, it is important to consider as well that the data analysis is based on one match (5 sets) more with men than with women.

By analyzing the video, the authors realize that the block is extremely important for the economy of the game. Indeed, the efficiency is very high. The block represents a fundamental strategic key.

The number of players on the block is another important performance factor. Rarely there is not any person on the block, while there are many occurrences of 3-player blocks, especially with women. As expected, due to the difficulty of moving, this type of block is carried out mainly against the opposing middle-hitter or by spikes from the center of the net.

The block has a high efficiency in relation to the number of touches made and considering that in indoor volleyball it is often difficult to reach 10% efficiency in this fundamental.

Receiving and related schemes

Through the video analysis, various receiving schemes were observed. The trend is to keep three people on the second line to make the first touch and three people on the front line very close to the net to make the block on the serve. In Sitting volleyball, the execution techniques are very specific and related to the athlete disability. Furthermore, the serve is often directed towards the setter to force him making the first touch, thus preventing him from carrying out his task on the second touch.

The quality of receiving, the first touch after the opponent's serve, is very interesting. As shown in the graph, most of the first touches received a positive or perfect evaluation, while less than one out of 10 was a direct or indirect ace.

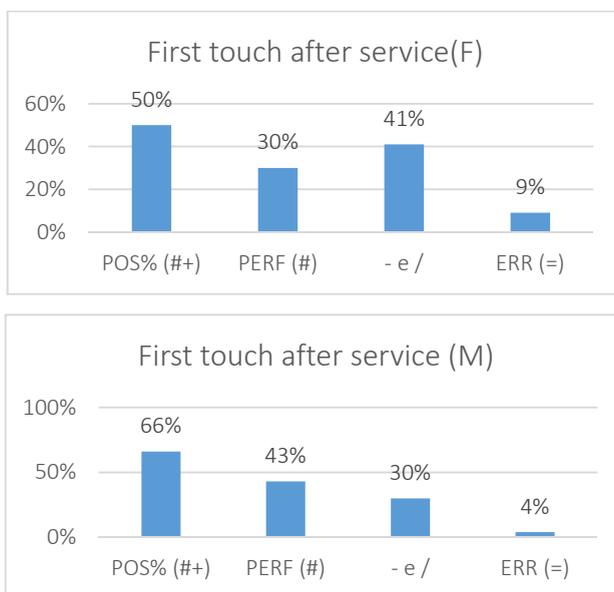


Figure 1. Quality of female (n=696) and male (n=988) receiving.
Note that the perfect receiving is part of the positive receiving.
The Data Volley software also reports within the positive receiving (POS) the perfect receiving (PER).

Since the Sitting volleyball court is very small compared to its participants, there are less chances of error. In addition, the block on the serve greatly influences the strength of the opponent's serves, making them less incisive. In fact, a positive increment in performance can be seen with men. By regulation, it is allowed to receive both in set and in bagher. Sitting volleyball players prefer for ease of execution to perform mainly the set receiving; however, one out of three first touches is performed in bagher, especially in the case of powerful or short serve. Therefore, both techniques are useful and functional to the game of sitting volleyball and both must be trained. With men it is evident that Egypt and China are the teams that performed higher quality receiving. With women, Brazil achieved better quality on the first touch, followed by the USA and China.

The figure below is very useful to allow national teams in comparing their performance with their competitors. One of the elements widely used in match analysis is the performance comparison to see any congruence or non-congruence of the Performance Model of each team.

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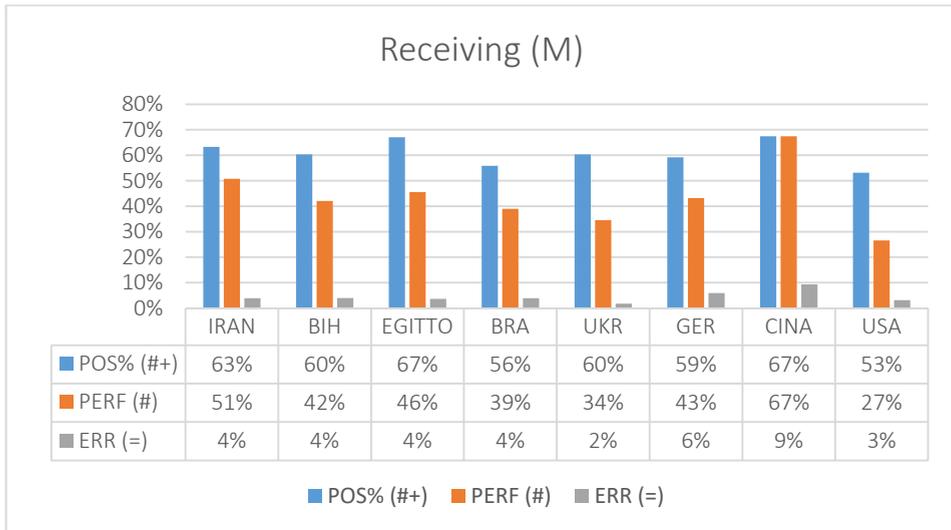


Figure 2. Receiving in Male, a comparative analysis.

Identification of the setter(s)

This aspect of the game is not easily standardized. The setter, the manager of the second touch, in volleyball and beach volleyball has a very high importance in managing the game. He is an equally important figure in the game of Sitting volleyball. There is a general tendency to have only one player managing the second touch. Each team evolves its game based on the characteristics of both the setter and the team itself in a constant adaptation aimed at maximizing the ability to score in each situation. Indeed, in some teams two or three players set the ball for hitters.

Distribution of the second touch

This study allows understanding which player attacks the most and how effectively and efficiently the attacks were carried out. Usually, the percentages of effectiveness and efficiency of the attack areas decrease as the number of balls increases, a phenomenon that occurs also in volleyball and beach volleyball, due to a physiological decrease in performance during the match. Thanks to this analysis, it is possible to easily identify the trends of setters, automatically highlighted by the program with black squares, or non-trends (e.g. areas with low quantities, where few balls arrive) automatically circled in red.

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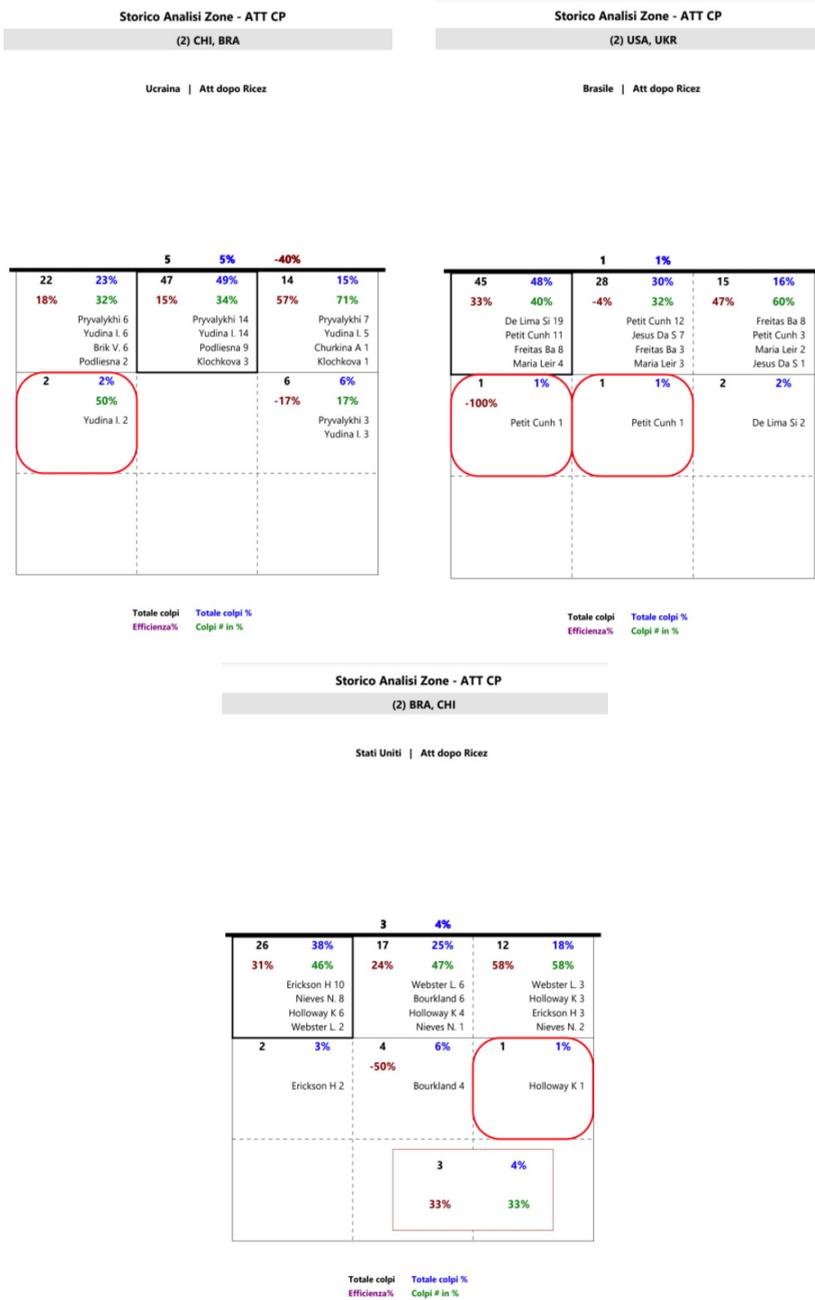


Figure 3. Distribution of the setter (Ukraine, Brazil and USA)

It has been noted that the distribution of setters tends to be balanced in some cases and to be unbalanced in other areas of the field for others. This is certainly due to individual and team characteristics. For example, teams like Iranian men rely on a single player in attack, while other teams have more players on a homogeneous level.

Attack and its directions (with a particular focus on first and second intention attacks)

The spike in Sitting Volleyball is the most used gesture to win a point. All the efforts of the team, as well as the organization and division of roles within the team, is aimed at being able to attack. On the other hand, the opponent tries to prevent it in all ways or to limit its effects, through the block and the serve.

Comparing the quality of spikes, a lower efficiency emerges with men, due to a greater difficulty in performing the spike while sitting and the constant presence of the opponent's block too. Very interesting features of Sitting Volleyball are spikes performed before the third touch. In volleyball and beach volleyball, there are many types of attacks called first intention often performed by the first line setter.

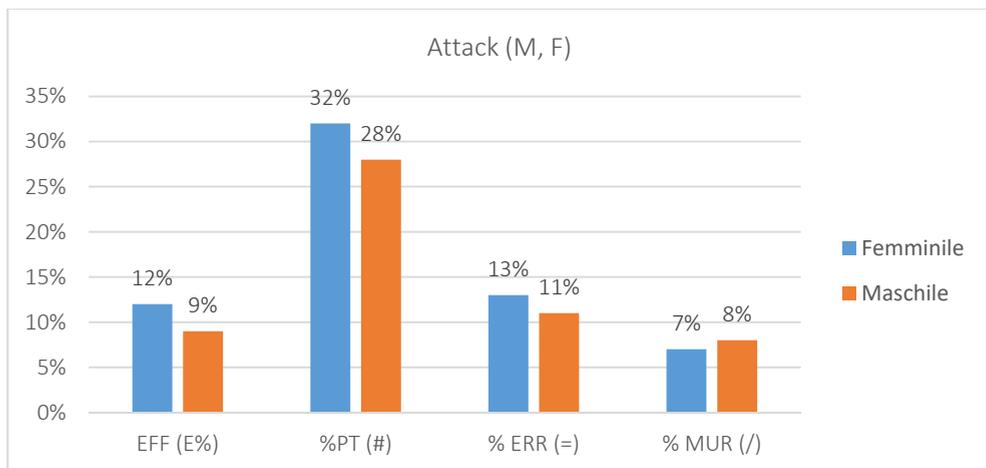


Figure 4. Attack, a comparative analysis between Male (M) and Female (F)

In Sitting Volleyball, due to the speed of the game and the difficulty of moving, there is a very high frequency of spikes performed on the second touch (13%), on the first touch (7%) and even on the first touch after the opponent's

serve (1%) in women. Focusing on men, the spike on the third touch (86%) rises, even if first or second intention spikes are still important variables (9% and 4,9% respectively).

Side-out and breakpoint

Side-out is the game phase where players do the three (or less) touches after the serve. Breakpoint is the game phase after the side-out. Conventionally, the serve is part of the breakpoint. Points during the side-out and breakpoint phases are usually scored with spikes. The side-out data are very similar for men and women. This is very different from volleyball or beach volleyball where men perform better than women. The breakpoint phase in during the interview with privileged witnesses, it emerged that fouls represent a very important variable of performance. As previously seen, the difficulties of the game, both physical ones and those deriving from the game itself (e.g. quick actions) lead to various situational errors. Most of them are attack fouls, followed by lifting fouls, and serve fouls. In men, the increase in receiving errors stands out. However, it is not possible to say that fouls are so crucial for the performance. On the other hand, the competitions analyzed are part of a Paralympic final, so athletes are well trained and do not generally commit fouls. Stead differs between men and women, especially the block and the counterattack.

In the breakpoint phase, almost half of the points are scored thanks to opponent's errors.

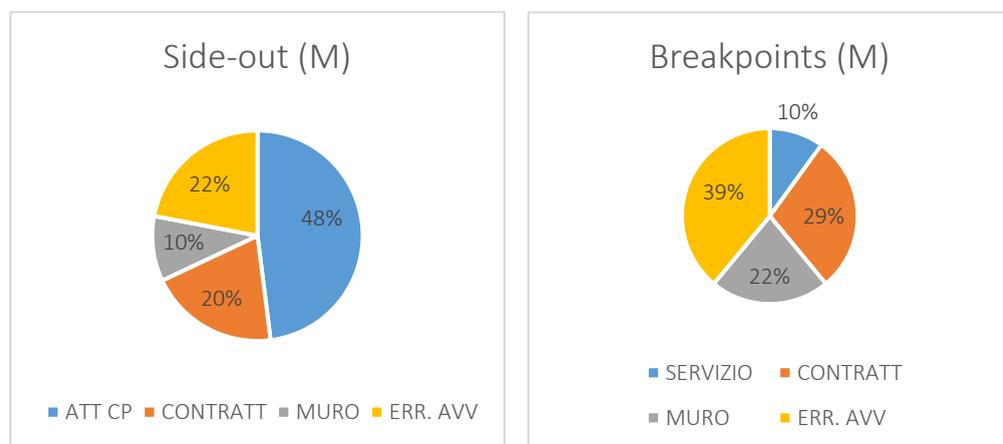


Figure 5. Side-out and break-point in Male.

Within an international competition of this level, such many errors were not expected.

What are the performance factors that determine a winning performance?

For this last analysis we want to proceed for two research lines:

- What happens in the field of a winning or losing team?
- Is there any correlation between victory and a technical gesture or between victory and a phase of the game (side-out or breakpoint)?

From the analysis of the data, it emerged that the quality of serve, receiving, attack and blocking is important for women. The US team, which won the competition, can be a performance benchmark. In the male sector, Iran is the winning team and its performance can be taken as a performance model. The high quality of receiving, attack and block can be compared to the losing teams. Attached to this document there are two tables for men and women.

In the previous analysis, the authors described the performance. Nevertheless, is there a correlation between some fundamentals or phases of the game and the victory of a set?

Different aspects of the game were analyzed, such as serve, receiving, side-out, breakpoint and block. The aim is to understand if these factors were connected or not with the overall performance. The analysis was divided into the female sector and the male sector.

First, summary tables were created with all the values of the performance of the winning team and the respective loser in the women's and men's sectors. An arbitrary value was then attributed to the set won or lost:

- 0 (zero) in case of a lost set
- 1 (one) in case of a won set

Giving a number to victory or loss makes it easier to identify any correlations between sets won and the fundamental taken into consideration. The correlation was calculated through the Pearson correlation index obtained by comparing the won/lost sets (which correspond for convenience to the values 1 and 0) to a certain aspect of the game. The table below shows a brief example of how the data analysis was set up. A similar table was created for the female teams.

The different aspects of the game didn't show any strong correlation, but there are several correlations for the serve and the efficiency in attack. This was expected for a complex game such as sitting volleyball. Indeed, it must be considered that the Performance Model is not universal as each team can find its own way to achieve victory. It depends also on the individual characteristics of its components, and on many measurable, intangible, or even random variables.

Table 1. Set analysis (M)

		Serve	Receiving		Attack		Attack Side-out		Attack Breakpoint		Block
Match	Set	EFF%	POS%	(PRF%)	EFF%	PT%	EFF%	PT%	EFF%	PT%	EFF%
EGI-BOS1	0	42%	44%	33%	3%	19%	18%	18%	-4%	19%	-6%
EGI-BOS1	1	54%	76%	52%	6%	20%	29%	33%	-9%	12%	0%
EGI-BOS2	0	56%	79%	50%	-10%	16%	-8%	15%	-11%	17%	32%

Sport excites above all for its high degree of unpredictability and this must be taken into consideration for research. On the other hand, at very high levels, the structure of the game, the level expressed by individual players and the evolution of the game itself bring out common features that play a key role for victory. A single aspect of the game cannot be deeply linked to victory; otherwise, the game would be dominated by only one aspect of the game.

Table 2. The drawn up for the women's sector

Serve	Receiving		Attack		Side-out		Breakpoint		Block
EFF%	POS%	(PRF%)	EFF%	PT%	EFF%	PT%	EFF%	PT%	EFF%
0.47	0.22	0.29	0.45	0.39	0.28	0.29	0.34	0.3	0.3

Table 3. The drawn up for the men's sector

Serve	Receiving		Attack		Side-out		Breakpoint		Block
EFF%	POS%	(PRF%)	EFF%	PT%	EFF%	PT%	EFF%	PT%	EFF%
0.22	0.18	0.31	0.61	0.65	0.50	0.58	0.48	0.50	0.32

Subsequently, graphics were created for every aspect of the game considered relevant. The serve is the starting point of the game and one of the first things to be learned. It is no coincidence that in all return sports it has a very high strategic importance. The following graph shows that for women the possibility of winning a single set (blue line) increases as the efficiency in serve also increases (orange line).

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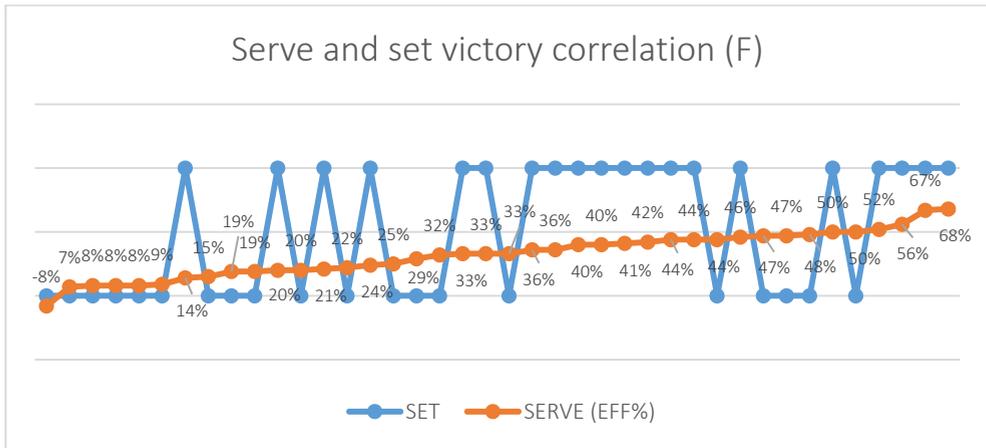


Figure 6. Serve and set victory correlation

The same phenomenon can be observed in the attack. As the attack efficiency increases, the probability of winning a single set in both the male and female sectors increases. The correlation is stronger for men than for women.

In the men's sector, there is a correlation between points scored in attack and the victory of a set. The Victory of a Set, in terms of Attack Points, can be identified in three moments:

1. Lost Point: Under 20% the team has a high probability of losing.
2. Uncertainty plateau: between 20% and 29% the performance is unstable.
3. Win point: above 30% there is a high probability of winning the set.

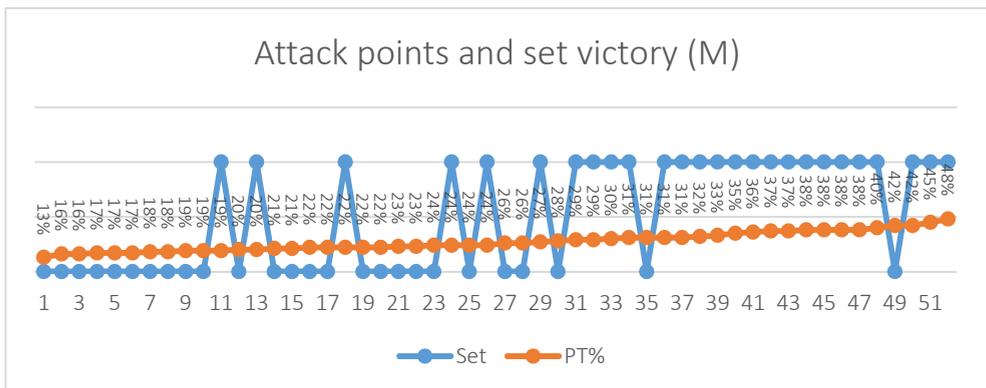


Figure 7. Attack points and set victory in male

Concerning other aspects of the game, no significant correlations were found that could clearly influence the game. For this reason, another type of analysis was used. Julio Velasco³ used to say that in Volleyball “you don’t have to play well, but better than others”, underlining a recurring concept of Sports Games. The performance expressed depends on and it is greatly influenced by the opponent. For this reason, another set of data has been created starting from the previous analysis, highlighting the difference in performance in that gesture or phase of the game. This “Differential” algebraically subtracts the performance of one team from that of the other; for example, the serve efficiency of team “A” subtracts from the serve efficiency of team “B” and vice versa.

Table 4. Male differential

Differential	Serve	Receiving			Attack		Side-out Attack		Breakpoint		Block
		Match	Set	EFF%	POS%	(PRF%)	EFF%	PT%	EFF%	PT%	
EGI-BOS1	0	-12%	-32%	-19%	-3%	-1%	-11%	-15%	5%	7%	-6%
EGI-BOS1	1	12%	32%	19%	3%	1%	11%	15%	-5%	-7%	6%
EGI-BOS2	0	24%	29%	14%	-28%	-20%	-53%	-40%	-11%	-7%	-9%

The next table shows the connection between the differentials of the gestures and the game phases and the victory of a set.

Table 5. Female Differential

Differential	Serve	Receiving		Attack		Side-out		Breakpoint		Block
	EFF%	POS%	(PRF%)	EFF%	PT%	EFF%	PT%	EFF%	PT%	
Correlation	0.73	0.38	0.40	0.6	0.55	0.35	0.40	0.48	0.42	0.48

³ Julio Velasco is an Argentine sports manager and volleyball coach naturalized Italian, technical director of the youth sector of the FIPAV. His fame is linked to his role as head coach of the Italian national men's volleyball team, a position he held from 1989 to 1996: under his management the Azzurri, who had previously been on the fringes of world volleyball, during the 1990s became one of the strongest teams of all time, in what has gone down in history as the epic of the “ generation of phenomena”.

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Table 6. Male Differential

Differential	Serve		Receiving		Attack		Side-out		Breakpoint		Block
	EFF%	POS%	(PRF%)	EFF%	PT%	EFF%	PT%	EFF%	PT%	EFF%	
Correlation	0.29	0.22	0.42	0.82	0.76	0.68	0.70	0.66	0.65	0.46	

A summary table with all sitting volleyball performance indicators was then created. Achieving these benchmarks can indicate whether one's team has a high chance of winning or not.

Table 7. Performance values

	Lost point	Uncertainty	Win point
Serve diff (F)	< -20%	-20% / 20%	> 21%
Attack diff (F)	< -4%	-4% / 3%	> 4%
Attack Eff diff (M)	< -4%	-4% / 3%	> 4%
Side-out diff (M)	< 10%	9% / 10%	> 11%
Break-point Eff diff (M)	< 10%	9% / 9%	> 10%

Conclusions

In the female sector, the fundamentals that considerably determine performance are the serve and the attack. In the male sector, the attack in all its forms, both general and in the ball change phase and in the breakpoint phase, acquires a significantly more important dimension than in the female sector. The serve loses its value also considering the higher number of centimeters that the men block manages to oppose.

In both areas it is interesting to note that the accuracy in the first touch is not so indicative of the ability to win the set, even if the error number can affect his defeat. In fact, it can be said that the first receiving touch is a technical prerequisite without which it is impossible to build the action and organize an effective third touch. In fact, all the teams manage to express a good average level in this fundamental; when the opponent's serve manages to make consecutive aces, they gain a considerable advantage in winning the set and the game.

The high correlation regarding all attack phases lead to classify Sitting Volleyball as a game devoted to attack, which makes the third touch, in the classic form of the dunk, one of the foundations of the Performance Model. The block also has a very important value. Like receiving, it can be seen as a

block also has a very important value. Like receiving, it can be seen as a requirement, in this case a tactical one, without which it is impossible to think of limiting the opponent's attacks and serves. In particular, the structuring of modern Sitting volleyball, with the low net and one of the smallest fields among all the Sports Games, requires its constant presence both on the serve and on the opponent's attack.

All these analyses are based on the final matches of the Rio 2016 Paralympic Games, which, despite representing the highest competition level in sitting volleyball, must not be seen as a representative number to generate absolute truths and it cannot represent the entire model of sitting volleyball performance. This study represents the beginning of a much longer process that could have lasting effects on the increase in the performance capabilities of sitting volleyball teams, taking them out of their pioneering stadium towards a more professional dimension. Furthermore, it is always worth remembering that

Performance Models are not absolute laws as the game itself evolves continuously; this is especially true for young and growing sports such as sitting volleyball seems to be. Given that team performance essentially depends on the performance of individuals, the turnover of a few elements is sufficient to generate new Performance Models. This does not mean, however, that it is not possible to categorize or reconstruct these models. If the rules and structures on which the game of sitting volleyball remains unchanged over time, it is therefore possible to build forecast performance models.

The institutions on their side must foster this growth. The parent companies producing the Software can easily integrate some Sitting volleyball rules into the Statistical Analysis software, thus allowing easier access from an economic point of view in a truly inclusive perspective.

The organizing bodies and the Federations in charge must support the transition from a niche phenomenon based on the goodwill of individuals, to a sport movement organized with a championship and active recruitment. The constitution of national groups was an excellent step towards this direction, but there is still much to do to equalize the performance towards other international competitors.

However, the performance must not cloud the Sitting volleyball context. Sport in general must not be aimed exclusively at performance, but we must know that transforming sport into a purely inclusive phenomenon risks deflecting its mission in the same way. Sport is fun, participation, performance, group, the joy of learning, challenges with one's limits and many other positive and negative aspects that must all be weighed to use sport as a moment of inclusion in our society.

In conclusion, this study brings significant innovations in the world of Sitting volleyball that can be implemented immediately with a little training and organizational effort.

Conflicts of interest:

The authors have not conflicts of interest to declare.

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