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EFFECT OF HIGH AND LOW FLEXIBILITY ON AGILITY, ACCELERATION SPEED AND VERTICAL JUMP PERFORMANCE OF VOLLEYBALL PLAYERS

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Abstract:
This study aimed to assess the effect of high and low levels of flexibility on key performance indicators of volleyball performance. Eighty-four volleyball players (n=84; mean±SD; decimal age: 16.57±1.51; height (cm): 176.23±8.77; body mass (kg): 66.14±11.79) were selected for the study. The design of the study was cross-sectional and to measure selected variables i.e. agility, lower body muscular power, and acceleration speed; 6×10 m shuttle run, countermovement jump (with arm swing) test and 20 m sprint test (standing start) were used. To measure the flexibility level of the players, sit and reach test was used. Shapiro-Wilk normality test was conducted to check the distribution of data and the Levine test was applied to check homogeneity of the variance in data. Participants were divided into two groups i.e. High Flexibility Group (HFG) and Low Flexibility Group (LFG) using k-means cluster analysis and independent t-test was applied to find the differences between HFG and LFG. The level of significance was set at $p < 0.05$. Results showed statistically significant difference between HFG and LFG in agility, acceleration speed and lower body muscular power and, based on the results, it was concluded coaches should include flexibility training in the regular training programme. The results obtained supported the rationale that baseline flexibility may influence the performance of volleyball players.

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1. Introduction

Volleyball is one of the popular team sports which is played both indoors and outdoors. In indoor volleyball rallies include intensive actions such as jumping, multidirectional movements, spiking, blocking and striding, and intervals between the rallies include low intensive recovery breaks such as walking and standing (Gabbett et al., 2006; Holmberg, 2013; Kerksick et al., 2018; Marques et al., 2009).

The nature of the game and physiological demands exerted makes it necessary to attain a high level of fitness combined with other factors such as technical, tactical and psychological (Greco et al., 2019; Pradhan, 2017). Research evidence shows that volleyball players require a high level of speed, agility, power, muscular strength and aerobic endurance (Gabbett et al., 2006; Oldenburg, 2015; Pradhan, 2017; Reeser & Bahr, 2003).

Flexibility, the range motion achievable at a joint or group of joints without getting injured (Gremion, 2005), is considered an important aspect of sports performance, however, its role in each sport varies depending on the nature and demands involved (Rey et al., 2016). It is postulated that high flexibility level has a significant effect on performance, however, studies exploring the relationship of flexibility with sports performance are limited and have heterogeneous results. It is also difficult to generalize this postulation because sports performance is influenced by several internal and external factors (Lee et al., 1989; Singh, 1991).

In Volleyball, high level of lower body muscular power is needed as players have to perform several vertical jumps (Gabbett & Georgieff, 2007; Kenny & Gregory, 2006; Ziv & Lidor, 2010). It is required as players have to perform number of skills that needs jumping such as spiking, blocking, jump set and jump serve (Hedrick, 2007; Newton et al., 2006; Powers, 1996).

Several studies exploring the relationship of flexibility with vertical jumping performance, but results are not homogeneous. In a study, it was found that dynamic stretching significantly improved kinetic variables of vertical jumping in female volleyball players (Kruse et al., 2015). In another study, positive effects of the stretching on jumping performance were also reported (Palaniappan & Deivendran, 2013). In contrast to the above findings, there is number of studies that do not agree with the above results (Church et al., 2001; Cornwell et al., 2001; Little & Williams, 2006; Walsh, 2017; Young & Behm, 2003).

In volleyball, high-level reaction and acceleration speed are required as players have to react very quickly because the ball travels at high velocity and the volleyball court is also relatively small in the area which inhibits them to attain maximal speed (Johnson et al., 2010). However, researches on the relationship of flexibility with speed and agility are also limited and have conflicting results (Alikhajeh et al., 2012; Alipasali et al., 2019; Bazett-Jones et al., 2008; Fletcher & Jones, 2004; Herman & Smith, 2008). In studies, it has been found that dynamic stretching is effective in the improvement of agility performance (Taleb-beydokhti & Haghshenas, 2015; Van Gelder & Bartz, 2011). On the other hand, Bishop & Middleton, (2013) concluded that there are no significant differences in the performance of speed, agility and jump after warm-up using dynamic and dynamic cum static protocols.

Though stretching exercises in the warm-up are common practice in volleyball (Alipasali et al., 2019), but the relationship of flexibility with volleyball performance is not fully explored. Agility, acceleration speed and vertical jump are key determinants of volleyball performance (Gabbett et al., 2006; Marques et al., 2009; Newton et al., 2006; Oldenburg, 2015; Pradhan, 2017; Reeser & Bahr, 2003). Therefore, this study is an attempt to assess the effect of high and low levels of lower back and hamstring flexibility on agility, acceleration speed and vertical jump among young volleyball players.

2. Methodology

2.1 Participants

A total of eighty-four male young volleyball players (n=84; mean±SD; decimal age: 16.57±1.51; height (cm): 176.23±8.77; body mass (kg): 66.14±11.79), undergoing regular training were selected for the study. All the participants were healthy and physically fit with no history of injury in the past six months. The participants were informed in detail about the nature of the study and investigational procedures, and all the participants have voluntarily given their consent to be the part of this study.

2.2 Design

This study used a cross-sectional designed to assess the effect of high and low flexibility (lower back and hamstring) on agility, acceleration speed and vertical jump performance. To measure selected variables i.e. agility, lower body muscular power, and acceleration speed; 6×10 m shuttle run, countermovement jump (with arm swing) test and 20 m sprint test (standing start) were used, respectively. To measure the level of flexibility Forward bend and reach test was used. The selected tests were administrated during the pre-competition phase in two experimental sessions. The first experimental session included the measurement of basic anthropometric, flexibility, and agility measurement of participants. On the second experimental session, vertical jump and acceleration speed performances were recorded.

To avoid potential diurnal effects on the performance, tests were conducted at the same time in every session. A day between two experimental sessions was kept as a regular training day with no heavy training. All the participants were informed in advance about the testing procedures and two days before the testing, two sessions were kept to familiarize them with the testing protocols. In both familiarization and testing (experimental) sessions, a proper warm-up for 20 minutes was performed by the participants under the supervision of the coach. The warm-up consisted of 05 minutes of static stretches of major muscles of the lower and upper body followed by low-intensity aerobic activities (jogging, running and multilateral movements) for 10 minutes and at last total body dynamic stretches for 05 minutes.

To minimize the training-induced fatigue, the preceding session of the first testing session was kept for active recovery and it was also ensured that there should be no heavy training on the day falling between the two testing sessions. To avoid the effect of the daily routine on the test performance the players were asked to take proper rest and refrain themselves from unnecessary activities apart from their daily routine. Besides, players were encouraged to eat healthy and nutritious food, and intake of acute performance-enhancing substances before and during testing were barred.

3. Procedure

3.1 Anthropometric Measurements

On the first experimental session, anthropometric measurements of participants i.e. height, body mass and standing vertical reach were taken before warming up. The height of the participants was measured with a standardized Anthropometer (GPM-100) with an accuracy of 0.001 m. Standing vertical reach was measured using a standardized scale mounted on the wall with an accuracy of 0.01 m. To measure the body weight of participants a standardized weighing scale (Omron HN-286) with an accuracy of 0.01 kg was used.

3.2 Flexibility Measurement

Post-warm-up, the flexibility of the lower back and hamstring was measured with sit and reach test (Wells & Dillon, 1952) using a standardized sit-and-reach box. Mayorga-Vega et al., (2014) reported that the classic Sit and Reach Test was a better indicator of hamstring flexibility as compared to other sit and reach tests (modified sit and reach test) and when it is not possible to use angular flexibility tests. The participants were asked to sit on the floor barefoot with legs fully extended and placed against the sit-and-reach box. Then they were asked to extend their arms and place the palms (facing down) on the scale and slide forward as far as possible and hold the position at a maximal distant point for a minimum of 03 seconds. They were given three chances and the best performance was taken as the final score.

3.3 Agility Measurement

Agility was measured using the 6×10 m shuttle run test (SAI, 2016). In this test, two parallel lines with a 10-m distance were marked on the plain surface. Participants were asked to stand behind the starting line in the ready position. On the signal, they were asked to run fast and touch the other line (with one hand) and then come back to the starting line and touch it. They were told to repeat this procedure for three-time (total six shuttles) with maximum speed. The test performance was measured nearest to 0.01 second. With optimum recovery time, total two attempts were given, and the best performance was taken as final score.

3.4 Vertical Jump Measurement

On the second experimental day, lower body muscular power and acceleration speed were measured. After following the same warm-up protocol, lower body muscular power was measured using countermovement jump with arm swing (Acero et al., 2012) on a wall-mounted calibrated vertical jump tester (Tandem Sport). The participants were asked to stand beside the device and jump as high up as possible with arm swing but without taking any approach or step and touch the highest point on the device. Three attempts were given to each participant and the final score was obtained by subtracting the standing vertical reach from their best vertical jump performance.

3.5 Speed Measurement

The acceleration speed of participants was measured using a 20-m Sprint test with standing start. For the test, a straight lane of the 400-m track was used where starting and finishing points were marked with a distance of 20 m. The participants were asked to run with maximum speed from starting point to finishing point after auditory signal and performance nearest to the 0.01 second, was measured. With optimal recovery, two attempts were given, and the best timing was taken as the final score.

4. Statistics Applied

First, descriptive statistic, mean and standard deviation (SD) were calculated. The Shapiro-Wilk normality test was conducted to check whether the data were normally distributed or not, and to check homogeneity of the variance in data Levine test was applied. Based on the level of hamstring and lower back flexibility, players were divided into two groups i.e. High Flexibility group (HFG) and Low Flexibility group (LFG) using k-means cluster analysis. Independent T-test was applied to find the difference in the level of agility, lower body muscular power and acceleration speed among the High Flexibility Group (HFG) and Low Flexibility Group (LFG). The level of significance was set at $p < 0.05$ and Statistical Package for Social Science (SPSS version 23.0, Chicago, IL, USA) was used for the analysis.

5. Results

In Table 1, anthropometrical variables i.e. decimal age, height and body mass are presented for all the participants and as well as HFG and LFG. Intergroup differences presented in the group shows that there were minor differences in the HFG and LFG, but these differences were not statistically significant ($p>0.05$) that depicts that in terms of age, height and body mass there were no differences in both the groups.

Table 1: Anthropometric characteristic of all participants (n=84) and High Flexibility Group (n=47) and Low Flexibility Group (n=37)

Variables	Participants (n=84) (Mean±SD)	HFG (n=47) (Mean±SD)	LFG (n=37) (Mean±SD)	Intergroup difference (%)	p-Value
Age (decimal)	16.57±1.51	16.37±1.37	16.83±1.65	0.46 (2.7)	.169
Height (cm)	176.23±8.77	177.35±9.61	174.80±7.44	2.55 (1.5)	.187
Body Mass (kg)	66.14±11.79	65.39±10.38	67.09±13.46	1.70 (2.5)	.514

In Table 2, along with flexibility, performances of both HFG and LFG in selected test i.e. shuttle run, 20-m sprint and vertical jump with arm swing is presented. Intergroup differences between the groups are also presented for a better understanding of the results. After comparative analysis of selected variables statistically significant differences ($p<0.05$) were observed between HFG and LFG in shuttle run, vertical jump and 20-m sprint performances. It shows that the performance of HFG was better as compared to LFG in agility, lower body muscular power and acceleration speed.

Table 2: Comparative analysis of shuttle run, 20-m sprint and vertical jump performance of High Flexibility Group (n=47) and Low Flexibility Group (n=37) of volleyball players

Variables	Participants (n=84) Mean±SD	HFG (n=47) (Mean±SD)	LFG (n=37) (Mean±SD)	Intergroup difference (%)	p-Value
Flexibility	13.75±5.65	17.81±3.42	8.58±3.07	9.24 (107.7)	<.001
Shuttle Run	15.11±0.93	14.87±0.94	15.42±0.84	0.55 (3.6)	.006
20-m Sprint	3.31±0.21	3.27±0.20	3.37±0.21	0.09 (2.8)	.039
Vertical Jump	50.94±9.49	53.87±9.66	47.22±7.94	6.66 (14.1)	.001

6. Discussion

The purpose of this study was to analyse the level of agility, lower body muscular power and acceleration speed among volleyball players with low and high flexibility. Flexibility training is an integral part of the total training process (Bompa, 1994) and it is very common in volleyball (Alipasali et al., 2019), but the role of flexibility on volleyball performance is not well explored. To the best of the authors' knowledge, this is the first study that assesses the role of high and low flexibility among volleyball players. In this study, it was hypothesized that volleyball players with high flexibility of hamstring and lower back may exhibit better performance in agility, acceleration speed and vertical jump as compared to the players with low hamstring and lower back flexibility.

The key findings of this study showed better performance of HFG in agility with the intergroup difference of 0.55 seconds which was 3.6% better as compared to LFG. In the case of acceleration speed, the intergroup difference was 0.09 seconds leading to 2.8% better performance in HFG. For vertical jump performance, results were highly statistically significant, where the intergroup difference was 6.66 cm and performance of HFG was 14.1% better than LFG. There are number of evidences available which supports the outcomes of the present study. In a study conducted on young football players, it was reported players with high levels of flexibility were better in agility, acceleration and sprinting and countermovement jump (García-Pinillos et al., 2015). Some other studies also agree with the outcomes of the present study (Taleb-beydokhti & Haghshenas, 2015; Van Gelder & Bartz, 2011). The results of these studies reported that dynamic stretching was effective to improve agility performance, which shows that improved flexibility has a positive relationship with agility performance. In the case of vertical jump performance, results were in line with Kruse et al. (2015); where they concluded that dynamic stretching significantly improved vertical jumping in female volleyball players. In another study, positive effects of stretching on jumping performance were also reported (Palaniappan & Deivendran, 2013). In the case of acceleration speed, only one study found which supported the results of the present study, where it was reported that after six-week training, both static and dynamic stretching protocols significantly improved the performance 4.5 and 9 m sprint tests among recreational volleyball players (Alipasali et al., 2019). Studies also reported positive effects of active dynamic stretching on sprint performance (Alikhajeh et al., 2012; Fletcher & Jones, 2004; Herman & Smith, 2008). On the other hand, they also concluded that static stretching included in warm-up may decrease short sprint performance. However, Bazett-Jones et al., (2008) reported no significant improvements in sprint and vertical jump performances in female athletes after a 6-week static stretching protocol. With contradictory results of the studies, it can be concluded that the relationship of flexibility with speed is still not clear. However dynamic stretching protocol seems to be having a positive effect on the speed.

7. Conclusions

The results obtained from the current study shows that volleyball players with high flexibility were better in agility, acceleration speed and lower body muscular power as compared to players with low flexibility level. Based on the results it can be calculated that, for volleyball players, flexibility is a key component of training as it helps in better performance in agility, acceleration speed and vertical jump. Therefore, it is suggested that coaches and trainers should include flexibility training in the regular training programme. The results obtained support the rationale that baseline flexibility may influence the performance of volleyball players. Keeping in view the cross-sectional design of the study, which restricts to establish a causal relationship, and heterogeneous results of the previous studies, further investigations are suggested.

Conflict of Interest Statement

The authors declare no conflicts of interests.

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