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THE RELATIONSHIP BETWEEN BODY COMPOSITION MEASURES AND AEROBIC CARDIORESPIRATORY FITNESS IN FEMALE SOFTBALL OUTFIELDERS AND INFIELDERS

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THE RELATIONSHIP BETWEEN BODY COMPOSITION MEASURES AND AEROBIC CARDIORESPIRATORY FITNESS IN FEMALE SOFTBALL OUTFIELDERS AND INFIELDERS

by

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ABSTRACT

THE RELATIONSHIP BETWEEN BODY COMPOSITION MEASURES
AND AEROBIC CARDIORESPIRATORY FITNESS
IN FEMALE SOFTBALL OUTFIELDERS
AND INFIELDERS

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Researchers have found that the different positions in a sport can play a significant role in the internal proportions of the body. This work focused on comparing the body composition and cardiorespiratory fitness between softball infielders and outfielders.

Six female collegiate softball players (20.0 ± 0.89 yrs, 64.9 ± 1.7 in, 65.2 ± 8.1 kg), were split into two groups, infielders and outfielders, in order to compare the differences between the two groups. Subjects were asked to report to The University of Texas at Arlington MAC 153 on one occasion for 30 minutes. Body composition was taken using the BodPod, a machine that measures the body's fat and fat-free mass, and cardiorespiratory fitness was measured as maximal oxygen consumption (VO_{2max}) using the Bruce Protocol.

Results found that infielders had lower cardiorespiratory fitness (42.63 ± 8.14 VO_{2max}) and higher fat mass (21.5 ± 10.04 percent body fat). Overall, the position within this sport appears to have an impact on the player's fitness levels and body composition.

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CHAPTER 1

INTRODUCTION

Cardiorespiratory fitness is defined as "the measurement of the maximum amount of oxygen that your body is capable of consuming to generate energy that can be used at the cellular level" and is measured through VO_{2max} testing (Daley 2017). In simpler terms, cardiorespiratory fitness assesses the strength and function of the aerobic energy system. Cardiorespiratory fitness is divided into two components: delivery of oxygen to the muscles, and the absorption and use of the oxygen at the muscles (Daley 2017).

The ability to delivery oxygen to the muscles is dependent on the coordination between the heart, arteries, veins, and lungs (Daley 2017). The lungs are crucial in cardiorespiratory fitness because they help provide the oxygen needed by the working muscles (Janot 2004). Air enters the lungs through inhalation and then diffuses into the blood in the capillaries that surround the lungs. That oxygenated blood is then transported to the left side of the heart, the left atrium, via the pulmonary veins. As the atrium contracts, blood moves through the mitral valve into the left ventricle. As the blood volume increases in the left ventricle, the mitral valve will close to prevent backflow into the left atrium. This will cause a build up of pressure in the left ventricle, shunting the blood out of the heart through the aortic valve into the aorta (WebMD 2018). Blood will then move into the arteries that will deliver the oxygenated blood to the muscles. Once the blood has reached the muscles, the blood in the capillaries located around the muscles will move very

Slowly, which allows the oxygen to diffuse into the muscles and the accumulated carbon dioxide, a byproduct of metabolism, to diffuse out. The now carbon dioxide rich blood will travel to the right atrium via the systemic veins. From there, the carbon dioxide will travel from the right atrium into the right ventricle and get ejected through the pulmonary arteries to the lungs. In the lungs there is less carbon dioxide than in the capillaries. This allows the diffusion of the carbon dioxide from the capillaries into the lungs where it is exhaled into the atmosphere and oxygen is inhaled. This will start the cycle again (Daley 2017).

Once the oxygen has reached the muscles, it will be used to generate ATP to sustain the prolonged activity. There are many factors that can affect the ability of the muscles to absorb and use the oxygen, such as the mitochondrial density of the muscles and the blood capillary distribution to the muscles. These factors play a vital role in cardiorespiratory fitness, as the ability to absorb and use the oxygen in the muscles is just as important as the ability to inhale oxygen (Daley 2017).

Cardiorespiratory fitness is an important component to assess in an athlete. It provides vital information including: current fitness levels, the ability to create a specialized and individualized exercise program for the athlete, recognizes specific limitations in exercise, identifies risks for cardiovascular disease, assesses progression in an exercise program, and evaluates cardiovascular responses to exercise (Janot 2004). The body adapts to repeated exercises; therefore, repeated training methods for athletes can differentiate their overall cardiorespiratory fitness. This evaluation can help trainers and coaches formulate training methods that are best suitable to athletic positions.

Body composition is a crucial factor in athletics for many reasons. Certain sports require a specific body composition to ensure optimal performance. These are seen in sports such as gymnastics, ballet, and diving. Tracking body composition may be of benefit for athletes testing out the effects of different training regimens (Loughborough), or to mark preseason and postseason changes that result from strength-training programs (Warner, Fornetti, Jallo, Pivarnik, 2004).

Body composition can be assessed using many different methods such as Dual-Energy X-Ray Absorptiometry (DXA), skinfold calipers, and Whole-Body Plethysmography (BodPod). The golden standard for measuring body compositions is using DXA as it is the most accurate method. It entails the participant laying down under an open scanner for about ten minutes as their body composition (lean tissue and body fat) and bone mineral density is assessed (Beestone 2018). Skinfold calipers gage the percent body fat through the use of skinfold calipers that "measure a double fold of skin and subcutaneous adipose tissue and apply a constant pressure to the site" (Beestone 2018) and an equation based on gender. This method is based on the theory that subcutaneous fat is proportional to total body fat, and that one-third of the body fat it located between the muscle and skin (ACSM 2014). BodPod asseses body composition by determining body volume and dividing that by the participant's mass. Body volume is calculated by measuring the reduction in the chamber volume once the participant enters the chamber with a fixed air volume (Beestone 2018).

Researchers have found that the different positions in a sport can play a role in the internal proportions of the body (Marina, Władysław, Zh.L., 2007). Past research conducted entailed the comparison of body composition and cardiorespiratory fitness between female collegiate softball and volleyball players. Body composition was determined by using skinfolds. It was found that due to their similar training regiments (aerobic and anaerobic training), they did not have significant differences in their cardiorespiratory or body fat percentage; however, results showed a high standard deviation in the percent body fats of the softball players. This is hypothesized to be due to the different positions in softball. This was confirmed by a past study that compared the body compositions between professional baseball infielders and outfielders. Results found that outfielders averaged 8.36 percent fat, while infielders averaged 9.33 percent fat (Coleman and Lasky, 1992). The BodPod will be crucial in this experiment as it will determine the percent body fat in each portion of the body. Researchers have found that the different positions in a sport can play a role in the internal proportions of the body (Marina, Władysław, Zh.L., 2007).

Recent studies used equations, based on the total time participants were on the treadmill, in order to determine VO_{2max}. Bertucci and peers found that prediction equations to determine VO_{2max} overextended the participant's true $VO_{2\ max}$ (Bertucci, et al. 2016). However, because cardiorespiratory fitness is an important factor to consider in athletes, I will use a mouthpiece that will be connected to the computer in order to measure true VO_{2max}.

CHAPTER 2

METHODS

2.1 Subjects

Six female softball athletes from the University of Texas at Arlington participated in the study. The experimental protocol was fully explained to the participants and they all signed an informed consent document.

2.2 Experimental Design

Subjects were asked not to consume alcohol or caffeine 24 hours before the study and not to consume food nor exercise 2-3 hours prior to the study. On the date of the study, they reported to the UTA Kinesiology Lab – MAC 153 and signed an informed consent form before starting the study. The study consisted of one 30-minute session. At the session, the following measurements were recorded: age, height, weight, body fat percentage, heart rate (HR), VO_{2max}, and RPE (rate of perceived exertion).

To assess body fat percentage, participants first changed into a latex/spandex swimsuit and put on a swim cap. Participants' heights were taken using a height rod provided in the room. In order to obtain body composition measurements, participants sat in the BodPod for the duration of the test. That consisted of two 1-minute stages. If the numbers obtained from those two stages were significantly different, a third stage was added. While in the BodPod, participants were informed to have their back against the machine, hands flat on their thighs, eyes and mouth closed, and little to no movement during the one minute stages. Failure to do any of the mentioned procedures could lead to incorrect data. Once the stages have been complete, the BodPod will print the following information regarding the participants' body fat percentage: percent fat mass, percent fat free mass, pounds of fat mass, and pounds of fat free mass.

Aerobic cardiorespiratory fitness was determined by the Bruce Protocol test followed with the use of a Parvo metabolic cart to determine VO_{2max}. Participants were asked to rest five minutes before they began the exam. A heart rate monitor with sigma gel was placed over the participant's sternum to ensure their heart rate stays in a safe range-not exceeding their max heart rate as calculated by the following equation: 220 – age. Athletes wore a mouthpiece supported by a headgear to capture important data such as their VO_{2max}. Athletes began the Bruce Protocol test that entailed three-minute stages starting at 1.7 mph at a 10% grade and increased in grade and speed at each stage. Before participants were about to start the next stage, they were asked to point to a number on the Rate of Perceived Exertion Chart to track the intensity of the workload, subjectively. Participants were encouraged to complete this max test to their fullest capabilities and only stop when they have truly hit their max. In order to inform the tester they were ready to stop the test, they grabbed onto the treadmill handle.

2.3 Instruments

The participants' heights were taken using a height rod. The BodPod was used to determine body fat composition. A heart rate monitor was used to track heart rate, and an RPE chart was used to track intensity levels. The Bruce Protocol was conducted on the Quinton q-stress treadmill. A headgear and mouthpiece was attached to a Parvo metabolic cart to determine VO_{2max}.

2.4 Statistical Analysis

The data was analyzed for statistical significance using a one-way repeated measure ANOVA using SPSS 24.0. Both cardiorespiratory fitness and percent body fat were compared between the two positions, infield and outfield. The alpha level was set to 0.5 to test for significance. The independent variable was Softball position (2 levels: outfield and infield).

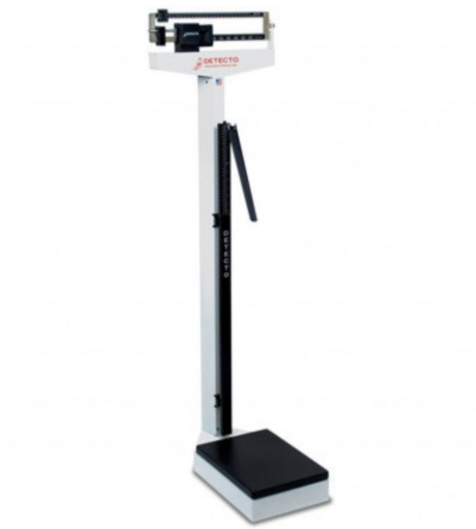

Figure 2.1: Height Rod

Figure 2.2: BodPod

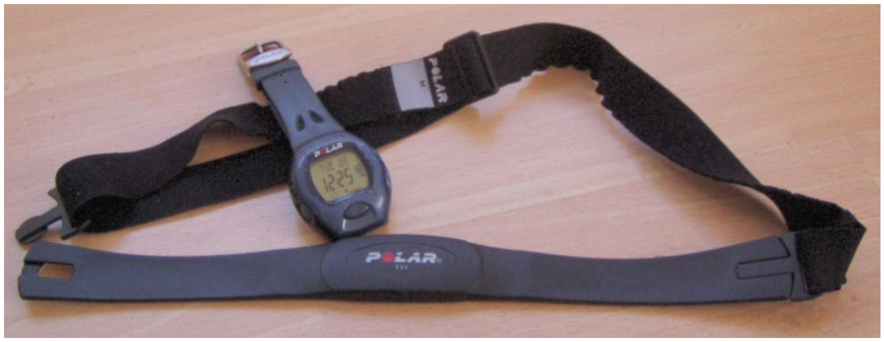

Figure 2.3: Polar Heart Rate Monitor

Rating	Perceived Exertion
6	No exertion
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Figure 2.4: RPE Chart

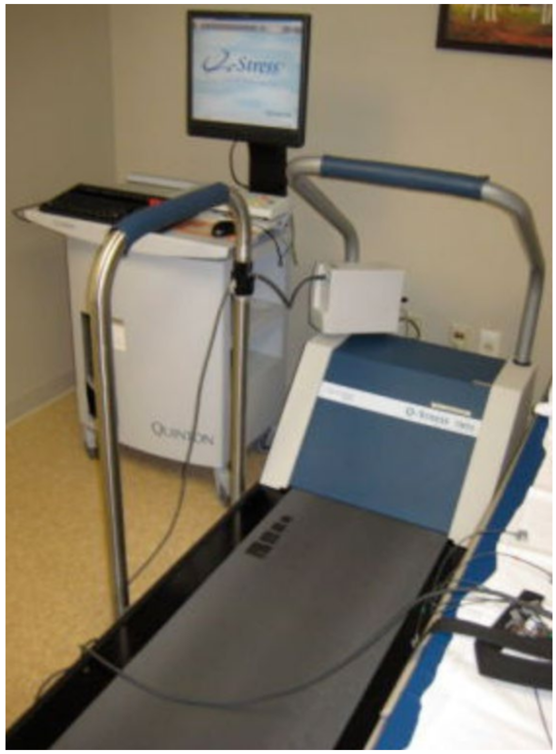

Figure 2.5: Quinton Q Stress Treadmill

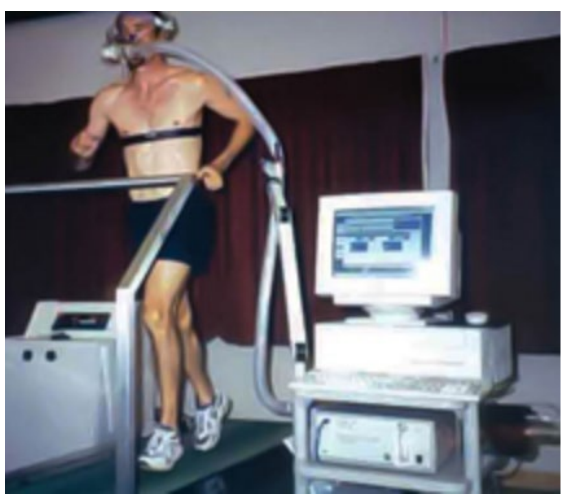

Figure 2.6: Parvo Metabolic Cart and Headgear with Mouth Piece

CHAPTER 3

RESULTS

The six participants consisted of female collegiate softball players competing at The University of Texas at Arlington. All six participants were tested using the BodPod and Bruce Protcol connected to a Parvo metabolic cart. All the softball participants' had a mean of 20.0 ± 1 years. The mean height was 65.08 ± 2.53 inches for the infielders and 64.67 ± 0.76 inches for the outfielders. The mean weight was 68.66 ± 11.20 kgs for the infielders and 61.72 ± 1.00 kgs for the outfielders.

Table 3.1: Demographic Variables

Variable	Group	Mean	± Stand. Deviation
Age (years)	Infield	20.0	1
	Outfield	20.0	1
Height (inches)	Infield	65.08	2.53
	Outfield	64.67	0.76
Weight (kgs)	Infield	68.66	11.20
	outfield	61.72	1.00

Following the BodPod analysis, infielders averaged 21.5 ± 10.04 percent body fat while the outfielders averaged 20.17 ± 0.59 percent body fat. Following the Bruce Protocol test for cardiorespiratory fitness, infielders averaged a VO_{2max} of 42.63 ± 8.14 ml/kg/m while the outfielders averaged a VO_{2max} of 43.22 ± 5.43 ml/kg/m.

Table 3.2: Participant Results

Variable	Group	Mean	± Standard Deviation
Percent Body Fat	Infield	21.5	10.04
	Outfield	20.17	0.59
VO_{2max} (ml/kg/m)	Infield	42.63	8.14
	Outfield	43.22	5.43

The alpha was set at $p < 0.05$ for statistical analysis purposes. Results found no significant differences between the infielders and outfielders in terms of cardiorespiratory fitness and body composition percent body fat. The F-statistic and p-value for the body composition portion of the experiment were: $F [1,4] = 0.053$, $p > 0.05$ ($p = 0.830$). The F-statistic and p-value for the cardiorespiratory fitness portion of the experiment were:

$F [1,4] = 0.011$, $p > 0.05$ ($p = 0.922$).

CHAPTER 4

DISCUSSION

The ANOVA test revealed no significant difference in mean VO_{2max} and mean percent body fat between the softball infielders and outfielders. Analyzing these results shows that the different positions within the sport does not induce differences in cardiorespiratory fitness and body composition.

This could have occurred due to one infielder whose data was significantly different than her following test group. This is seen drastically in the high standard deviation, within the infielders group. After further speaking with the participants, this could be attributed to the fact that she plays both infield and outfield throughout the seasonal games. Therefore, not playing in a specific set position has not allowed her body to adapt to the body composition and cardiorespiratory fitness levels seen in any specific group.

Another factor of error could be attributed to the participants not meeting the appropriate criteria (i.e not having exercised nor eating 2-3 hours prior to the test). Due to the participants currently being in season and training twice a day, meeting those standards were at times difficult.

The last source of error could be attributed to the different equipment used throughout the test. Halfway into collecting data, the first Parvo metabolic cart encountered technical difficulties and was temporary out of order. That resulted in the use of a different Parvo metabolic cart for the second half of data collection.

Overall, results in this study were similar to results previously seen in Marina, Władysław, and Zh.L.'s 2007 test where they found that the different positions in a sport can play a role in the internal proportions of the body (Marina, Władysław, Zh.L., 2007). Further research is necessary to compare the extent of which different positions within a sport influence cardiorespiratory fitness and body composition.

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BIOGRAPHICAL INFORMATION

Niveen Joulani was born in Jerusalem and grew up, for the most part, in Arlington, Texas. She attended a local private elementary school where she was exposed to magnificent teachers and an amazing atmosphere that promoted education. During Junior High and her freshman year of High school, Niveen attended schools in Jerusalem where she was exposed to a different culture and a new lifestyle. She moved back to Arlington to finish High School and then attended the University of Texas at Arlington (UTA) to study Kinesiology, where she graduated with an Honors Bachelors of Science in Exercise Science degree.

At UTA, she was allowed to the opportunity of conducting research. For her first research project, she tested and compared the cardiorespiratory fitness and body composition of female softball collegiate athletes to female volleyball collegiate athletes. Her results found a high standard deviation within the softball athletes in terms of both body composition and cardiorespiratory fitness. This fueled her interests that the difference could be due to the different softball positions – infielders vs outfielders- and dedicated her senior Honors thesis to exploring this hypothesis. She presented both research projects as poster formats to the Department of Kinesiology.

Niveen plans on attending Physician Assistant's School and fulfilling her goal of becoming a PA. Wherever the road may lead her, she will never forget all UTA has done for her.