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ABSTRACT

The measuring of athletic performance via pre participation experiments has been the norm for a long time from high school sports, all the way to professional athletics. These tests help gauge an athlete's physical growth over the offseason, as well as aid in predicting their potential performance in the future. However, performance may diminish as multiple maximum effort assessments are completed due to fatigue. The purpose of this study was to examine targeted assessments for possible novel qualities as performance predictors. Baseline data was taken from a larger performance enhancement study for analysis. Twenty-six men (age: 25±4 yr; height 1.78±0.07m; body mass 83.3±11.4kg) and 24 women (age: 23±3 yr; height 1.65±0.08 m; body mass 62.6±7.8 kg) completed the baseline testing. Subjects were shown a video which helped familiarize them with the testing protocol, as well as the exercises to be completed. The order of the tests were as follows: sit-and-reach flexibility, single leg medial-lateral balance, QuickBoard visual reaction time, vertical jump, a 10 meter sprint, bench toss, and finally the Plyo Press Power Quotient (3PQ). A step-wise multiple regression was then ran on the data, focusing primarily on the QuickBoard and 3PQ assessments, with significance set at $p \leq 0.05$. Body mass was found to be a very strong predictor of power output on 3PQ, however this was not the case for QuickBoard. When the regression was performed without consideration of mass, bench toss and vertical jump accounted for a large percentage of the variance in 3PQ. This suggests that 3PQ could be very useful as a single assessment of athletic performance. In contrast, very little variance in QuickBoard performance was explained by the same predictor variables, suggesting that agility and reaction are a separate construct.

INTRODUCTION

Countless hours are spent on the assessment of athletes and their physical abilities in all sports. The motivation behind this report is the fact that there is a clear need for assessment of an athlete's power, agility, muscular endurance, speed, and cardiovascular performance in order to predict their potential on-field performance (6). Pre participation tests have also been developed to assure athletes are capable for safe participation in their sport of choice (3). These assessments may involve many tests of different aspects of athleticism to give us an idea of their potential athletic performance. However, this begs the question - do all these tests provide us with unique information? Could there potentially be a way to utilize fewer assessments and still gather the same information on an athlete's potential performance? This question leads us to the examination of two specific experiments in the search for possible novel qualities.

The Plyo Power Press Quotient (3PQ) (Plyo Press 625 III, Frappier Acceleration, Fargo, ND) exercise is a test that is similar to the Wingate Anaerobic Test for power output. However, the 3PQ exercise is considered to be more sports-specific (4, 5) of these two exercises and therefore is more applicable to the assessment of competitive athletes. This tests consists of 30 seconds of maximal jumps on a horizontally positioned double-leg press machine, with 125% of the subjects body weight used as the resistance. We felt that this test was a key component for analysis due to the fact that even though it is a fairly commonly used test for power output, there has been very little research done on predictors of performance, nor correlation to other exercises.

On a different end of the spectrum, the QuickBoard test (The Quick Board, LLC, Memphis, TN) focuses on the quickness, agility and accuracy of the subjects as opposed to their pure power output. This test uses reactions to an indicator light which informed participants as to which corresponding sensor on the board over a span of 20 seconds. When a sensor is correctly hit, a new indicator light illuminates, cycling the process. Clearly, one would believe that pure lower body strength (which should dictate performance on the 3PQ machine) would not be correlated to performance on a test like this which requires agility and precision.

The purpose of this study was to assess the relationships between predictors of performance with specific attention to the 3PQ and QuickBoard. We analyzed data from a previous report which permitted assessment prior to interventions directed at enhancing performance. If tests of performance are highly correlated , then fewer tests could potentially be needed to assess athletic performance. If this is the case, my results may lead to more efficient use of time and resources devoted to assessment.

METHODS

Experimental Approach to the Problem

To assess the relationships between measures of power, balance, and agility and 3PQ/QB, baseline data from a larger performance study were analyzed (2). A standard warm-up and identical order of testing was utilized in the study. College aged, athletic subjects were targeted, and resistance training experience was required. The experiment was designed around high-speed anaerobic power and force exercises (3PQ, Bench toss, and Vertical jump) as well as non-power related exercises such as sprint, QuickBoard, flexibility, and balance. A pre-test regiment of two cups of water in the evening before, as well as the morning of the visit to ensure proper hydration of the athletes.

Subjects

Twenty-six men (age: 25±4 yr; height 1.78±0.07m; body mass 83.3±11.4kg) and 24 women (age: 23±3 yr; height 1.65±0.08 m; body mass 62.6±7.8 kg) completed the baseline testing. All subjects were resistance trained, and were athletes or former athletes in collegiate sports. In addition to the resistance training, all subjects were cleared for testing by a physician medical monitor. Subjects provided informed consent after having the experimental risks and benefits of the investigation explained to them. The investigation was approved by the University of Connecticut's Institutional Review Board for use of human subjects in research.

Procedures

Subject testing occurred between the hours of 7am-5pm, dependent on individual schedules. Before any physical testing occurred, subjects viewed a familiarization video which introduced them to all of the exercises performed in the study. After a standard warm-up, subjects performed exercises in the following order. First, a seated sit and reach test (flexibility) was conducted. A balance test followed, where subjects stood still for 20 seconds on their non-dominant leg while positioned on a force plate (Advanced Mechanical Technology, Inc, Watertown, MA) and "medial-lateral dispersion was measured using DartPower 2.0 software (Athletic Republic, Park City, UT)" (2). Next, the QuickBoard test was performed, which is covered in more depth in the following section. Following this, a countermovement vertical jump test (VJ) which consisted of three maximal, continuous repetitions with hands on hips for each attempt was performed. Positive peak power from a force plate was recorded for analysis. After that, subjects completed a ten meter sprint, with times recorded with the Test Center Timing System (Brower Timing Systems, Draper, UT). Then, The bench throw which consisted of three discontinuous maximal throws on a smith machine (LifeFitness, Schiller Park, IL) was performed, with peak power output on a Myotest (Myotest Inc, Durango, CO) being recorded. Finally, the subjects completed the protocol on the 3PQ machine, which is also covered in depth below. Excluding the 3PQ, up to three attempts for each test were permitted, with the best score used for analysis.

QuickBoard™ Visual Reaction Time Test

The QuickBoard™ system (The Quick Board, LLC, Memphis, TN) is comprised of a visual stimulus board with five lights and a corresponding step pad. The duration of this test was 20 seconds, in which subjects were instructed to react to the visual light board by stepping on the correct sensor on the step board. Once the correct sensor is stepped on, the light that is lit would switch and the subject would then be required to repeat the process of stepping on the corresponding sensor. The illumination sequence on the visual board was randomized to keep any type of practice error from having an effect.

The minimum reaction time was recorded (measured from the time the light is illuminated until the correct sensor was touched) with the best of the three trials being used for analysis.

Plyo Press Power Quotient (3PQ)

This test had a 30 second duration on the Plyo Press (Plyo Press 625 III, Frappier Acceleration, Fargo, ND) which is a double-leg press machine with the tester positioned in a recumbent posture. The machine is set up with 125% of the subject's body weight added as resistance, and they are instructed to attempt to jump as high as they can in an "explosive" fashion. Subjects continue this motion as many times as they possibly can until the 30 seconds expires. The peak positive power production (both maximum and average) for the 3PQ were recorded and examined in this investigation.

Statistical Analyses

Data entered into the analyses included the best effort in sit and reach, measured in inches, fastest time record in the sprint (seconds), and best time recorded on the QuickBoard in a single trial. Vertical jump performance was defined as the average of the highest power output of each jump in a single, 3-jump trial. Peak power during bench toss was obtained from the best of 3 repetitions. Finally, the two different 3PQ measurements were obtained. Peak power was the highest overall power output during any repetition of the exercise (MaxpPower) while the average peak power (AvgPeakPower) was the average of peak output from all repetitions.

Data were examined for assumptions and criteria for use in linear statistics. Significance for this investigation was defined as $p \leq 0.05$. Prior to regression analyses, correlations and collinearity statistics were examined to determine the relationships among the dependent variables. A stepwise regression provided the best model for reaction time: correlations among reaction time and all other dependent variables were below 0.4 (please reference Table 2) and unlike the load-bearing tests, reaction time was not dependent upon body mass. For peak 3PQ power, the regression was designed to account for body mass before progressively adding peak vertical jump power, peak bench throw power, best sprint, flexibility, and sex to the model. Our analysis revealed that mass is a strong predictor of 3PQ, bench toss power and VJ power production. A subsequent stepwise regression was performed examining the relationships between performance measures only.

RESULTS

Performance data on each of the predictor and criteria variables for 3PQ and QB are summarized in Table 1. Table 2 presents the correlation matrix for variables entered into the prediction equation for 3PQ performance.

Table 1: Descriptive Statistics

	Mean	Std. Deviation
BestQBmin	.375 seconds	.1525
PeakSR	45.44 inches	10.72
BestVJAvgPeakPower	3275.21 watts	1115.97
BestSprint	1.64 seconds	.150
BestBTPeakPower	396.51 watts	182.36
threePQMaxpPower	2125.13 watts	752.45
threePQAvgPeakPower	1859.21 watts	654.65

BestQBmin: Minimun reaction time on QuickBoard **PeakSR:** Performance on sit and reach **BestVJAvgPeakPower:**Vertical jump average peak power output. **BestSprint:** Performance on 10m sprint **BestBTPeakPower:** Max power achieved on bench toss. **threePQMaxpPower:**Max power achieved on 3PQ **threePQAvgPeakPower:**Average peak power per repetition on 3PQ

Table 2: Correlations of Dependent Variables with 3PQ and Reaction Time

	3PQ	Body Mass	Sex	BestVJ AvgPeak Power	BestBT Peak Power	Best Sprint	BestQB min	PeakSR
3PQ	[redacted]	0.811	0.808	0.801	0.853	-0.621	-0.147	-0.255
BestQBmin	-0.147	-0.211	-0.346	-0.308	-0.296	0.081	[redacted]	0.259
Body Mass	0.811	[redacted]	0.721	0.768	0.867	-0.531	-0.211	-0.434

The subject's body mass accounted for 72.6% of the variance associated with 3PQ peak power as shown in Table 3. VJ Peak Power increased the R square by 6.9%, bench throw power by 8.4%, and sprint time 1.5%. Reaction time, flexibility, and sex did not further explain 3PQ peak power

Table 3: Model Summary for Peak 3PQ Positive Power

Model	Description	R	R Square	Adj R Square	SE of Estimate	R Square Change	Sig F Change
1	Body Mass	0.855	0.731	0.726	3940.22	**0.731**	0.000
2	BestVJAvgPeakPower	0.895	0.801	0.792	3430.08	**0.069**	0.000
3	BestBTPeakPower	0.941	0.885	0.877	2630.60	**0.084**	0.000
4	BestSprint	0.949	0.900	0.891	2480.37	**0.015**	0.012
5	*BestQBmin*	*0.949*	*0.901*	*0.889*	*2500.26*	***0.001***	*0.574*
6	*PeakSR*	*0.952*	*0.906*	*0.892*	*2470.01*	***0.005***	*0.148*
7	*Sex*	*0.956*	*0.913*	*0.899*	*2390.48*	***0.008***	*0.060*

In the secondary regression analysis (Table 4), we found that for 3PQ, best bench toss peak power, average power performance in VJ, and best QB performance (minimum reaction time) explained 80% of the variance in 3PQ performance when factors such as body mass, flexibility, and sex were removed. Bench toss alone accounted for 72% of the variance, while addition of VJ and QB data accounted for 5.5% and 2.9% of the variance respectively.

Table 4: 3PQ Model Summary:

Model	R	R Square	Adj R Square	St. Error of the Esitmate	R Square Change	F Change	Df1	Sig F Change
1	.848	.719	.713	350.54	.719	125.38	1	.000
2	.880	.764	.764	317.72	.055	11.65	1	.001
3	.896	.803	.791	299.52	.029	7.01	1	.011

Predictors:

1. BestBTPeakPower
2. BestBTPeakPower, BestVJAvgPeakPower
3. BestBTPeakPower, BestVJAvgPeakPower, BestQBmin

In contrast to 3PQ, these same predictors accounted for very little of the variance in the QB trails (Table 5). BestBTpeakpower was the best predictor, but only explained 11% of variance. Addition of 3PQ Max Peak Power and average VJ Peak Power explained another 7.7% of variance each (in total, 26.6% was explained by baseline predictors).

Table 5: QB Model Summary:

Model	R	R Square	Adj R Square	St. Error of the Esitmate	R Square Change	F Change	Df1	Sig F Change
1	.335	.112	.094	.14510	.112	6.198	1	.016
2	.435	.189	.155	.14014	.077	4.527	1	.039
3	.516	.266	.219	.13471	.077	4.947	1	.031

Predictors:

1. BestBTPeakPower

2. BestBTPeakPower, threePQMaxpPower

3. BestBTPeakPower, threePQMaxpPower, BestVJAvgPeakPower

DISCUSSION

During the offseason (or even in season), athletes may be required to complete strength and power assessments. These assessments may include multiple exercises, such as the bench toss and vertical jump. Fatigue resulting from multiple maximal effort may diminish performance and thus validity of the test data (1). These data suggest that the 3PQ can be utilized as a fairly accurate summary of power task performance. Body mass is such a strong predictor of 3PQ performance. However, when body mass is kept relatively constant over a period of time (i.e. over the offseason) variations in 3PQ performance would need to be explained by other factors. This is confirmed by the secondary regression on 3PQ, which shows that the other assessments were able to explain a large majority of the variation in the data. Given time constraints on strength assessment, and the fact that fatigue may affect performance when multiple measures are required, these results suggest that the 3PQ may be a very useful single test assessment for power performance.

In contrast to these results, it seems that the QB captures a separate aspect of athletic performance. In addition to this, there seemed to be very little correlation between body mass and performance in this assessment. Part of this may be due to the fact that there is a visual piece to the assessment, as well as that it was a reaction test (as opposed to power). This suggests that agility/reaction assessment requires a distinct set of testing, as well as the fact that power and agility/reaction are not strongly correlated in an athletic population.

While all of the subjects were athletic individuals, they come from different backgrounds in sports. Different sports require different specializations in regards to physical development (think about a the "ideal" body of a golfer versus a that of a football player). Conversely, success in individual sports is not as simple as building power and agility. However, power and agility are a key component in the success in many sports such as basketball, football, and soccer to name just a few. Moreover, future investigations may allow better understanding of what attributes predict athletic success.

In conclusion, our purpose was to learn more about strength of association between performance assessments typically used in an athletic environment and the 3PQ and QB tests. We found that performance on the 3PQ can be largely explained by BestBTPeakPower, BestVJAvgPeakPower, BestQBmin while these predictors explained a small portion of the variation in the QB data, suggesting that it is a separate construct.

PRACTICAL APPLICATIONS

As previously mentioned, almost all collegiate level athletes will undergo some type of physical assessment, whether that is in the middle of the season, or the offseason to, to check for physical improvements. Usually this is done in the form of multiple assessment tests (such as a bench throw, vertical jump, etc.) conducted in one day which could potentially diminish performance due to fatigue resulting from repeated maximal efforts. The 3PQ machine may be a good predictor of power generation and power related athletic performance and reduce the time required for testing. Agility, as measured on the QuickBoard however is a unique construct in athletic performance and requires additional testing to assess performance.

REFERENCES

1. Ament W, Verkerke GJ. Exercise and Fatigue. *Sports Medicine* 39(5): 389-422. 2009
2. Dunn-Lewis C, Luk HY, Comstock BA, Szivak TK, Hooper DR, Kupchak BR, Watts AM, Putney BJ, Hydren JR, Volek JS, Denegar CR, Kraemer WJ. The Effects of a Customized Over-The-Counter Mouth Guard on Neuromuscular Force and Power Production in Trained Men and Women. *J Strength Cond Res* 26(4): 1085-1093, 2012.
3. Myers A, Sickles T. Preparticipation Sports Examination, in: *Primary Care: Clinics in Office Practice* 25(1). Columbus, Ohio. The Ohio State University of Medicine and Public Health, 1998.
4. Nelson M. High-Speed Incline Treadmill Training versus Traditional Ground-Based Training: A Comparison of Speed, Power Output, and Agility, in: *Health, Physical Education, Recreation.* Ann Arbor, MI: South Dakota State University, 2004.
5. Raml MA. Establishing Validity And Reliability Of A New Power Ergometer When Compared To Wingate Anaerobic Power Testing And Isokinetics, in: *Health, Physical Education, and Recreation*. Ann Arbor, MI: South Dakota State University, 2004.
6. Sayers A, Sayers BE, Binkley H. Preseason Fitness Testing in National Collegiate Athletic Association Soccer. *Strength and Conditioning Journal* 30(2): 70-75, 2008