Abstract

The purpose of this study was to investigate the relevance of body composition and physical fitness to field tests representing the performance of women’s softball players. The subjects of the study were 22 players from women’s softball teams located in “D” city, and they signed a consent form after confirming their willingness to participate voluntarily. The correlation analysis of Pearson was conducted to determine the relevance of field tests (three items: bat speed, throw distance, and base running) to body composition (10 items) and physical fitness (14 items). Results: In field test and body composition, female softball players showed a positive correlation with the forearm circumference in bat speed, and base running with the muscle-related variables (muscle mass and LBM), and the fat-related variables (fat ratio and abdominal fat ratio) showed negative correlation. Results: In field test and body composition, women’s softball players showed a positive correlation with the forearm circumference in bat speed, and base running with the muscle-related variables (muscle mass and LBM), and the fat-related variables (fat ratio and abdominal fat ratio) showed negative correlation. In field test and physical fitness, there was a correlation between throw distance and lower limbs muscular endurance (repeating jump), response (standing long jump and vertical jump), agility (side step), and flexibility (trunk forward flexion). Base running showed a significant relevance with muscular strength (grip power), muscular endurance (sit up), response (standing long jump and vertical jump), agility (side step), and flexibility (trunk forward flexion). Body composition and physical fitness were divided into muscle-related and fat-related variables. To sum up, the continuous management of physical composition and the increase in basic and professional physical fitness of female softball players are important factors in improving performance and preventing injury.

[Keywords] Bat Speed, Throw Distance, Base Running, Body Composition, Physical Fitness

1. Introduction

Softball has three critical variables for the outcome of the game. To explain these three variables, there are throwing, hitting, and running skills[1]. Improving these basic skills is a goal for softball players to train every day, and to develop specialized training methods. It is essential to improve the performance of an individual or team by developing these basic skills and training programs and applying them to the players[2].

One of the first factors in softball, throwing is the most representative ability regardless of position, and the fielders throw upward or sideways, but the pitcher has the characteristics of throwing downward rather than upward[3]. Throwing motion has a mechanism that transmits the force from the feet of the lower body to the upper limbs through core muscles and upper body[4]. Body composition and physical fitness are important factors in creating this mechanism.
of motion. Throwing motion also requires accuracy and strong throwing ability, and the main factors are muscle mass of body composition, strength, flexibility, and equilibrium[5].

The second factor is the bat speed. Batting requires bat speed and accuracy, and fast bat speed is the most important factor among many hitting factors. Similar to the throwing motion, the mechanism of batting is transmitted from the toe of the lower limbs to the hips, core muscles, and upper body and limbs. It is delivered in a very short period of time and can be explained by the movements made by contraction, relaxation, and rotation of the muscles[6]. When all the processes are done like one movement and softness and strength work at the same time, one can achieve a good batting posture. In the whole process of swing, bat speed is represented by the force derived from these sequential movements of the body[7]. Thus, bat speed is the result of individual body composition and physical fitness. In addition, the type of muscular contraction and the angle of body segments during a swing are among the other variables[8]. These factors are closely related to body composition and physical fitness, and the players are repeating their training every day to automate their muscles under the control of the nervous system[9][10]. So the way to improve softball performance is to improve body composition and physical fitness[11].

The third element is base running. Running through the bases is called base running, and one hits the ball and reaches first base in 4.0-4.4 seconds[12]. Base running is an important factor in scoring because one has to turn around the bases and come back home quickly when in the offense. Also, "stealing" bases are one of the offense tactics with the ability to advance one more base[13]. Running is an important factor in tracking and catching the ball not only in offense but also in defense. Running is a process in which the lower and core muscles repeatedly contract and stretch. Softball has this characteristic of base running. To be good at this kind of running, one needs to improve the muscle strength and power[14].

In defense, one has to catch the ball that rolls on the ground or flies in the air. To catch, one visually judges and the brain directs the muscles that are dominated by motor nerves. This reaction is a sequence of processes from the brain to the peripheral nerves, in which the nervous system can be taught through repeated training activities to automate them. Through this repetitive training, the players are training to reduce the range of error in their movements. Muscles under the control of the neuromuscular system are adapted and characterized in the form appropriate to these movements[15]. The fundamental platform for this is body composition and physical elements. It is important for coaches and trainers of softball to create and apply training programs to improve individual players' abilities and team performance, taking this into account. In addition, injury prevention and rehabilitation are also important[16][17].

Measuring and evaluating body composition is important for athletic ability and improvement and maintaining physical health. The level of individual ability of the players shall be assessed by measuring and evaluating the body composition. Personalized training programs should be applied to individual players to observe their athletic performance during the season and off-season. The ways to improve body composition can be found with this approach[18]. To operate the physical fitness programs, measurement and evaluation of body composition must be conducted, through which training in the field and auxiliary training must be combined[19]. In particular, the batting or throwing action requires muscular strength and endurance and instantaneous power, and muscle mass is the basis of these forces. Therefore, body composition is important in all sports events, including softball. Such factors include LBM(lean body mass) and muscle mass. More muscle mass usually means more muscle strength, and it increases muscle strength and power along with the adjustment of the nervous system. These muscle mass or LBM's per-weight ratios play an important role in the performance of throwing, batting, and sprinting. It is important that the distribution of LBM and FM(fat mass) is clearly identified as a major variable in relation to motor ability. Therefore, measuring and assessing how the
body's components are distributed will be an important factor in preventing and rehabilitating shoulder and elbow injuries for the players[20]. Accordingly, it is important to investigate the relevance of players' health, athletic ability, and injury prevention to obtain basic data on body composition and motor skills to match the characteristics of softball[21]. Also, coaches and trainers must be interested in body composition to create training programs to manage these body composition during the season[22].

The body composition varies depending on the gender, season, or off-season, and there are studies related to male body composition, but studies on the changes in the body composition of female athletes are somewhat lacking. Also, there are many papers on female softball players related to injury, but there are not enough papers on their body composition[23][24].

Physical fitness is the most important factor for athletes, and there are various factors such as muscle strength, muscle endurance, flexibility, equilibrium, response, agility, and coordination, and they are closely related to each other[25][26]. The way to improve bat speed, throw distance, and base running in softball is to improve physical fitness. Therefore, trainers and coaches are putting a lot of effort into organizing physical training programs. Muscle strength is related to all elements of batting, throwing, and running[27] and flexibility and equilibrium are additionally important to further upgrade your athletic ability. In softball games, physical fitness is not just one factor, but also an improvement in athletic ability when it consists of one or more complex elements[28]. Therefore, female softball players are committed to muscle improvement and conditioning for many hours a week, and they invest their time to improve their physical fitness. Most of these muscle and conditioning programs focus on improving muscle strength, power, speed, and turning skills[29]. By applying these improvements, most coaches and sports scientists are trying to prescribe them as programs that enhance the strength and power to improve the combined athletic abilities.

Examining the relation between body composition and physical fitness by field test(bat speed, throw distance, and base running ability) for female softball players will be valuable as data that can be used for collecting basic data on players' body composition and physical fitness, as well as for injury prevention and rehabilitation programs. Therefore, the purpose of this study is to investigate body composition and physical fitness of female softball players by field test category.

2. Research Method

2.1. Research subjects

The subjects of this study were female softball players of "D" company located at "D" city. The purpose and contents of the experiment were explained in advance, confirming their willingness to participate voluntarily and receiving consent. The general characteristics of the subjects are as shown in <Table 1>.

<table>
<thead>
<tr>
<th>N</th>
<th>Age</th>
<th>Height(cm)</th>
<th>Weight(kg)</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>24.10</td>
<td>162.95</td>
<td>63.14</td>
<td>23.43</td>
</tr>
<tr>
<td></td>
<td>±5.07</td>
<td>±5.64</td>
<td>±7.97</td>
<td>±3.45</td>
</tr>
</tbody>
</table>

Note: Values are mean and SD.

2.2. Measurement items and method

2.2.1. Body composition items
The height (cm) was measured using BSM 370 (Biospace, Korea) and the body composition items (weight, LBM, muscle mass, fat ratio, BMI, abdominal fat ratio, thigh, and lower leg) were measured using Inbody 720 (Biospace, Korea). They were measured after removing all metal objects attached to the body that may affect the measurement, maintaining the measurement position presented in the equipment manual for stability.

2.2.2. Physical fitness

To check for changes in physical fitness factors, muscle strength (grip power and back muscle strength), muscle endurance (sit up, push up, repeating jump), response (standing long jump and vertical jump), full-body reaction test (light and sound), agility (side step), equilibrium (one foot standing with eyes closed and dynamic equilibrium), coordination (visual perception response), and flexibility (trunk forward and backward flexion).

2.2.3. Field ability

Throw distance: The maximum throw distance measured the maximum distance the players threw a softball from the home plate. A reference line was made at the home plate location for measurement, and an additional 2m line was set rearward to enable two-step run-up. Distance measurements were made by standing on the home plate and using a laser pro XE (USA) and marking the spot where the ball fell with a flag. The maximum distance was recorded in meters (m) by conducting a total of five times per player.

Bat Speed: Measurements of bat speed were made five bat swings at bat after warming up for 10 minutes. Speed gun (Bushnell Velocity Speed Gun, USA) was set to measure, and average speed (km/h) was recorded for 3 times excluding the highest and lowest values from 5 measured values.

Base running: To evaluate players' base running speed after hitting, the players started with a batting position at bat, and the time to return to home through the first, second, and third base was measured with a stopwatch. Arrival was based on stepping on the plate at each point, measured twice each, recording the fastest time in seconds.

2.3. Data analysis

The data processing method of this study was used to calculate the mean and standard deviation of all measurement items using the SPSS Ver.25.0 (Statistical Package for Social Science SPSS, Inc., Chicago, IL, USA) for Windows and to analyze the relevance. Pearson's correlation analysis was conducted to determine the correlation between field test (bat speed, throw distance, base running (first, second, third base and home)) and body composition and physical fitness. The statistical significance level is set to $p < .05$.

3. Result and Discussion

The results of the correlation analysis for female softball players to examine the relation between field test and body composition and physical fitness are as follows.

3.1. Correlation of body composition by field test

The results of analyzing the correlation between field test (bat speed, throw distance, and base running) and body composition are shown in Table 2.

<table>
<thead>
<tr>
<th>Item</th>
<th>Bat speed (km/h)</th>
<th>Throw distance</th>
<th>Base running(seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1st base</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Significant trends were shown in bat speed and muscle mass (p=.064) and LBM (p=.068), and a significant relevance was shown with left forearm (r=.613, p=.002) and right forearm (r=.458, p=.032). In throw distance, there was no significant relevance in all items. There were significant relevance in base running: for the 1st base with left forearm (r=-.433, p=.044), for the 2nd base with fat ratio (r=.432, p=.044) and abdominal fat ratio (r=.439, p=.041), for the 3rd base with fat ratio (r=0.458, p=.032), and for the home with LBM (r=-.468; p=.028), fat ratio (r=.584, p=.004), muscle mass (r=.472, p=.027), and abdominal fat ratio (r=.496, p=.019).

Looking at the correlation between bat speed and body composition, there was a tendency of relevance between bat speed and muscle mass and LBM, but it was not significant. Muscle mass and LBM are known to increase bat speed, but this study did not show any relevance. In addition, significant correlation in left and right forearm suggests that forearm is involved. According to a study by Ebben & Fotsch (2006) [1], multimode resistance training increases batting power in baseball, while Petushek, at al. (2018) [30] reported the importance of developing and verifying efficient evaluation tools to increase muscle mass through these muscle training. These results suggest that in the case of female softball players, bat speed is related to muscle mass and that improving bat speed of softball players requires the development of training programs that increase muscle mass and circumference. There was no significant association in all categories when it comes to throw distance. These results are believed to be the result of measuring the long throw of softball players. Unlike short distance, long distance throw with overall body force is more related to physical fitness than body composition, and most studies have reported on pitchers' ball speed and injury [31][32]. It is believed that the method of measuring throw speed measured at the distance between bases should be considered for future research on the relevance of the throw ability. Significant correlations were found in left forearm for the 1st base, fat ratio for the 2nd base, abdominal fat ratio for the 3rd base, and LBM, muscle mass, fat ratio, and abdominal fat ratio for the home. These results are consistent with studies [33][34] that higher muscle mass increases the running speed and that increased fat-related factors slow the running speed, and coaches and trainers should consider this in the process of setting up programs by measuring and evaluating the body composition of softball players [35].

3.2. Correlation between field test and physical fitness

3.2.1. Correlation between muscular strength and muscular endurance by field test

The results of analyzing the correlation between field test (bat speed, throw distance, base running) and muscle strength (grip power and back muscle strength) and muscle endurance (sit up, push up, repeating jump) are shown in <Table 3>.
Table 3. Correlation between muscular strength and muscular endurance by field test.

<table>
<thead>
<tr>
<th>Item</th>
<th>Bat speed (km/h)</th>
<th>Throw distance (m)</th>
<th>Base running (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1st base</td>
</tr>
<tr>
<td>Strength (kg)</td>
<td>Grip</td>
<td>0.363</td>
<td>0.343</td>
</tr>
<tr>
<td>Muscle Endurance (Count)</td>
<td>Back muscle</td>
<td>0.373</td>
<td>0.313</td>
</tr>
<tr>
<td></td>
<td>Sit up</td>
<td>0.063</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>Push up</td>
<td>0.349</td>
<td>0.333</td>
</tr>
<tr>
<td></td>
<td>Repeating jump</td>
<td>0.418</td>
<td>0.556**</td>
</tr>
</tbody>
</table>

Note: *p<.05, **p<.01.

Grip power, back muscle strength, and repeating jump tended to be significant. In throw distance, repeating jump showed a significant relevance (r = -.556, p = .007). In base running, there were significant relevances in grip power for the 1st base (r = -.587, p = .004), grip power (r = -.506, p = .016) for the 2nd base, grip power (r = -.609, p = .003), sit up (r = -.506, p = .013), and repeating jump (r = -.570, p = .016) for the 3rd base, and grip power (r = -.683, p = .001), sit up (r = -.526, p = .012), and repeating jump (r = -.597, p = .003) for the home.

Looking at the correlation between bat speed and muscular endurance, grip power, and repeating jump tended to be significant, and throw distance showed a significant correlation with repeating jump. For base running, a significant correlation was shown with grip power, sit up, and repeating jump. Plummer & Oliver (2014) [36] reported in a study of female softball players that activation of hip muscles determines the relation of the motor function of the torso. These results show that muscular strength and muscular endurance are important variables for all athletes and are important factors in improving the level of athletic ability. It can be seen that repeating jump representing the muscular endurance of the lower body increases the long-distance throw and it suggests that they are also an important factor in improving the base running ability. Therefore, since all movements of batting, throwing, and running in relation to the characteristics of softball are closely related to muscular strength and muscular endurance [37], training programs for improving athletic ability are believed to prevent injuries and improve performance.

3.2.2. Correlation between response and response time and agility by field ability

Correlation results of response (standing long jump and vertical jump), response time (sound and light), and agility (side step) by field test (bat speed, throw distance, base running) are shown in <Table 4>.

Bat speed showed a significant relevance with standing long jump (p = .081) and vertical jump (p = .062). Throw distance showed a significant relevance with standing long jump (r = .502, p = .017), vertical jump (r = .475, p = .025), and Side step (r = .503, p = .017). For base running, a significant relevance was shown for the 3rd base with standing long jump (r = .670, p = .001), vertical jump (r = -.511, p = .015), and side step (r = -.479, p = .024).

<table>
<thead>
<tr>
<th>Item</th>
<th>Bat speed (km/h)</th>
<th>Throw distance (m)</th>
<th>Base running(seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1st base</td>
</tr>
<tr>
<td>Leg power</td>
<td>Standing long jump</td>
<td>.380</td>
<td>.502*</td>
</tr>
</tbody>
</table>
Looking at the correlation between bat speed and response and response time and agility, there was a significant trend but no relevance with bat speed and standing long jump and vertical jump. A significant correlation was shown between throw distance and base running and standing long jump, vertical jump, and side step. Magrini & Dawes et al.(2018)[13] suggested that power, speed, and agility are important in the characteristics of softball, and physical fitness and conditioning experts are recommended to apply these training programs. These results suggest that the ability to throw and base run in softball is related to lower limb power and agility.

3.2.3. Correlation between coordination and equilibrium and flexibility by field ability

Correlation results of coordination(visual perception coordination), equilibrium(one foot standing with eyes closed and dynamic equilibrium), and flexibility(trunk forward/backward flexion) by field test(bat speed, throw distance, base running) are shown in <Table 5>.

### Table 5. Correlation between coordination and equilibrium and flexibility by field ability.

<table>
<thead>
<tr>
<th>Item</th>
<th>Bat speed (km/h)</th>
<th>Throw distance (m)</th>
<th>Base running(seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1st base</td>
</tr>
<tr>
<td>Coordination (sec)</td>
<td>Visual perception</td>
<td>-.398</td>
<td>-.532*</td>
</tr>
<tr>
<td></td>
<td>One foot standing with eyes closed</td>
<td>.202</td>
<td>.303</td>
</tr>
<tr>
<td>Balance (sec)</td>
<td>Dynamic equilibrium</td>
<td>.099</td>
<td>.256</td>
</tr>
<tr>
<td>Flexibility (cm)</td>
<td>Trunk forward flexion</td>
<td>.183</td>
<td>.484*</td>
</tr>
<tr>
<td></td>
<td>Trunk backward flexion</td>
<td>.055</td>
<td>-.047</td>
</tr>
</tbody>
</table>

Note: *p<.05, **p<.01.

No items showed significant relevance for bat speed. When it comes to throw distance, there was a significant relevance with visual perception coordination(r=.532, p=.011), and trunk forward flexion(r=.484, p=.023). There was a significant relevance between the 3rd base running and trunk forward flexion(r=-.487; p=.022).

Looking at the results of the correlation between bat speed and coordination, equilibrium, and flexibility, there was no significant association in all categories in bat speed. For throw distance, there was a significant relevance with visual perception coordination and trunk forward flexion. For base running, the 3rd base running had a significant relevance with trunk forward flexion. Throwing a ball in softball is composed of complex mechanisms and the complex stability of hip and pelvis is important[37] and to prevent injury by distortion of upper and lower bodies flexibility and equilibrium are important[38]. These results were consistent with the significant relevance of the visual perception coordination and flexibility of the
throwing motion in this study. In addition, equilibrium is highly related to the motor function in softball, and players with joint or muscle injuries experience a sharp decline in balance [39][40].

### 3.3. Analysis of correlation between body composition and physical fitness

The results of analyzing the correlation between body composition (weight, LBM, muscle mass, fat ratio, BMI, abdominal fat ratio, and circumference) and physical fitness are shown in [Table 6].

**Table 6. Analysis of correlation between body composition and physical fitness.**

<table>
<thead>
<tr>
<th>Items</th>
<th>Weight (kg)</th>
<th>LBM (kg)</th>
<th>Muscle mass (kg)</th>
<th>Fat ratio (%)</th>
<th>BMI (kg/m²)</th>
<th>Abdominal fat ratio (%)</th>
<th>Thigh (cm)</th>
<th>Forearm (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip power (kg)</td>
<td>0.089</td>
<td>0.544**</td>
<td>0.551**</td>
<td>-0.550**</td>
<td>-0.019</td>
<td>-0.419</td>
<td>-0.001</td>
<td>0.012</td>
</tr>
<tr>
<td>Back muscle power (kg)</td>
<td>0.227</td>
<td>0.508*</td>
<td>0.513*</td>
<td>-0.325</td>
<td>0.096</td>
<td>-0.268</td>
<td>0.227</td>
<td>0.191</td>
</tr>
<tr>
<td>Sit up (times)</td>
<td>-0.405</td>
<td>0.223</td>
<td>0.224</td>
<td>-0.795**</td>
<td>-0.435*</td>
<td>-0.691**</td>
<td>-0.256</td>
<td>-0.233</td>
</tr>
<tr>
<td>Push up (times)</td>
<td>-0.430*</td>
<td>-0.076</td>
<td>-0.071</td>
<td>-0.495*</td>
<td>-0.240</td>
<td>-0.521*</td>
<td>-0.109</td>
<td>-0.126</td>
</tr>
<tr>
<td>Repeating jump (times)</td>
<td>-0.121</td>
<td>0.372</td>
<td>0.380</td>
<td>-0.639**</td>
<td>-0.352</td>
<td>-0.528*</td>
<td>-0.031</td>
<td>-0.008</td>
</tr>
<tr>
<td>Standing long jump (cm)</td>
<td>-0.234</td>
<td>0.350</td>
<td>0.355</td>
<td>-0.760**</td>
<td>-0.453*</td>
<td>-0.671**</td>
<td>-0.267</td>
<td>-0.270</td>
</tr>
<tr>
<td>Vertical jump (cm)</td>
<td>0.595**</td>
<td>0.053</td>
<td>0.057</td>
<td>-0.846**</td>
<td>-0.654**</td>
<td>-0.862**</td>
<td>-0.405</td>
<td>-0.365</td>
</tr>
<tr>
<td>Sound (sec)</td>
<td>-0.172</td>
<td>-0.455*</td>
<td>-0.459*</td>
<td>0.288</td>
<td>0.164</td>
<td>-0.014</td>
<td>-0.212</td>
<td>-0.245</td>
</tr>
<tr>
<td>Light (sec)</td>
<td>-0.118</td>
<td>-0.502*</td>
<td>-0.503*</td>
<td>0.410</td>
<td>0.272</td>
<td>0.113</td>
<td>-0.151</td>
<td>-0.204</td>
</tr>
<tr>
<td>Side step (times)</td>
<td>-0.424*</td>
<td>0.090</td>
<td>0.096</td>
<td>-0.682**</td>
<td>-0.561**</td>
<td>-0.641**</td>
<td>-0.192</td>
<td>-0.132</td>
</tr>
<tr>
<td>One foot standing with eyes closed (sec)</td>
<td>-0.244</td>
<td>-0.152</td>
<td>-0.150</td>
<td>-0.132</td>
<td>-0.097</td>
<td>-0.144</td>
<td>0.091</td>
<td>0.052</td>
</tr>
<tr>
<td>Dynamic equilibrium (sec)</td>
<td>0.550**</td>
<td>-0.131</td>
<td>-0.130</td>
<td>-0.565**</td>
<td>-0.504*</td>
<td>-0.576**</td>
<td>-0.497*</td>
<td>-0.466*</td>
</tr>
<tr>
<td>Trunk forward flexion (cm)</td>
<td>-0.192</td>
<td>0.273</td>
<td>0.276</td>
<td>-0.589**</td>
<td>-0.419</td>
<td>-0.465*</td>
<td>-0.157</td>
<td>-0.165</td>
</tr>
<tr>
<td>Trunk backward flexion (cm)</td>
<td>-0.213</td>
<td>0.307</td>
<td>0.306</td>
<td>-0.631**</td>
<td>-0.336</td>
<td>-0.515*</td>
<td>-0.084</td>
<td>-0.131</td>
</tr>
</tbody>
</table>

*Note:* *p<.05, **p<.01

In muscle power and endurance, there was a significant correlation with grip power and LBM (r=.544, p=.009) and muscle mass (r=.551, p=.008) and a negative significant correlation with fat ratio (r=-.550, p=.008). There was a significant correlation with back muscle power with LBM (r=.508, p=.016) and muscle mass (r=.513, p=.015). For sit up, there was a negative significant correlation with fat ratio (r=-.795, p=.001), BMI (r=-.435, p=.043), and abdominal fat ratio (r=-.691, p=.001). For push up, there was a negative significant correlation with weight (r=-.430, p=.046), fat ratio (r=-.495, p=.019), and abdominal fat ratio (r=-.521, p=.013). For repeating jump, there was a negative significant correlation with fat ratio (r=-.639, p=.001) and abdominal fat ratio (r=-.528, p=.012). For standing long jump, there was a negative significant correlation with fat ratio (r=-.760, p=.001), BMI (r=-.453, p=.034), and abdominal fat ratio (r=-.671, p=.001). For vertical jump, there was a negative significant correlation with fat ratio (r=-.846, p=.001), BMI (r=-.654, p=.001), and abdominal fat ratio (r=-.862, p=.001). There was a negative significant correlation for sound with LBM (r=-.455, p=.033) and muscle...
mass($r=-.459$, $p=.032$) and for light with LBM($r=-.502$, $p=.017$) and muscle mass($r=-.503$, $p=.017$). For side step, there was a negative significant correlation with weight($r=-.424$, $p=.049$), fat ratio($r=-.682$, $p=.001$), BMI($r=-.561$, $p=.007$), and abdominal fat ratio($r=-.641$, $p=.001$). For dynamic equilibrium, there was a negative significant correlation with weight($r=-.550$, $p=.008$), fat ratio($r=-.565$, $p=.006$), BMI($r=-.504$, $p=.017$), and abdominal fat ratio($r=-.576$, $p=.005$). For trunk forward flexion, there was a negative significant correlation fat ratio($r=-.589$, $p=.004$) and abdominal fat ratio($r=-.465$, $p=.029$), and for trunk backward flexion, there was a negative significant correlation fat ratio($r=-.631$, $p=.002$) and abdominal fat ratio($r=-.515$, $p=.014$). For the correlation between the circumference of body composition and physical fitness, grip power and left forearm($r=.451$, $p=.035$) showed a significant correlation, and for sound response, there was a negative significant correlation with right forearm($r=-.456$, $p=.033$). There was a negative significant correlation in dynamic equilibrium and left thigh($r=-.497$, $p=.019$) and right thigh($r=-.466$, $p=.029$) No significant correlation was shown in all other items.

Looking at the relation between physical fitness and body composition, it was found that there was a significant correlation between muscular variables (LBM and muscle mass) of body composition, muscular variables of physical fitness (grip power and back muscle strength), and response time variables (sound and light). These results suggest that increased muscle variables increase muscle strength and faster response time[41]. The increase in muscle mass caused by exercise directly affects the neuromuscular system, which improves the growth of the muscle and the conductivity of the nervous system[42].

In contrast, fat-related variables (fat ratio, BMI, and abdominal fat ratio) were found to be negatively related to muscle endurance (sit up, push up, and repeating jump), response (standing long jump and vertical jump), agility (side step), dynamic equilibrium, and flexibility (trunk forward/backward flexion) variables. It suggests that an increase in fat-related variables results in a decrease in the motor skills of physical fitness-related variables[18][43][44].

Significant relevances have been shown in the circumference of the body composition (left forearm) and in grip power and response to sound, which means that the greater thickness of forearm the greater grip power and the faster response to sound. However, there was a negative relevance for thigh and dynamic equilibrium, which, if not clear, is attributed to the accumulation of fat in the lower body parts of female softball players[45].

4. Conclusion

In field test and body composition, women’s softball players showed a positive correlation with the forearm circumference in bat speed, and base running with the muscle-related variables (muscle mass and LBM), and the fat-related variables (fat ratio and abdominal fat ratio) showed negative correlation. In field test and physical fitness, there was a correlation between throw distance and lower limbs muscular endurance (repeating jump), response (standing long jump and vertical jump), agility (side step), and flexibility (trunk forward flexion). Base running showed a significant relevance with muscular strength (grip power), muscular endurance (sit up), response (standing long jump and vertical jump), agility (side step), and flexibility (trunk forward flexion). Body composition and physical fitness were divided into muscle-related and fat-related variables. To sum up, the continuous management of physical composition and the increase in basic and professional physical fitness of female softball players are important factors in improving performance and preventing injury. In addition, further studies of body composition and physical fitness related to field tests are required in future studies.
5. References

5.1. Journal articles


5.2. Additional references


6. Contribution

6.1. Authors contribution

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<tr>
<td>Lead Author</td>
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<td>-Significant contributions to concepts, designs, practices, analysis and interpretation of data</td>
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