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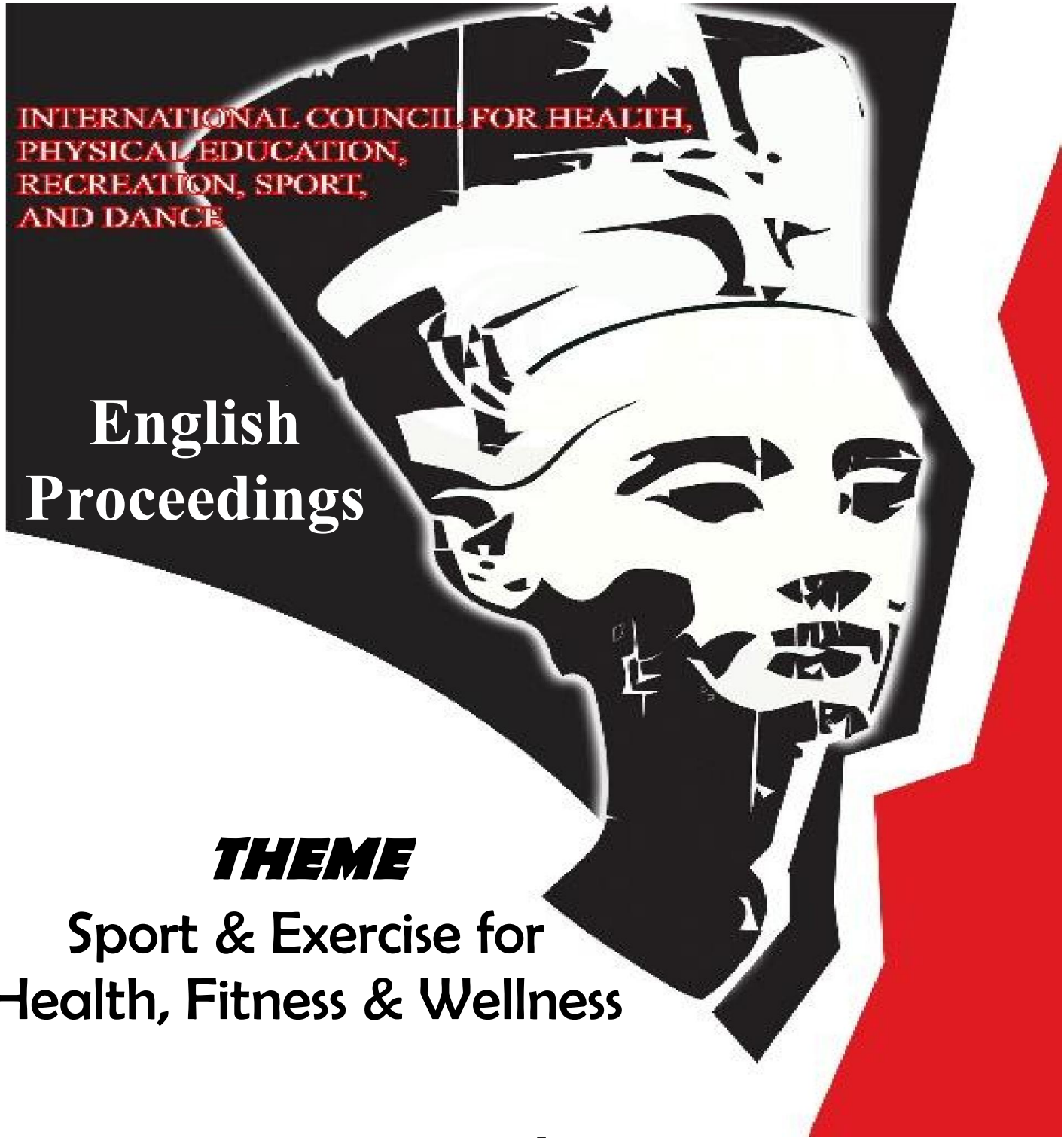
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Correlation of Body Mass Index and Flexibility among Selected Badminton Players in Northern Nigeria

Abdullahi Yahaya

Badminton comprises a number of skill-related movements, such as: footwork in the playing center using a split jump/pre-tension jump, footwork, lunge, scissors jump, two-feet landing, and two legged jumps, and movement back towards the playing center using many different movement patterns. The body mass index and flexibility of badminton players are basic tools for assessing performance of badminton players. Competitive badminton requires good stroke production and good physical fitness, as well as psychological characteristics that will enable successful performance at the competitive level (Faccini & Dalmonte, 1996).

The physical fitness of a player however, can be a prime determinant of success during a tournament (Smekal, et al., 2001). Similarly, a racket sport player would need to develop higher levels of basic physical qualities such as strength, flexibility, endurance, speed and agility to be able to compete effectively against stronger opponents (Groppel & Roetert, 1992). Chin, Wong, So, Siu, Steininger and Lo (1995), recommended that if a player wants to achieve reasonable success at international badminton competitions, improvements in physical fitness need to be emphasized in addition to skill training. It is therefore useful to assess both physiological and motor performance components thought to be important in a particular sport at various levels (Elliot, Ackland, Blanksby, Hood, & Bloomfield, 1989).

Body composition is an important aspect of fitness (Reilly & Stratton, 1995). A standard anthropometric analysis during a physical fitness assessment would involve determining the height, mass, somatotype and body fat percentage of an individual or athlete (Maud & Foster, 1995). Height does not seem to be a determinant of success in badminton (Reilly & Palmer, 1995), as most adult players are taller than the top of the badminton net which is 1.52 to 1.55 metres from the floor. Body mass is a factor that plays a role in influencing performance in throwing sports, and because it can impose resistance to movement, it is also an important factor in contact sports. In sports where body weight has to be lifted repeatedly against gravity, such as in badminton, extra mass in the form of fat would be disadvantageous (Reilly & Stratton, 1995).

It has been well established that excess body fat is detrimental to health and that the body fat percentage required for excellence in performance differs between males and females, and varies from sport to sport (Powers & Howley, 1997). Junior males differ from females in many morphological and physiological characteristics, and it is therefore important to consider the sexes separately in data analysis (Marshall, 1978 as reported in Van Lieshout, 2002).

Top competitive players tend to have a low body fat percentage, as the negative impact of excess body fat would increase the energy expended in moving around the court (Elliot *et al*., 1989; Chin *et al.*, 1995). Lower levels of body fat will enhance the game of badminton as it permits a more effective gradient for the rapid transfer of heat produced during high intensity exercise, and would be advantageous concerning moving quickly across the court and in leaping to smash the shuttle-cock. In a research carried out by Elliot *et al.,* (1989), body composition was found to be an important indicator of tennis performance for 11 - 15 year old male and female players. In studies performed on American footballers by Wilmore and Haskell (1972) as

reported in Van Lieshout (2002), it was concluded that lean body mass rather than total body weight was the critical factor relative to performance ability.

According to Jaski and Bale (1987), a moderate increase in lean body mass will result in greater speed, strength and power without a loss of flexibility and explosive power.

Flexibility is an important, yet often neglected component of physical fitness (Heyward, 1998). It is important not only in learning athletic skills satisfactorily, but also for general health and fitness, athletic performance, injury prevention, and rehabilitation (Waugh & Grant, 2006; MacDougall, Wenger & Green, 1991). It is a component of fitness that sport scientists and physiotherapists measure to gain an impression of a person's physical capacity (Harvey & Mansfield, 2000). Flexibility reflects the ability of the muscle-tendon units to elongate within the physical limitations imposed by the joint (MacDougall *et al.*, 1991), and refers to the looseness or suppleness of a joint. According to Maud and Foster (1995) and Heyward (1998), there are two types of flexibility namely static and dynamic flexibility. Static flexibility is the measure of the total range of motion at a joint whereas dynamic flexibility refers to the measure of the resistance to movement. Flexibility however, is not only specific to the sport, but also to the joint and joint action (Waugh & Grant, 2006). Joint flexibility is controlled by a number of morphological factors, such as the geometry of the joint capsule, adipose tissue, the muscles surrounding the joint, the tendons and ligaments around the joint, and the skin (Maud & Foster, 1995). The joint capsule contributes to approximately 47% of the ROM (range of motion), the muscles approximately 41%, and the tendons approximately 10%, and the skin approximately 2% (McGlynn, 1996).

It is an advantage to have above average flexibility levels of the trunk and shoulder regions for racket sports (Chin *et al*., 1995). This corresponds with Omosegaard (1996) who stated that a greater flexibility of the trunk and stroke arm is undoubtedly an important factor, as well as hip and hamstring flexibility. Therefore, with badminton, above average flexibility of the shoulder, trunk and hip is expected of players, as flexibility is important in reaching the shuttlecock, especially in stressful situations. An adequate level of flexibility also allows a player to perform the various strokes efficiently as much retrieval are made with the spine and shoulder joint in hyperextension, and with the hip and hamstrings fully flexed when lunge jumps are made at the net. This flexibility allows for more fluent stroking when forced to stretch and facilitates explosiveness on the court (Reilly & Palmer, 1995). A greater flexibility in badminton players would result in improved maximal strength, a greater ability to utilize the stretch-shorten cycles effectively, augmented efficiency and correct movement patterns throughout the required range of motion. It is for these reasons that flexibility is an important component of badminton (Chandler, Kibler, Stracener, Ziegler & Pace, 1992).

Methodology

The purpose of the current study was to assess the body mass index (physiological) and flexibility (motor performance) characteristics of selected badminton players in Northern Nigeria. And also, examine the correlation and differences between the players' body mass index and flexibility characteristics based on gender and status. A purposive sampling method was used to select the participants. One-shot study design was used for data collection. Twenty (20) male and nine (9) female participants from the Northern states totaling twenty nine (29) players were selected for the study. There were four (4) male and two (2) female national team players

among them, the remaining 23 were non-national team players. All the participants featured in the Common Wealth Games Trials 2010.

The following instruments were used for data collection: Bathroom weighing scale (by Hooya Import and export Co., Ltd, China): This was used to measure participants' weight (in kg). Height meter (Stadiometer by Quick Medical, North Bend. WA98045, USA): This was used to measure participants' height (in meters). Sit-and-reach box**:** a standard constructed sit-and-reach box, with a fixed ruler and slider**.**

Procedures

Standing height: Measurement was the maximum distance from the floor to the highest point on the head, undertaken when the subject was looking directly ahead. Shoes were taken off, feet together, and arms placed by the sides with face in Frankfort plane. Heels, buttocks and upper back were in contact with the wall. Height was measured to the nearest 0.1cm. This procedure was recommended by Badminton Australia (2008).

Body weight (mass): The participants stood with minimal movement with hands by their sides. Shoes and excess clothing were removed. Generally, the body mass in minimal clothing is sufficiently accurate (Badminton Australia, 2008). Body weight was measured to the nearest 0.1g. The data and that of standing height were used for the calculation of BMI, using: weight in kg divided by height in meters square ($^{W}/_{H}^{2}$).

Flexibility test: Flexibility was evaluated using a standardized sit-and-reach box. The preparation for and execution of all measurements were standardized. The test involves sitting on the floor with legs out straight ahead. Feet (shoes off) are placed with the soles flat against the box. Shoulder-width apart, both knees were held flat against the floor by the tester. With hands on top of each other and palms facing down, the subject reached forward along the measuring line as far as possible. After three (3) practice reaches, the fourth reach was held for at least two seconds while the distance was recorded. Records were taken only in the absence of jerky movement by the participant and fingertips remained level and the legs flat. Scoring: the score was recorded to the nearest centimeter as the distance before (negative) or beyond (positive) the toes.

Statistical Analysis

Data obtained were analysed using SPSS Version 17. Descriptive statistics including means and standard deviations ($\bar{x} \pm$ SD) were used to describe the BMI and flexibility. *Multiple correlation coefficient* (*r*) was computed, *independent t-test* was also computed to examine the significant differences in the BMI and flexibility between the sexes (*Male and Female*) and their status (*National and Non-national*). An alpha level of 0.05 was used for all statistical tests.

Results And Discussion

Table 1: Correlation Values between BMI and flexibility

S/No.	VARIABLES	R	*Prob*
a1	Height vs. sit & reach	0.02	***0.92***
a2	Weight vs. Sit & reach	0.07	***0.70***
a3	BMI vs. Sit & reach	0.06	***0.77***

***Correlation is significant at the .05 alpha level or <.**

Table 1A: Descriptive for all Participants Irrespective of Gender or Status

S/NO.	Variables	N	$\bar{x}$	SD
Physiological Characteristics				
1	Height (cm)	29	173.2	8.7
2	Weight (kg)	29	60.6	5.8
3	Body mass index (BMI) (kg.m^2)	29	20.4	2.9
Motor Performance Characteristic				
4	Flexibility (Sit and reach)	29	14.3	3.6

Table 2: *t*-Test Values between the selected Male and Female Badminton Players in Northern Nigeria

S/NO.	VARIABLES	SEX	N	$\bar{x}$	SD	*T*	Df	Prob
1	Height (cm)	Female	9	162.5	4.8	7.83	27	0.00*
		Male	20	177.9	4.9			
2	Weight (kg)	Female	9	61.2	4.5	0.36	27	0.72
		Male	20	60.4	6.5			
3	Body mass index (BMI) (kg.m^2)	Female	9	23.2	1.9	4.58	27	0.00*
		Male	20	19.1	2.3			
4	Flexibility (Sit and reach)	Female	9	15.1	4.3	0.7	27	0.43

Correlation is significant at the .05 alpha level or <.

Table 3: *t*-Test Values between the National and Non-national Badminton

S/NO.	VARIABLES	STATUS	N	$\bar{x}$	SD	*T*	Df	PROB
1	Height (cm)	Non-National	23	173.1	7.6	0.03	27	0.97
		National	6	173.3	13.0			
2	Weight (kg)	Non-National	23	60.7	6.1	0.13	27	0.89
		National	6	60.3	5.1			
3	Body Mass Index (BMI) (kg.m^2)	Non-National	23	20.4	2.6	0.12	27	0.91
		National	6	20.5	4.3			
4	Flexibility (sit & reach)	Non-National	23	13.7	3.7	1.73	27	0.09
		National	6	16.5	2.5			

***Significant at the .05 alpha level or < .**

Height

The participants in this study had a mean height of 173.2 ± 8.7cm (n=29) (Table IA). A significant correlation between height and flexibility was not found, where r = 0.02, p = 0.925 (Table 1). The male and female players in this study had a mean height of 177.9 ± 4.9cm (n=20) and 162.5 ± 4.8cm (n=9), respectively (Table II). There was a significant difference between the heights of selected male and female badminton players in Northern Nigeria. This is because the calculated t value was greater than the t critical value at 5% level of significant with p< 0.05. The males were significantly taller than the females (t= 7.83, p= 0.00) (Table II).

The national and non-national players in this study had a mean height of 173.3 ± 13.0 cm (n=6) and 173.1 ± 7.6 cm (n=23), respectively (Table III). There was no significant difference in height between selected national and non-national badminton players in Northern Nigeria. This

is because the calculated *t* value is less than the *t* critical value at 5% level of significant with p > 0.05 (*t*= 0.03, p= 0.97) (Table IV).

The result obtained seems similar to that of national badminton, state and top club level tennis players and national elite Swedish tennis players who have recorded mean heights of 181.0 ± 5.7cm, 175.4 ± 5.4cm, 181.0 ± 0.02cm, 182 + 7cm and 184 ± 6cm respectively (Reilly & Palmer, 1995; Faccini & DalMonte, 1996; Majumdar, Khanna, Malik, Sachdeva, Arif & Mandal, 1997). Studies by Rannou *et al.,* (2001) as Cited in Van Lieshout (2002) on national and international badminton players reported mean heights of 177.0 ± 1.4cm and 190.0 ± 1.2cm, respectively. These values are higher than those found in junior tennis players, top squash players, junior national squash players, and professional badminton players who have recorded mean heights of 163.4 ± 9.4cm to 174.5 ± 0.7cm (Elliot *et al.,* 1989; Todd & Mahoney, 1995), 166cm to 180cm (Chin *et al*., 1995), 173.0 ± 6.4cm (Mahoney & Sharp, 1995) and 172.0 ± 6.2cm to 177.2 ± 4.0cm (Chin *et al.,* 1992 & 1995), respectively. The values corresponds with values found in junior female badminton and tennis players who had mean values ranging from 160cm to 165cm (Ghosh, Goswani & Ahuja, 2000) and from 162.8 ± 7.5cm to 165.1 ± 5.2cm (Elliot *et al.,* 1989), respectively. These values are lower than those obtained by Powers and Walker (1982), and Hughes (1995) who recorded mean height values of 168.70 ± 2.35cm for female high school players, and 166.5 ± 6.4cm for senior national badminton players.

Weight

The participants in this study had a mean weight of 60.6 ± 5.8kg (n=29) (Table 1A). There was no significant correlation between weight and flexibility, where p = > 0.05. The male participants in this study had a mean weight of 60.4 ± 6.5 kg (n=20). Meanwhile, the females had 61.2 ± 4.5 kg (n=9) (Table 2). The result of this study revealed no significant difference in weight between the selected male and female badminton players in Northern Nigeria. The t-calculated is less than the t-critical values (t= 0.36, p= 0.72).

The national participants in this study had a mean weight of 60.3 ± 5.1kg (n=6). While, the non-national had 60.7 ± 6.1kg (n=23) (Table 3). No significant difference was found in the weight between selected national and non-national badminton players in Northern Nigeria. This is because the calculated t value is less than the t critical value at 5% level of significant with p > 0.05 (t= 0.13, p= 0.89) (Table 3).

These results are lower than values obtained for elite Danish badminton players whose values range from 73.3kg to 76.9kg (Omosegaard, 1996), and from 74 ± 2kg to 79.4 ± 0.8kg (Rannou *et al.,* 2001 in Van Lieshout, 2002), respectively. It is further lower than values obtained in studies on national male badminton players, leading junior tennis players, top squash, and professional badminton players who had values of 69.8 ± 4.8kg and 64.8 ± 6.9kg (Faccini & DalMonte, 1996; Majumdar *et al.,* 1997), and 67.7 ± 6.9kg and 67.7 ± 5.0kg (Chin *et al.,* 1992 & 1995). The value tends to correspond closely with that of elite female Danish badminton players, female high school tennis players and leading junior tennis players, whose body mass ranged from 57.0 to 66.7kg (Omosegaard, 1996), 57.99 ± 2.59kg (Powers & Walker, 1982) and 56.2 ± 8.1kg (Elliot *et al.,* 1989). These values however, are similar to those obtained for 14 to 15 year-old leading female tennis players of 52.5 ± 7.2kg and 54.2 ± 6.8kg by Elliot *et al.,* (1989). In Reilly, Secher, Snell and Williams (1990), it was concluded that lean body mass rather than total body weight was the critical factor relevant to performance ability.

Body Mass Index (BMI)

The participants in this study had a mean BMI of 20.4 ± 2.9 $kg.m^2$ (n=29) (Table 1A). There was no significant correlation between BMI and flexibility. The male participants in this study had a BMI of 19.1 ± 2.3$kg.m^2$ (n=20) and 23.2 ± 1.9$kg.m^2$ (n=9) for female participants. There was a significant difference in BMI between selected male and female badminton players in Northern Nigeria. This is because the calculated t value was greater than the t critical value at 5% level of significant $p < 0.05$. The females were significantly possessed more BMI than the males (t= 4.58, p= 0.00) (Table 2).

The national participants in this study had a mean BMI of 20.5 ± 4.3$kg.m^2$ (n=6). While, the non-nationals had 20.4 ± 2.6 $kg.m^2$ (n=23) (Table 3). No significant difference was found in the BMI between the selected national and non-national badminton players in Northern Nigeria. This is because the calculated *t* value was less than the *t* critical value at 5% level of significant with $p > 0.05$ (*t*= 0.12, p= 0.91) (Table III).

In research carried out on junior male and female tennis players by Elliot et al., (1989), body composition was found to be an important indicator of tennis performance for 11 - 15 year old male and female players. In studies performed on American footballers by Wilmore and Haskell (1972) as unveiled in Van Lieshout (2002), it was concluded that lean body mass rather than total body weight was the critical factor relative to performance ability. In this study males and females were treated differently as buttressed by Marshall (1978) as reported in Van Lieshout (2002) that; "junior males differ from females in many morphological and physiological characteristics, and it is therefore important to consider the sexes separately in data analysis."

Flexibility (Sit and reach)

The mean sit-and-reach values of the males in this study was 13.9 ± 3.3 cms (n=20). The females had a mean sit-and-reach values of 15.1 ± 4.3 cms (n=9) (Table 2). There was no significant difference in the sit-and-reach values of selected male and female badminton players in Northern Nigeria. *t*= 0.7 p= 0.43, the females were significantly more flexible than the males.

The mean sit and reach values of the national players in this study was 16.5 ± 2.5 cm (n=6). The non-national players had a mean sit and reach values of 13.7 ± 3.7 cm (n=23) (Table III). The study revealed no significant difference in the flexibility between the selected national and non-national badminton players in Northern Nigeria. The calculated *t* value was less than the *t* critical value at 5% level of significant, $p > 0.05$ (*t*= 1.73, p= 0.09), though, the national were more flexible than the non-national (Table III).

Chin *et al.,* (1995); Omosegaard (1996) supported that; high levels of flexibility are also needed so that the players are able to position themselves where they are able to hit the shuttlecock more powerfully (Nowak, 1998). Omosegaard (1996) stated that most right-handed badminton players have a reduced flexibility of the right hip in comparison to the left hip, which is probably due to greater loads imposed on the right leg during a jump, combined with inadequate stretching exercises.

Summary

In the correlation between BMI and flexibility, the following sequel was noted:

- A significant correlation between height and flexibility was not found.
- No significant correlation between weight and flexibility.

In testing the differences between ***males and females*** in BMI and flexibility, the following outcome was discerned:

- There is a significant difference between the heights of selected male and female badminton players in Northern Nigeria.
- There is no significant difference in weight between the selected male and female badminton players in Northern Nigeria.
- There is a significant difference in body mass index (BMI) between selected male and female badminton players in Northern Nigeria.
- No significant difference in the sit-and-reach values of selected male and female badminton players in Northern Nigeria. Even though the females were more flexible than their male counterpart was.

In testing the difference between ***National and Non-national*** in BMI and flexibility, the following results was obtained:

- ✓ No significant difference in height between selected national and non-national badminton players in Northern Nigeria. Even though, the national players were taller.
- ✓ No significant difference was found in the weight between selected national and non-national badminton players in Northern Nigeria. Even though, the non-national players were heavier.
- ✓ No significant difference was found in the BMI between the selected national and non-national badminton players in Northern Nigeria.
- ✓ No significant difference in the flexibility between the selected national and non-national badminton players in Northern Nigeria. Even though, the national players obtained higher values than the non-national.

Recommendations

The following recommendations were proffered:

1. The BMI and flexibility components of the players in this study need to be enhanced to meet up with international standards.
2. Athlete trainers, coaches, exercise scientists and all personnel concerned with designing training programs for badminton players should put all the physiological and motor performance components into consideration for enhancement.
3. Athlete trainers, coaches, exercise scientists and all personnel concerned with designing training programs for badminton players should place emphasis upon skill training. Skill tests seems to be a major variable left untouched by the foregoing study. Skill training seems a determinant of success in badminton.
4. Equally, it should be realized that males are physiologically disparate from females.

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