Original Research

Development of a Prediction Equation for Vertical Power in Masters Level Basketball Athletes

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ABSTRACT

International Journal of Exercise Science 7(2) : 119-127, 2014. Performance factors such as power, agility, and speed are important in sport-based competition for older individuals. Prediction models that assess these factors in masters level competitors are limited. The purpose of this study was to examine physical field measures of agility and speed and their ability to predict vertical power (VP) among basketball masters athletes (MA). Thirty-eight competitive MA from a Midwest Senior Olympic basketball tournament performed vertical jump, 20-yard dash (20-D), 40-yard dash (40-D), and T-test (TT) assessments. Regression analysis revealed a significant relationship (p = .002) using TT and 20-D to predict VP (R^2 = .37). Similar results were observed when replacing the 20-D with the 40-D (R^2 = .34; p = .003). Males and females were analyzed independently. Agility and speed measures significantly predicted VP in males (R^2 = .59; p = .005) and females (R^2 = .43; p = .044). Speed and agility are important factors in the performance of vertical jump (VJ). Results indicate any of the speed distances tested may be used to predict VP among this population, but it is recommended that the 20-D be used due to less demand, space, and time requirements. Utilizing speed and agility may help to minimize physical stress and reduce impact related injury, while improving overall VP performance in masters basketball players. Results of this study suggest need for experimental research to verify the cause and effect relationship between speed, agility, and VP.

KEY WORDS: Aging, performance, competition, sport, regression

INTRODUCTION

Since 1987, there has been a noticeable increase in older adults' participation in sporting events at competitive levels (24, 30). When the Senior Olympics first began in 1987, over 2,500 athletes competed in the games (20). The number of masters athletes (MA) has increased exponentially with an estimated 13,000 competitors expected at the 2013 Senior Olympics (20). MA are defined as adults as young as 35 and upward, participating in competitive sporting events (18). The increasing number of mature adults competing in sport-based events necessitates expanded research in performance and athletic profiles of this population (18).

For all older adults, age-related decrements in performance present a challenge for physical functioning as well as sport participation (25). It has been shown that continued participation in physical activity and exercise can attenuate these declines (3, 30). This has previously been

demonstrated in performance measures among MA as compared to age-matched sedentary older and younger adults (34). Studies indicated MA have less decline in performance measures as compared to their age-matched controls (29), but greater decline when compared to younger counterparts (5).

Of particular importance to MA, are performance components such as muscular power, speed, and agility. Muscular power, defined as the rate of work or the force generated multiplied by the velocity of movement (14), is important for sport-specific tasks and quick direction change. Along with power, speed and agility are important for daily function as well as for sport-based competition for older adults (2, 7). It has been suggested that athletic speed and power have a greater decline than endurance among aging athletes (15). Speed is important in many sports, such as basketball, tennis, and track, and has been shown to decline in MA by approximately 3.4% per year after the age of 35, with increasing exponential decline over the age of 80 (24). Agility, which is the ability to quickly change direction as well as maintain balance (22), is also important in specific sports such as basketball. Balance and agility have been noted to decrease with age (27), resulting in a decline in sports performance.

Regression models have been developed to predict muscular power during multiple jump-based assessments including the vertical jump (10), triple jump (9), and counter movement jump (12). Although vertical jump is traditionally utilized as an accepted measure of vertical power analysis in younger individuals, this may not always be a safe method of evaluation in

older adults due to issues of joint stiffness and mobility (33) along with a decrease in the shortening of the knee extensor musculature (8). When specifically examining the vertical jump, speed and agility have been determined to be significant predictors of power in college-aged men and women (23). Taken together, the ability of speed and agility to predict vertical power in MA may allow for accurate evaluation, without the risk for potential injury.

While many studies have assessed age and functional performance with regard to exercise (21), sport-related physical performance in older adults has been evaluated to a lesser extent, and regression models predicting power among MA are limited. A regression model predicting VP from speed and agility has been previously developed in younger athletes (23); however, due to physical changes with increasing age, it cannot be maintained that previous results are representative in MA. Therefore, the purpose of this investigation was to compare validated measures of speed and agility and their ability to predict VP among basketball MA. Based on previous literature (23), it was hypothesized that speed and agility would both be significant predictors of vertical power. Development of a prediction equation for VP in MA would allow for accurate evaluation, without increased risk of injury.

METHODS

Participants
Subjects for this study included MA (*n* = 38; 20 males, 18 females) competing in a Senior Olympic basketball tournament in the Midwest region (Table 1). All participants

were MA participating in a Senior Olympic basketball tournament for adults over 60 years of age. This study was carried out with approval from the Institutional Review Board at a Midwestern land grant institution. All subjects signed consent forms to participate in the tournament and separate informed consents to participate in the research study.

Table 1. Subject demographics.

	Age (yr) ± SD	Height (cm) ± SD	Mass (kg) ± SD	*Body Fat (%) ± SD
Combined	72.45 ± 4.86	174.22 ± 10.78	77.79 ± 13.04	21.92 ± 8.35
Males	74.95 ± 5.12	181.54 ± 8.92	85.10 ± 12.89	15.31 ± 4.52
Females	69.95 ± 3.03	166.90 ± 6.79	70.48 ± 8.40	28.53 ± 5.53

*Body fat % measured via pedal bioelectrical impedance analysis

Protocol
This study employed a cross-sectional research design with multiple regression analysis to determine the predictability of agility and speed (independent variables) on VP (dependent variable). Subjects were requested to complete their own warm-ups as they would normally prepare for competition. Although all subjects were asked to participate in the data collection process before undergoing game-based activity it was not a requirement for participation in the study. Subjects were informed that they had the option to undergo as many or as few of the tests as they felt comfortable. Participation in the tests could be terminated at any time.

Subject height was measured using an eye-level stadiometer (Webb City, MO). Subject weight and body composition were measured using Tanita™ InnerScan Segmental Body Composition Monitor

bioelectrical impedance analysis (BIA; Arlington Heights, Illinois).

VP was determined by using the Vertec™ Jump Trainer (Sports Imports, Columbus, Ohio). Subjects were instructed to stand facing the Vertec™, directly beneath and parallel to the plastic vanes. Without slouching and keeping feet flat on the floor, subjects were instructed to raise their dominant hand as high as possible and push through the furthest vane within reach. Initial reach height was calculated. When jumping, the subject performed a counter-movement jump starting with both feet flat on the floor (no stepping or running starts were permitted). Swinging or "cocking" of arms within the sagittal plane was permitted and encouraged. When ready, the subject jumped as high as possible, in line with the longitudinal axis of the Vertec™ and pushed their hand through the highest achievable vane. Subjects performed jumps until they recorded two consecutive failed attempts. A failed attempt occurred when the subject was unable to touch the next highest vane. Subjects recovered between trials based on their own exertion. Maximal VJ was calculated as the difference between final jump height and initial reach. Maximal VJ performance was used to calculate VP (12). This equation was chosen because it directly calculates power based on resultant vertical jump height while accounting for body weight. The equation used for VP determination is as follows:
Power (expressed in Watts) = 41.4 · jump height (cm) + 31.2 · body mass (kg) + 431.

Intra-session reliability of VJ analysis in older adults has been determined previously supporting its use as a

consistent measure of VP for this population (4). Intra-class correlations were reported at $r = .75 - .97$ in older men and $r = .77 - .95$ in older women.

The TT has been validated as an effective measure for agility and described in detail elsewhere (23). Four cones were arranged as illustrated in Figure 1. Subjects began at cone A and on the command, "Go" time was started. Subjects sprinted to cone B, touching the base of the cone with their right hand. Subjects then shuffled sideways (left) to cone C, touching its base with their left hand, then shuffled right to cone D, touching its base with their right hand. Finally, subjects shuffled back to cone B touching the base with their left hand, and sprinted backwards to cone A. Time was stopped after subjects passed cone A. Score for the TT was recorded in seconds. Two-trials were performed and the faster of the two trials was recorded. Intra-class reliability of the TT has been documented at $r = .98$ (Pauole et al., 2000).
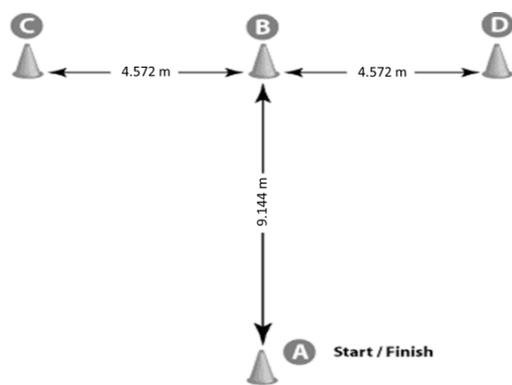
Figure 1. Proper set-up of cones for the T-test (TT).

The speed assessment involved running a single sprint over 40 yards, with time recorded at 20- and 40-yard intervals using a Lafayette™ Instrument Company Multi-Function Timer/Counter (Lafayette, IN).

Stop gates were placed at the 20- and 40-yard markers. The use of laser sensors has been suggested to be more accurate and prevents timing error on part of the technicians (11). Subjects were instructed to start from a comfortable position with their lead foot behind the starting line and begin when ready. Two-trials were performed and the faster of the two trials was recorded. Score for this test was recorded in seconds. Intra-class reliability for this test has been documented at $r \geq .95$ (16).

Statistical Analysis
SAS statistical software version 9.3 (Cary, NC) was used to analyze data. Cooks distance analysis was used to detect outliers. When outliers were detected, analysis was ran with and without the outlier to determine if it affected the outcome of the model. Hotelling's T-test was used to examine gender differences between performance variables. Multiple regression analysis employed measures of agility (TT) and speed (20-D, 40-D) to predict VP. Statistical significance was set at $\alpha < .05$ level and all results reported as means ± SD.

RESULTS

The Senior Olympic Basketball Tournament featured MA from the Midwest area competing at various age groups. Hotelling's T-test revealed significant differences between genders for VP, TT, 20-D, and 40-D measures (Table 2).

Twenty-yard and 40-D were not used simultaneously in analysis due to issues with multicollinearity ($r = .93$; Table 3). When examining VP for all subjects, regression analysis revealed a significant relationship $F(2, 28) = 7.23$, $p = .003$ with the

TT and 20-D as predictors. The resultant regression equation [VP = 3406.95 + TT(-129.46) + 20-D(16.42)] accounted for 34% of the variance (R^2 = .34). Semi partial correlations revealed TT and 20-D accounted for 25% and 9% of the variance, independently. An additional multiple regression analysis utilized the 40-D and TT as predictor variables. Results were similar as when using the 20-D as a predictor ($F_{(2, 28)}$ = 6.47, p = .005). The resulting regression equation was: VP = 3280.28 + TT(-124.55) + 40-D(11.26) and accounted for 32% of the variance (R^2 = .32). Further analysis revealed TT had the greatest unique contribution, accounting for 23% of the variance. Furthermore, due to 20-D and 40-D revealing similar results for the models, the 20-D was used for all subsequent analyses.

Table 2. Physical performance variables.

	Males: Mean ± SD	Females: Mean ± SD
VP (watts)	1783.53 ± 688.74*	1187.43 ± 333.61
TT (sec)	14.16 ± 3.82*	16.76 ± 2.57
20-D (sec)	4.28 ± 0.74*	4.93 ± 0.86
40-D (sec)	8.58 ± 1.68*	10.23 ± 1.84

*Indicates significant difference between males and females at the p < .05 level. Vertical power (VP), T-test (TT), 20-yard dash (20-D), 40-yard dash (40-D).

Males and females were analyzed independently to examine gender differences for VP. For males, regression analysis revealed a significant relationship $F_{(2, 12)}$ = 8.49, p = .005 when using the TT and 20-D as predictors of VP; the regression equation accounted for 59% of the variance (R^2 = .59) [VP = 4480.31 + TT(-24.74) + 20-D(-506.97)]. Semi-partial correlations revealed TT and 20-D accounted for 44% and 15% of the variance of VP independently. Females had similar results with regression analysis revealing significant relationships $F_{(2, 11)}$ = 4.20, p =

0.0442 when predicting VP using the TT and 20-D. The resultant regression equation [VP = 2948.62 + TT(-13.74) + 20-D(-330.65)] accounted for 43% of the variance (R^2 = .43), where TT and 20-D accounted for 30% and 13% of the variance, respectively.

Table 3. Correlation matrix for regression variables.

Variable	BF	VP	TT	20-D	40-D
BF	1.00				
VP	-0.53	1.00			
TT	0.62	-0.60	1.00		
20-D	0.41	-0.47	0.81	1.00	
40-D	0.52	-0.52	0.84	0.93	1.00

Body fat % (BF), Vertical power (VP), T-test (TT), 20-yard dash (20-D), 40-yard dash (40-D).

DISCUSSION

The primary purpose of this investigation involved the development of prediction equations for VP among MA basketball players using measures of speed and agility. VJ has long been suggested as a method for determining muscular power (28), but examining predictors of VP in MA has not been previously documented. Maharam, Bauman, Kalman, & Skolnik (17) compared longitudinal declines in performance in power (sprinting, weightlifting) and non-power based sports (swimming, distance running) and determined that MA experienced greater declines in performance in power-based sports. Data on this topic suggest a benefit to the incorporation of power training in MA to improve other physical measures such as balance, strength, gait, and muscle volume (31, 26). Developing a regression equation for determining VP through other performance measures may assist in advancing power training protocols for MA. Although VJ training cannot be replaced completely, utilizing other methods of training may help minimize

physical stress and reduce impact related injury among MA. Furthermore, VJ may also assist in measuring power output over time in MA to determine if certain training protocols are successful.

According to the present investigation, agility was suggested to be the most significant predictor of VP in MA. Current results using MA are in accordance with Pauole et al. (23) where findings in college-aged adults indicated the TT was the most significant predictor of VP. The 20-D and 40-D measures were also significant predictors of VP in the current investigation. Although agility was the most significant predictor of VP in the aforementioned studies, Young, James, & Montgomery (35) concluded that in younger males, muscular power assessed via the drop jump was not correlated with speed nor agility. Methodology variations and performance of VJ may give indications as to why the predictors were significant for MA as opposed to younger males. This may be due to the concentric-only movement with drop jump analysis as opposed to the counter-movement VJ, which uses more eccentric and elastic properties of the muscle (13). Generally, adults over the age of 60 produce less concentric and isometric force, with the most force production elicited during eccentric contractions (32). This understanding of force production in older adults could further contribute to the variation in results.

Typically, men generate higher absolute power than women. Within genders, however, relative power output should remain similar (6). Validated prediction equations for VP are not gender specific and have been suggested to be accurate for women (1). When analyzing the predictive

models between genders in the present investigation, significant results were observed for both males and females, respectively when using the same predictors. Therefore, the current model suggests similar outcomes and accurate results can be obtained for VP regardless of gender.

The TT and 20-D as predictors of VP are useful tools when assessing performance of MA. Measuring VP may be difficult due to lack of proper equipment. The need for equipment and potential for injury is minimal when utilizing the TT and 20-D as field tests. The strong correlation of the 20-D and 40-D suggests they can be used interchangeably to predict VP. Given sport specificity, time, and physical demand requirements, the 20-D test may be a more practical speed measure to predict VP. When choosing tests for individual competitors, the distance used should best represent the athlete's particular sport.

To prevent the need for timing gates, stopwatches can also be used to measure speed, but may overestimate test performance and have recorded significantly faster trials compared to timing gates (19). However, stopwatches were determined to be a viable method of measuring speed with a high intraclass correlation ($r = .99$), indicating consistency over multiple trials. Coaches and practitioners must understand the difference in speed determination, but given the ease of test administration, can be taught very quickly. This allows for evaluation of large numbers of individuals in short periods of time. Using speed and agility measures to predict VP in a field setting also minimizes the need for VJ-specific equipment.

Finally, MA would be able to personally evaluate themselves without access to VJ-specific equipment. From a training perspective, recognition of significant predictors for VP could influence training protocols in populations of masters basketball players. VJ is a sport-specific task that may provide some insight on ability to increase VP using multiple forms of training.

Although prediction models using speed and agility to predict VP have been developed for younger athletes, we present the first empirical evidence supporting the use of these variables to predict VP in MA. The 20-D and 40-D were both significant predictors of VP; however, distance does not seem to influence the model. Although the TT was a significant predictor of VP in this study, other agility tests need to be researched for predicting VP in MA. This would help determine if significance is based on general agility or if it is specific to the TT itself. Also important, is the finding that these results are not gender specific and can be used interchangeably between males and females. As this study analyzed only MA competing in basketball, it is suggested that other populations be investigated to determine if the predictors are effective for a more general population.

ACKNOWLEDGEMENTS

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