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Correlates of Anthropometric and Fitness Measures on Playing Positions of Ilocos Norte Collegiate Basketball Players

Cheryll Didi Nellie N. Obra MSPT PTRP
Mariano Marcos State University, Batac City

ABSTRACT

Basketball is a complex technical game requiring varying capabilities in the anthropometric and fitness domains. While several studies have documented the anthropometric and physiological characteristics of elite basketball players, investigations on collegiate players are limited. The purpose of this study were to create an anthropometric and fitness profile and to determine the relationship of anthropometric and fitness profile on playing positions of Ilocos Norte male collegiate basketball players. Forty players five men's basketball teams participated in this study. According to playing positions, players were categorized as guards (n=22), forwards (n=11), and centers (n=7). Subjects underwent anthropometric and fitness testing. ANOVAs revealed significant differences between the players across playing positions for height, weight, arms span. Guards are significantly shorter than forwards and centers while forwards and center do not differ significantly in height. Centers are significantly heavier than guards, however, forwards do not differ significantly in weight with any of the guards or centers. The arm span of centers is also significantly longer than the forwards who have significantly longer arm span than the guards. Data varied widely across playing positions for body circumferences, BMI, waist-hip ratio. There is statistically significant difference in peak oxygen consumption of the players, with the guards having significantly higher VO2max values while the centers having the lowest values. There are no significant differences in other fitness measures of the players regardless of their playing position. The collected profile data can contribute in idetifying possible athletes, selection procedures, evaluating and monitoring current players, and as a source of comparison with other athletic groups.

Keywords: Anthropometric and Fitness Measures

INTRODUCTION

Sports profiling certainly contribute to talent identification, selection procedures, and enhance performance in basketball (Hoare, 2000). Basketball is a complex technical and tactical game requiring varying capabilities in the anthropometric and fitness domains. While several studies have documented the anthropometric and physiological characteristics of elite basketball players, investigations on collegiate players are limited. The purposes of this study were to create an anthropometric and fitness profile and to determine the relationship of anthropometric and fitness measures on playing positions of male collegiate basketball players of Ilocos Norte. It is necessary to differentiate analysis on the basis of the playing position of the player based on the notion that each sport, event and even position within a sport demands its own unique set of physical and physiological attributes for success at the highest level (Norton & Olds, 2001). This gap in knowledge should be bridged inasmuch as evidence has underscored that the first step in individualization of basketball conditioning is the determination of current typical morphological and functional indices.

Basketball is a typical invasion game with repartition of participants according to playing position (Gocentas & Landor 2005). Players usually are assigned to different playing roles and positions (guards, forwards, centers) due to variations in size, fitness level, specific technique, and offensive strategies (Chia-Ming et al, in press). Based on players' specific roles on the court, each position usually would demonstrate a unique style of play at different spots of the court.

OBJECTIVES OF THE STUDY

The main aim of the study was to create an anthropometric and fitness profile and to determine the relationship of anthropometric and fitness measures on playing positions of male collegiate basketball players of Ilocos Norte.

Specifically, it aimed to:

1. describe the anthropometric characteristics of the basketball players;
2. determine their fitness measures in the fitness tests;
3. evaluate whether anthropometric characteristics are correlated with fitness measures.

METHODOLOGY

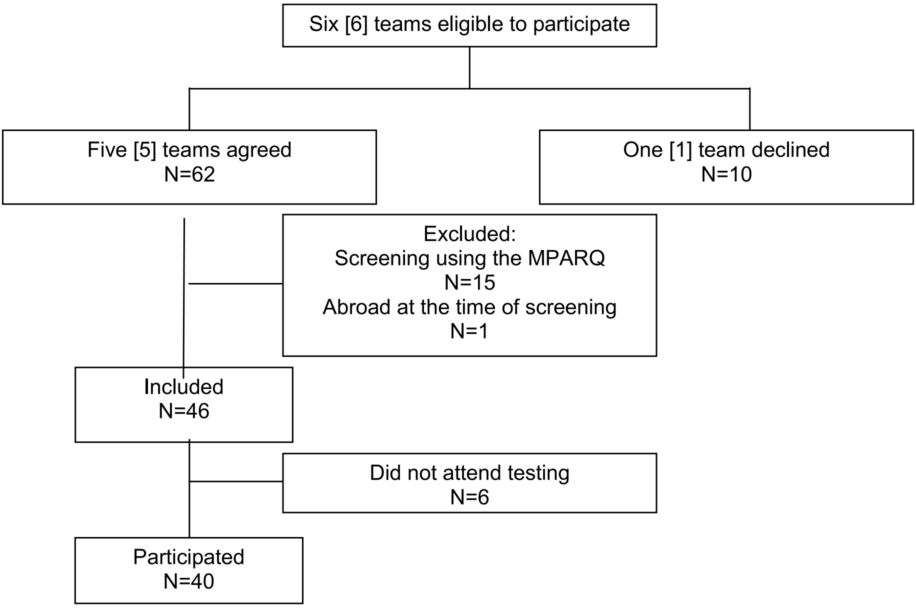
Research Design

This study used a descriptive-correlational design. The anthropometric and fitness measures of the collegiate basketball players were described. Correlations were performed on (a) anthropometric characteristics in relation to playing positions, (b) fitness measures in relation to playing positions, and (c) anthropometric characteristics in relation to fitness measures.

Sampling Procedures

All six collegiate men's basketball teams of Ilocos Norte that competed in the Private Schools Athletic Association (PriSAA) and State Colleges and

Universities Athletic Association (SCUAA) were recruited for this study. Five teams agreed to participate in the study (N=62) while one team declined (N=10) due to conflict of school activities. According to playing positions (based on the official first preferential position of the player in the team), players were categorized as guards (n=22), forwards (n=11), and centers (n=7).



Inclusion Criteria

The following were the inclusion criteria:

1. Male collegiate seasoned basketball players aged 16-25 years enrolled in a private school or state university of Ilocos Norte this school year 2007-2008.
2. Must be physically prepared for the activities (using the Modified PAR-Q).

Exclusion Criteria

The following were the exclusion criteria:

1. Those with recent musculoskeletal injury in the past six weeks.
2. Those who have undergone surgical operation in the past six months (based on the health history questionnaire).
3. Those who answered "yes" in any of the questions in the Modified PAR-Q.

Outcome Measures

Anthropometric Characteristics

1. Stretch stature or height (cm)
2. Weight (kg)

3. Arm span (cm)
4. Body mass index (kg/m2)
5. Body circumferences (cm)
6. Waist-hip ratio

Fitness Measures

1. Flexibility (cm)
2. Agility (sec)
3. Upper extremity strength (m)
4. Lower extremity strength and power (cm)
5. Muscular endurance (rep)
6. Speed and anaerobic power (sec)
7. Cardiorespiratory endurance (bpm for maximum HR and mlO2/kg for VO2max)

Research Procedures

Invitational letters were forwarded to school authorities. A pre-test health screening using a Modified PAR-Q and health history questionnaire were distributed to all players of the five participating teams. All subjects were given informed consent to participate and all were fully informed verbally and in writing about the nature and demands of the study.

Prior to the actual conduct of the study, an orientation of all assessors was held to ensure good understanding of the methods to be used. Validity of the measurements was confirmed and reliability of the assessors was conducted. The measures on height, weight, arm span, flexibility, and agility were used for reliability testing. Results showed a very high consistency of measurements for each assessor as indicated by the intra-tester correlation coefficient (ICC) which ranged from 0.89–1.00 and a very high agreement of measurements among assessors as indicated by the inter-tester correlation coefficients (ICC) which ranged from 0.93-0.99.

All study procedures took place in a standard athletic facility. Prior to data collection, all subjects participated in one introductory session on the proper form and technique of each fitness test. The tests were performed in the proper order of administering the tests (Baechle & Earle, 2000) with identical equipment, positioning and technique for all subjects. In the 24 hours before the testing, the subjects did not participate in any prolonged exercise or perform any vigorous physical activity. Subjects completed a warm-up of 5-10 minutes of stretching and individual exercise prior to the fitness tests.

Anthropometry

Stretch stature (nearest 0.1cm) was determined with a stadiometer (Detecto) with the subject standing with the feet together without shoes, looking straight ahead and inhaling (Young & Pryor, 2007). The intraclass correlation coefficient (ICC) for test-retest reliability and typical error of measurement (TEM) for height was 0.99 and 0.2%, respectively (Gabbett et al, 2007).

Body weight (nearest 0.1kg) was determined with balance beam scale (Detecto) with the subject standing still wearing light clothing and without shoes (Young & Pryor, 2007). The ICC for test-retest reliability and TEM for weight was 0.99 and 0.8%, respectively (Gabbett et al, 2007).

Arm span (nearest 0.1cm) was determined using a mounted new tape measure from the middle fingertip of one hand to the middle fingertip of the other hand with the arms abducted 90 degrees[6]. The test-retest reliability for arm span was 0.997 (Brown et al, 2002).

Body mass index (BMI) was calculated as the body weight (kg) divided by standing height (m) squared. In the study of Ode et al, (2007), using percent fat as the criterion, BMI sensitivity was high (0.83-1.0) and specificity was low (0.27-0.66) in male athletes.

In general, the subject was measured (nearest 0.1cm) in a standing position in light clothing. For measuring the relaxed *arm circumference*, the new non-elastic tape was passed around the arm at the level of the midpoint of the upper arm. For measuring the *biceps circumference*, the subject fully contracted the biceps and the tape was passed around the arm so that it touched the skin surrounding maximum circumference. For *waist circumference*, the tape was applied horizontally midway between the lowest rib margin and the iliac crest, near the level of the umbilicus, at the end of gentle expiration. The *hip circumference* measurement was taken at the point yielding the maximum circumference over the buttocks, with the tape held in a horizontal plane. Proximal *thigh circumference* was measured just below the gluteal fold and perpendicular to its long axis; the subject standing erect with the feet slightly apart and the mass evenly distributed between both legs. The intra-observer reliability for circumferences was greater than 95%[10] while inter-observer reliability was greater than 90% (Moreno et al, 2003). The *waist-hip ratio* was calculated by dividing waist circumference with hip circumference (Salmi, 2003).

Fitness Tests

Sit and Reach gauges the flexibility of the hamstrings and low back muscles, with reliability measure of 0.92 (Behm et al, 2006). It was performed with shoes removed, hands placed on top of one another, slowly extended and held at the maximum stretch point for a count of three. Two trials were given with the longest distance recorded (Hoare, 2000).

Agility T-test is used to determine speed with directional changes such as forward sprinting, left and right side shuffling, and backpedaling. It is selected because of its reported validity and reproducibility. Three cones were set five meters apart on a straight line and a fourth cone was placed 10 meters from the middle cone so that the cones form a T. The subject started at the base of the T, ran to the middle cone and touched it with the right hand, side step 5m to the left cone and touched it with the left hand, side step 10m to the far cone and touched it with the right hand, side step 5m back to the middle cone and touched it with the left hand, then ran 10m backward and touched the cone at the base of the T (Pauole et al, 2000).

Medicine Ball Chest Pass is valid and reliable (0.996 test-retest reliability) to assess explosive power for an analogous total-body movement pattern and general athletic ability (Stockbrugger & Haennel, 2005). The athlete was seated with buttocks, back and head resting against a wall. The legs rested on the floor horizontally in front of the body. The athlete used a two-handed chest pass to push the ball in the horizontal direction as far forward as possible. Two trials were given with the longest distance recorded (Hoare, 2000).

Vertical Jump (No Step) is effective measure of power specific to basketball players (Hoffman et al, 2000). The ICC for test-retest reliability and TEM for the vertical jump was 0.96 and 3.3%, respectively (Gabbett et al, 2007). It is measured (nearest 0.5cm) as the distance from the highest point reached during standing and the highest point reached during the vertical jump obtained from two trials (Gabbett et al, 2007).

2-minute Sit-up determines the endurance of the abdominal muscles and hip flexors. Cross the arms in front of the body and perform as many sit-ups as possible in 2 minutes (Brittenham, 1996).

20-meter Sprint is an excellent measure of anaerobic power and speed (shorter time to finish, greater anaerobic power). The ICC for test-retest reliability and TEM for the 20-meter sprint was 0.97 and 1.3%, respectively (Gabbett et al, 2007). The subject ran as quickly as possible along the 20m distance from a standing start. This is the fastest value (nearest 0.01s) from two trials (Brittenham, 1996).

20-meter Shuttle Run gives a valid estimate of aerobic power (Leger et al, 2007). The ICC for test-retest reliability and TEM for the multi-stage fitness test was 0.90 and 3.1%, respectively (Gabbett et al, 2007). This test involves continuous running between two lines 20m apart. It is made up of 23 levels where each level comprises of a series of 20-meter shuttles where the starting speed is 8.5km/hr and increases by 0.5km/hr at each level. The athlete score is the level and number of shuttles reached before he is unable to keep up with the CD recording (Leger et al, 2007).

Statistical Analyses

Descriptive statistics was calculated using the measures of central tendencies as the means +/- standard deviations. Statistical analysis was performed using Pearson's correlation coefficient for reliability testing and repeated comparisons. Pearson's correlation coefficient was also used to determine relationship between anthropometric and fitness measures of players. The Analysis of Variance (ANOVA) was used to determine if there were any significant effect differences between playing positions on each variable. If this were the case, Duncan Multiple Range Test (DMRT) was used to determine the playing positions that differed significantly. Values of $p<.05$ were considered to be statistically significant. The SPSS 11.0 was used for all statistical analysis.

RESULTS AND DISCUSSIONS

The review of literature on sports profiling of basketball players revealed a focus primarily on international and professional athletes. There is a dearth of such profiling data in the country, particularly in Ilocos region. Thus, there is difficulty of making direct comparisons on anthropometric and fitness measures of Ilocos Norte collegiate players with published studies. Nonetheless, the unpublished study of Reyes (2007) on the anthropometric and fitness profiles of the senior male basketball players of the University of Santo Tomas can be used to compare the profiles of the investigated athletes.

Table 1. Anthropometric characteristics of collegiate basketball players of Ilocos Norte

Variables		Playing Position						Total (n=40)		
		Guard (n=22)		Forward (n=11)		Center (n=7)				
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Range
Anthropometrics	Height (cm)	172.14	6.24	177.80	4.91	179.06	5.07	174.90	6.40	162.50-185.50
	Weight (kg)	65.86	10.30	68.63	6.66	77.01	12.63	68.58	10.49	52.00-103.40
	Arm Span (cm)	176.03	6.18	181.38	3.68	186.29	3.85	179.30	6.50	165.80-194.00
	Circumferences									
	Arm (cm)	27.95	2.24	28.85	3.69	29.61	3.15	28.49	2.86	24.00-37.50
	Bicep (cm)	30.30	2.51	30.76	2.67	31.99	3.91	30.73	2.82	26.30-39.40
	Waist (cm)	76.20	8.09	78.22	8.33	84.30	7.88	78.17	8.46	63.00-101.00
	Hip (cm)	91.31	5.62	91.62	8.73	97.66	6.70	92.52	7.01	68.90-108.00
	Thigh (cm)	53.30	4.72	53.61	3.74	56.30	5.47	53.91	4.63	44.40-66.00
	Waist-Hip Ratio	0.83	0.05	0.86	0.08	0.86	0.04	0.85	0.06	0.69-1.01
	BMI	6.17	2.40	5.72	1.64	6.93	2.66	6.18	2.24	2.92-12.22

The age range of the Ilocos players is 17-24 years with a mean age of 19.53 years. Their mean height, weight and arm span are lower in comparison with the anthropometric profile of the UST players.

Table 2. Fitness measures of collegiate basketball players of Ilocos Norte

Variables		Playing Position						Total (n=40)		
		Guard (n=22)		Forward (n=11)		Center (n=7)				
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Range
Fitness Measures	Flexibility (cm)	30.60	6.90	32.65	5.97	28.21	10.34	30.75	7.31	12.50-45.20
	Agility (sec)	12.33	0.99	11.92	0.70	12.54	0.93	12.25	0.92	10.86-15.27
	UE strength (m)	3.49	0.50	3.53	0.44	3.79	0.47	3.55	0.48	2.86-5.23
	LE strength (cm)	64.18	9.38	62.41	5.79	60.43	8.31	63.04	8.29	30.50-72.50
	Muscle endurance	32.91	11.43	31.45	7.15	28.14	9.56	31.68	10.03	16.00-57.00
	Speed (sec)	3.58	0.25	3.40	0.31	3.52	0.23	3.52	0.27	2.98-3.93
	Max HR (bpm)	79.77	19.01	77.18	17.12	76.00	13.63	78.40	17.35	48.0-108.0
	VO2max (mlO2/kg)	37.92	4.37	39.19	4.73	32.60	4.25	37.34	4.90	26.80-49.30

The investigated athletes have greater scores in the sit and reach and 20-meter sprint while lower scores in the agility T-test, vertical jump, 2-minute sit-up and shuttle run that their UST counterparts.

Table 3. Anthropometric characteristics across different playing positions

	Variables	Playing Position			F-test
		Guard (n=22)	Forward (n=11)	Center (n=7)	
Anthropometrics	Height (cm)	172.13a	177.8b	179.06b	5.83*
	Weight (kg)	65.86a	68.63ab	77.01b	3.37*
	Arm span (cm)	176.03a	181.38b	186.29c	11.28*
	Circumferences				
	Arm (cm)	27.95	28.85	29.61	1.03ns
	Bicep (cm)	30.30	30.76	31.99	0.94ns
	Waist (cm)	76.2	78.22	84.3	2.64ns
	Hip (cm)	91.31	91.62	97.66	2.47ns
	Thigh (cm)	53.3	53.61	56.3	1.16ns
	Waist-Hip Ratio	0.83	0.86	0.86	0.95ns
	BMI	6.17	5.72	6.93	0.61ns

*-difference is significant at .05 level
ns- difference is not significant
Means labeled with the same letter do not differ significantly using DMRT.

The guards are significantly shorter than the forwards and the centers, however, the forwards and the centers do not differ significantly in height. The centers are significantly heavier than the guards, however, the forwards do not differ significantly in weight with any of the guards or the centers. The arm span of centers is significantly longer than forwards who have significantly longer arm span than guards.

The present findings are in agreement with the study of Jelicic et al (2002) that have found prominent longitudinal and transversal skeletal dimensions characterized players on the position of centers while guards achieved significantly lower values in all anthropometric measures. The centers and the forwards are involved in higher level of physical contact in which greater body bulk could be considered advantageous. The physical attributes of centers could help them to dominate in a low-post position (Ostojic et al, 2001). In many cases, the primary role of the center is simply to be very large and to use his size to score close to the basket. He has to defend the opponent's center (who can also be a monster player) as well as blocking shots and dealing with rebounds. On the other hand, a forward is both primarily involved in rebounding and in scoring. Guards are smaller in absolute body size than the forwards and the centers (Hoare, 2000). This is to be expected as the guards are generally involved in ball handling and in making passes requiring lighter frames.

Data on body circumference measurements and waist-hip ratios vary widely across different playing positions. Further, there was no consistent pattern for BMI in agreement with the recent study of Gocentas and Landor (2005). Therefore, these parameters are not essential factors for playing basketball but may determine the playing position of the players.

Table 4. Fitness measures across different playing positions

	Variables	Playing Position			F-test
		Guard (n=22)	Forward (n=11)	Center (n=7)	
Fitness Measure	Flexibility (cm)	30.60	32.65	28.21	0.79ns
	Agility (sec)	12.33	11.92	12.54	1.12ns
	UE strength (m)	3.49	3.53	3.79	1.04ns
	LE strength (cm)	64.18	62.41	60.43	0.58ns
	Muscular endurance (rep)	32.91	31.45	28.14	0.59ns
	Speed (sec)	3.58	3.40	3.52	1.72ns
	Max HR (bpm)	79.77	77.18	76.0	0.16ns
	VO2 Max (mlO2/kg)	37.92b	39.19b	32.60a	5.11*

*-difference is significant at .05 level
ns- difference is not significant
Means labeled with the same letter do not differ significantly using DMRT.

Despite the marked differences in the mean values of fitness measures between centers, forwards and guards, this study cannot confirm that these differences are significant. It only succeeded in establishing statistically significant differences for individual playing position in maximal oxygen uptake where the centers have significantly lower VO2max than of the guards and forwards, who are just comparable with each other.

In agreement with previous studies, there were no inter-playing positional differences on medicine ball throw (Hoare, 2000) and vertical jump height (Ostojic et al 2006) of the subjects. The absence of significant positional differences suggests that the investigated athletes have good upper extremity and lower extremity strength and power regardless of their playing position. All players may have deemed vital to have overall strength as basketball is no longer strictly a finesse sport and today's players must be ready for contact. Overall strength can increase the range of shot and can increase jump performance of the players during the game (Brittenham, 1996).

It is reported in the study of Hoare (2000) that the guards are faster and more agile than the forwards and the centers, being the major transporters of the ball during the game. However, forwards scored highest in the sprint and agility tests. These suggest that despite their greater body size, the forwards do not compromise speed and quick directional changes to a greater extent. Further, the forwards scored highest in the sit and reach, implying that they are more flexible than the guards and the centers. Such results give credence that the forwards are versatile of the three playing positions as they are involved in scoring, rebounding, and passing duties (Wu, 1998). The forwards are also responsible in interior defense to prevent the opposing team from scoring high percentage shots.

The guards performed the most numbers of sit-ups implying that they have greater abdominal strength and trunk endurance compared with the forwards and the centers. The guards typically are ball carriers that require stability and agility (Hoare, 2000). A strong and stable core can improve optimal neuromuscular efficiency throughout the kinetic chain by helping to improve dynamic postural control. It provides proximal stability for efficient lower extremity and upper extremity movements (Hodges & Richardson, 1997). This core strength enables the guards to execute a continuous trapping defense and in setting up attacks that are sometimes completed by the taller players. The centers performed the lowest number of sit-ups, as the increased moment of inertia due to higher trunk mass of the centers may weaken their performance in sit-up test (Hulens et al, 2001).

Game intensity may differ according to playing position being greatest in guards (Abdelkrim et al, 2007). The present findings found the guards to have the highest maximum heart rate may be due to their involvement in repeated multiple high-intensity activities with minimal rest periods. Stressing many muscle groups simultaneously produces a greater response from the cardiovascular system. The centers have the lowest maximum heart rate since they spend significantly lower actual playing time competing in high-intensity activities than the guards and the forwards (Abdelkrim et al, 2007). However, the study of Ostojic et al (2006) has found the guards to have the lowest maximum HR during the last minute of the shuttle run test. Lower heart rate during basketball-specific activity is associated with better aerobic fitness characterized by functional efficiency of the heart, lungs, and circulatory system.

The present findings corroborate the study of Ostojic et al (2006) that the centers have a significantly lower VO_2max values compared with the forwards and the guards. This is probably a consequence of the style of play undertaken by the centers that have the lowest work rate in the game. Nonetheless, this suggests that the centers can successfully participate in basketball with relatively low oxygen consumption properties. A study (Cormery et al, 2007) found that the guards exhibited the highest VO2max. However, the present findings found that the guards and the forwards do not differ significantly in VO2max values. It is suggested that differences in the maximal oxygen consumption between the guards and the forwards could be statistically confirmed by comparison of larger groups.

Table 5. Relationship between anthropometric characteristics and fitness measures

			Fitness Measures							
			Flexibility	Agility	UE strength	LE strength	Muscular endurance	Speed	Max HR	VO2 Max
Anthropometrics	Height	r-value	-0.18	-0.07	0.36*	-0.01	-0.10	-0.11	-0.46*	0.18
		p-value	0.28	0.69	0.02	0.95	0.54	0.48	<0.01	0.28
	Weight	r-value	-0.16	0.40*	0.78*	-0.17	-0.07	-0.24	-0.33*	-0.34*
		p-value	0.34	0.01	<0.01	0.29	0.67	0.14	0.03	0.03
	Arm Span	r-value	0.04	0.02	0.47*	0.03	-0.06	-0.17	-0.21	-0.15
		p-value	0.80	0.92	<0.01	0.84	0.74	0.31	0.19	0.37
	Arm Circumference	r-value	0.21	0.25	0.66*	-0.16	0.01	0.03	-0.23	-0.19
		p-value	0.20	0.11	<0.01	0.34	0.95	0.86	0.16	0.25
	Bicep Circumference	r-value	0.06	0.42*	0.73*	-0.09	-0.09	-0.05	-0.23	-0.33*
		p-value	0.70	<0.01	<0.01	0.57	0.55	0.76	0.15	0.04
	Waist Circumference	r-value	-0.09	0.43*	0.71*	-0.33*	-0.07	-0.16	-0.33*	-0.37*
		p-value	0.58	<0.01	<0.01	0.04	0.67	0.34	0.04	0.02
	Hip Circumference	r-value	-0.08	0.34*	0.64*	-0.13	-0.04	-0.05	-0.13	-0.46*
		p-value	0.63	0.03	<0.01	0.43	0.81	0.78	0.44	<0.01
	Thigh Circumference	r-value	-0.11	0.40*	0.78*	-0.01	-0.20	-0.08	-0.30	-0.31*
		p-value	0.50	0.01	<0.01	0.95	0.21	0.61	0.06	0.05
	BMI	r-value	-0.01	0.23	-0.08	-0.09	-0.90*	0.43*	0.03	-0.08
		p-value	0.96	0.16	0.62	0.59	<0.01	<0.01	0.87	0.62
	WHR	r-value	-0.04	0.27	0.35*	-0.37	-0.08	-0.20	-0.36*	-0.06
		p-value	0.83	0.09	0.03	0.02	0.65	0.21	0.02	0.69

*- correlation is significant at .05 level

The agility, upper extremity strength, and speed of the players positively correlated with anthropometric characteristics. While the lower extremity strength, trunk endurance, maximum heart rate and estimated VO_2max negatively correlated with anthropometric characteristics.

A complete explanation about the insignificant correlations between flexibility and anthropometric characteristics may not be possible. The methods of assessment and testing equipments used are factors that may have influenced the sit and reach measurements.

Agility positively correlated with weight and circumference measurements which imply that a heavier and larger player is less agile. Agility is a rapid whole body movement with change of velocity or direction in response to a stimulus. It is described in terms of response to an opposing player and moving target (Sheppard & Young, 2006). As such, the ability of this player to navigate quickly on the court and to steal the ball by reaching low is compromised.

Upper extremity strength resulted to a positive correlation with all anthropometric characteristics except BMI. This means that a taller, heavier, and larger player has greater upper extremity strength. A higher level of upper extremity strength allows a player for more powerful assist, shooting, and passing the ball to a greater distance (Brittenham, 1996).

Lower extremity strength negatively correlated with waist circumference which means that a player with larger waist circumference has lower vertical leap. Waist circumference is known to be a precise measure of abdominal adiposity (Janssen et al, 2002). As such, abdominal adiposity weighs down the player in projecting his body off the ground. A possible explanation is that the increased mechanical work weakens force production in abdominally obese individual (Hulens et al, 2001).

Muscular endurance correlated negatively with BMI which means that a player with more body fat has lower trunk endurance. BMI has a negative influence on performance tasks requiring the support of the body off the ground like in sit-up. This is for the reason that gravity may pull the trunk down, thus, decreasing strength for obese individual (Hulens et al, 2003).

Speed positively correlated with BMI, which means that a player with more body fat sprint slower and has lower anaerobic power. An obese player is endangering his health by having to lug around excess fat weight on the basketball court and is more susceptible to fatigue and injury (Brittenham, 1996).

Maximum heart rate correlated negatively with height, weight, waist circumference and WHR. This means that a taller, heavier player with greater waist circumference and waist-hip ratio has lower maximum heart rate as he is less mobile and spends relatively little time running. Running is generally seen to produce the highest heart rate for any given individual.

Maximal oxygen consumption (VO_2max) negatively correlated with weight and circumference measurements of biceps, waist, hip, and thigh. This means that a heavier and larger player has lower cardiovascular endurance as he is less involved in high-stress maximal level activities. The better able a player is to perform at a high intensity for a longer duration, the more effective he will be on the court.

Table 6. Post-hoc analysis on the power of the statistics used

Variables		Value of statistic	Probability of Type II Error (Beta)	Power (1- Beta)
Height vs.	UE strength	r = 0.36	0.02	0.98
	Max HR	r =-0.46	<0.01	>0.99

Weight vs.	Agility	r = 0.40	0.01	0.99
	UE strength	r = 0.78	<0.01	>0.99
	Max HR	r =-0.33	0.03	0.97
	VO2 Max	r = -0.34	0.03	0.97
Arm Span vs.	UE strength	r = 0.47	<0.01	>0.99
Arm Circumference vs.	UE strength	r = 0.66	<0.01	>0.99
Bicep Circumference vs.	Agility	r = 0.42	<0.01	>0.99
	UE strength	r = 0.73	<0.01	>0.99
	VO2 Max	r =-0.33	0.04	0.96
Waist Circumference vs.	Agility	r =0.43	<0.01	>0.99
	UE strength	r = 0.71	<0.01	>0.99
	LE strength	r =-0.33	0.04	0.96
	Max HR	r =-0.33	0.04	0.96
	VO2 Max	r =-0.37	0.02	0.98
Hip Circumference vs.	Agility	r = 0.34	0.03	0.97
	UE strength	r = 0.64	<0.01	>0.99
	VO2 Max	r =-0.46	<0.01	>0.99
Thigh Circumference vs.	Agility	r = 0.40	0.01	0.99
	UE strength	r = 0.78	<0.01	>0.99
	VO2 Max	r =-0.31	0.02	0.98
BMI vs.	Sit-up	r =-0.90	<0.01	>0.99
	Sprint	r = 0.43	<0.01	>0.99
Waist-Hip Ratio vs.	UE strength	r = 0.35	0.03	0.97
	Max HR	r =-0.36	0.02	0.98
Height vs.	Playing position	F = 5.83	<0.99	>0.99

Weight vs.	Playing position	F = 3.37	0.05	0.95
Arm Span vs.	Playing position	F = 11.28	<0.01	>0.99
Waist-Hip Ratio vs.	Playing position	F = 5.11	0.01	0.99

The table affirms that the statistics used in this study have powers of 0.95 and above. This implies that the sample size used in this study can ensure at least 95% chance of correctly rejecting the false null hypotheses of the study. Type II error is committed when the null hypothesis is erroneously accepted when it is actually false. This error is partly attributed to sampling error (that is, sample size and sample choice).

CONCLUSIONS

The study has created a comprehensive profiling data on anthropometric and fitness measures on male collegiate basketball players of Ilocos Norte. As for anthropometric characteristics, there are significant differences between players across playing positions for height, weight, and arm span. However, this study cannot confirm existence of a consistent pattern for body circumferences, BMI and waist-hip ratios of the players. As regards to fitness measures, there are statistically significant differences between players in different playing positions in maximal oxygen uptake. No significant differences in other fitness measures across playing positions.

Anthropometric and fitness profiling can be used for systematic way of possibly identifying talented athletes and evaluating current players. Nonetheless, it is postulated that other basketball components such as age, playing years and experience, are imperative in the final sport result, thus, requires further investigation.

However, it is observed in this study that the schools who participated had no comprehensive sports development program and that there are no regular basketball tournaments the schools are involved with to make the collegiate players to be competitive the whole year through. Consequently, the schools do not adopt an extensive recruitment program for talent identification as manifested by the absence of pool of players that will replace those who graduate or who are removed by reason of injuries and of eligibility rules.

Thus, it is highlighted in this study the need for the schools to have anthropometric and physiological criteria as part of their holistic monitoring of future and current players. Furthermore, the schools should form institutional basketball tournaments aside from the PriSAA and the SCUAA to develop constant interests in recruiting talented players and in intensifying training of their athletes for them to maintain their athleticism all year-round.

The collected profile data will prove useful to future researchers as a source of comparison with other athletic groups. Future research is necessary to explicate relationships between anthropometric characteristics and fitness measures with performance in basketball.

REFERENCES

Abdelkrim B, El Fazaa S, El Ati J. (2007). Time-motion analysis and physiological data of elite under-19 year old basketball players during competition. ***Br J Sports Med*** **41(2),** 69-75.

Baechle TR, Earle RW. (2000). Essentials of strength training and conditioning: 2nd Edition. Champaign, IL: Human Kinet.

Behm DG, Bradbury EE, Haynes AT, Hodder JN, Leonard AM, Paddock NR. (2006). Flexibility is not related to stretch-induced deficits in force or power. ***J Sports Sci Med 5,*** 33-42.

Bittenham G, (1996). Complete conditioning for basketball. Champaign (IL): Human Kinetics, 1-107.

Brown J, Feng J, Knapp T. (2002. Is self-reported height or arm span a more accurate alternative measure of height? ***Clin Neuro Res 11(4),*** 417-32.

Chia-Ming Chang, Cheng-feng Chiu, Steve Chen. The individual offensive strategies of Taiwanese collegiate students in basketball. ***The Sports Journal,*** article in press.

Cormery B, Marcil M, Bouvard M. (2007). Rule change incidence on physiological characteristics of elite basketball players: a 10-year investigation. ***Br J Sports Med,*** article in press.

Gabbett T, Kelly J, Ralph S, Driscoll D. (2007). Physiological and anthropometric characteristics of junior elite and sub-elite rugby league players, with special reference to starters and non-starters. ***J Sci Med Sport,*** article in press.

Gocentas A, Landõr A. (2005). Morphological and physiological parameters in relation to playing position of high level male basketball players. ***Papers on Anthropology XIV,*** 42-52.

Hoare D. (2000). Predicting success in junior elite basketball players-the contribution of anthropometric and physiological attributes. ***J Sci Med Sport*** **3(4),** 391-405.

Hodges PW, Richardson CA. (1997). Contraction of the abdominal muscles associated with movement of the lower limb. ***Phys Ther 77,*** 132.

Hoffman J, Epstein S, Einbinder M, Weinstein Y. (2000). A comparison between the Wingate anaerobic power test to both vertical jump and line drill tests in basketball players. ***J Strength Cond Res* 3,** 261-64.

Hulens M, Vansant G, Classeas AL, Lysens R, Muls E, Brugmane E. (2001). Study of differences in peripheral muscle strength of lean versus obese women: an allometric approach. ***Int J Obes Relat Metab Disord 25,*** 678-681.

Jannsen I, Heymsfield SB, Allison DB, Kotler DP, Ross R. (2002). Body mass index and waist circumference independently contribute to the prediction of non-abdominal, abdominal subcutaneous, and visceral fat. ***Am J Clin Nutr 75,*** 683-688.

Jelicić M, Sekulić D, Marinović M. (2002). Anthropometric characteristics of high level European junior basketball players. ***Coll Anthropol* 26,** 69-76.

Leger LA, Mercier D, Gadoury G, Lambert J. (2007). The multistage 20 meter shuttle run test for aerobic fitness. ***J Sports Med Phys Fitness* 47(3),** 276-83.

Moreno L, Gross M, Gutierrez A, et al. (2003). Harmonization of anthropometric measurements for a multicenter nutrition survey in Spanish adolescents. ***Nutrition 19,*** 481-86.

Norton K, Olds T. (2001). Morphological evolution of athletes over the 20th century: Causes and consequences. ***Sports Med* 31(11),** 763-783.

Ode J, Pivarnik J, Reeves M, Knous J. (2007). Body mass index as a predictor of percent fat in college athletes and non-athletes. ***Med Sci Sports Exerc 39(3),*** 403-409.

Ostojic S, Mazic S, Dikic N. (2006). Profiling in basketball: Physical and physiological characteristics of elite players. ***J Strength Cond Res* 20(4),** 740-44.
Pauole K, Madole K, Lacourse M. (2000). Reliability and validity of the T-test as a measure of agility, leg power, and leg speed in college-aged men and women. ***J Strength Cond Res 14,*** 443-50.
Reyes JB. (2007). Fitness and physiological profile of the 70th UAAP Season senior male athletes of the University of Santo Tomas. (unpublished).

Salmi, J. (2003). Body composition assessment with segmental multi-frequency bioimpedance method. ***J Sports Sci Med 2(3),*** 1-29.

Sheppard JM, Young WB, Doyle TA, Sheppard TA, Newton RU. (2006). An evaluation of a new test of reactive agility and its relationship to sprint speed and change of direction speed. J Sci Med Sport, article in press.

Stockbrugger B, Haennel R. (2005). Validity and reliability of a medicine ball explosive power test. ***J Strength Cond Res 15(4),*** 431-38.

Wu, B. (1998). Developing a forward player. ***J Tungnan College 21,*** 219-224.

Young W, Pryor L. (2007). Relationship between pre-season anthropometric and fitness measures and indicators of playing performance in elite junior Australian Rules football. ***J Sci Med Sport 10,*** 110-18.