Athletes Have Significant Imbalances Between Strength and Speed

78% of Athletes that are above the 50th percentile in power production have an imbalance of strength and speed, with a majority of those falling into the strength dominant category.

by Will Waterman, PT, DPT, OCS, PRT, COMT, CSCS

Abstract

Data collected on the Proteus Motion system was utilized to measure the difference in the performance of power and acceleration of athletes. Performance was categorized into 1 of 4 classifications: Low Strength, Strength Dominant, Speed Dominant, or High Strength and Speed. Results showed that of the athletes that possess baseline strength (those above 50th percentile in power), a majority (78%) possess imbalances of strength and speed–with over 50% of those individuals possessing higher levels of strength vs speed. The results highlight the importance and need to measure, track, and personalize training programs based on an athlete's needs vs taking a global approach.

Introduction

When creating a training program, specificity is of the utmost importance. Training has been shown repeatedly to only improve what is specifically trained. You cannot improve strength by only training speed. You also cannot improve speed by only training strength.

However, due to the difficulty of measuring strength and speed consistently, it has been very hard for trainers to know exactly which athletes need to focus on speed versus which athletes need to focus on strength. Therefore most athletes are placed on the same training program even if they need to focus on different aspects of training.

Methods

To analyze athletes in our database and get a sense of where individuals are categorized against their peers historically, Proteus analyzed males from 20-30 years old across all of our locations who performed the same standardized test (Cressey Performance Test) from September 1, 2021 to Aug 31, 2022. This is an ideal test for evaluating the performance of rotational sports. It was specifically designed for baseball players but is also used with Tennis, Golf, MMA, and other athletes. The test consists of the following movements (17 total), 5 reps each, at max effort, performed in the standing position, on the left and right unless otherwise noted:

- **Single Hand Horizontal Push**
- **Single Hand Horizontal Pull**
- **PNF D2 Flexion**
- **PNF D2 Extension**
- **Static Start Straight Arm Trunk Rotation**
- **Counter Movement/Plyo Straight Arm Trunk Rotation**
- **Lateral Bound**
- **Counter Movement Vertical Jump (not performed unilaterally)**
- **Full Body Rotational Shot Put**

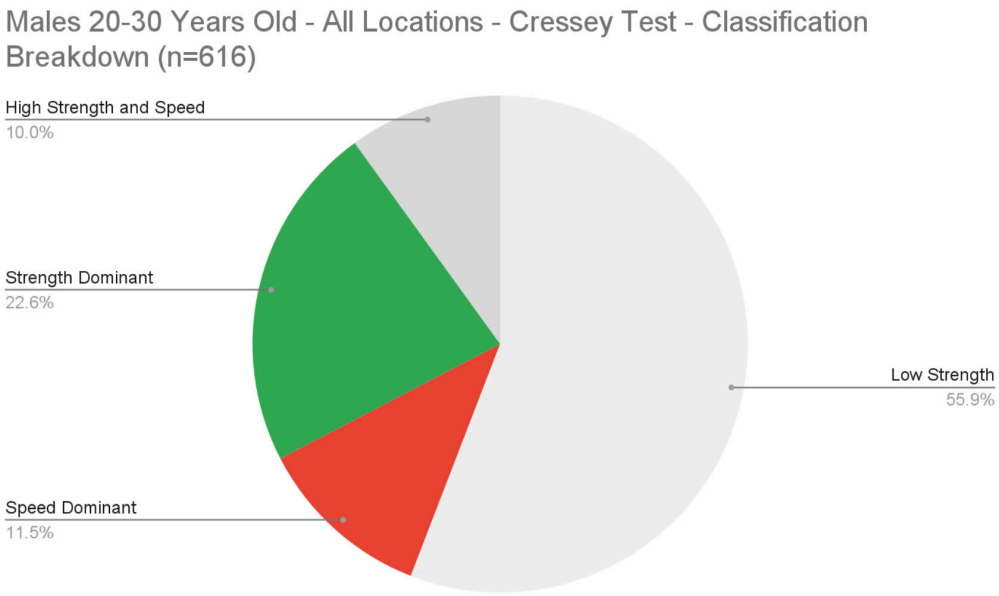
Categorization

We then categorized athletes into 4 specific classifications based on their overall average percentile rankings of all movements in both power and acceleration among all males between 20-30 years old. Below are the criteria for these classifications:

LOW STRENGTH	SPEED DOMINANT	STRENGTH DOMINANT	STRENGTH & SPEED
Individuals that fall below the 50% baseline of power production	Individuals that possess baseline power (>50 percentile) but have a significantly higher amount of speed production over strength (>5 percentile points acceleration over power)	Individuals that possess baseline power (>50 percentile) but have a significantly higher amount of power production over speed (>5 percentile points power over acceleration)	Individuals that possess baseline power (>50 percentile) and have a balanced amount of speed and strength production (<5 percentile points difference between power and acceleration)

Results

A total of 616 tests were analyzed for a total of 52,360 reps (616 tests x 17 movements x 5 reps each). 55.9% fell into the Strength Deficit category, 22.6% into the Strength Dominant, 11.5% into Speed Dominant, and 10.0% into the Balance of Strength and Speed.



Discussion

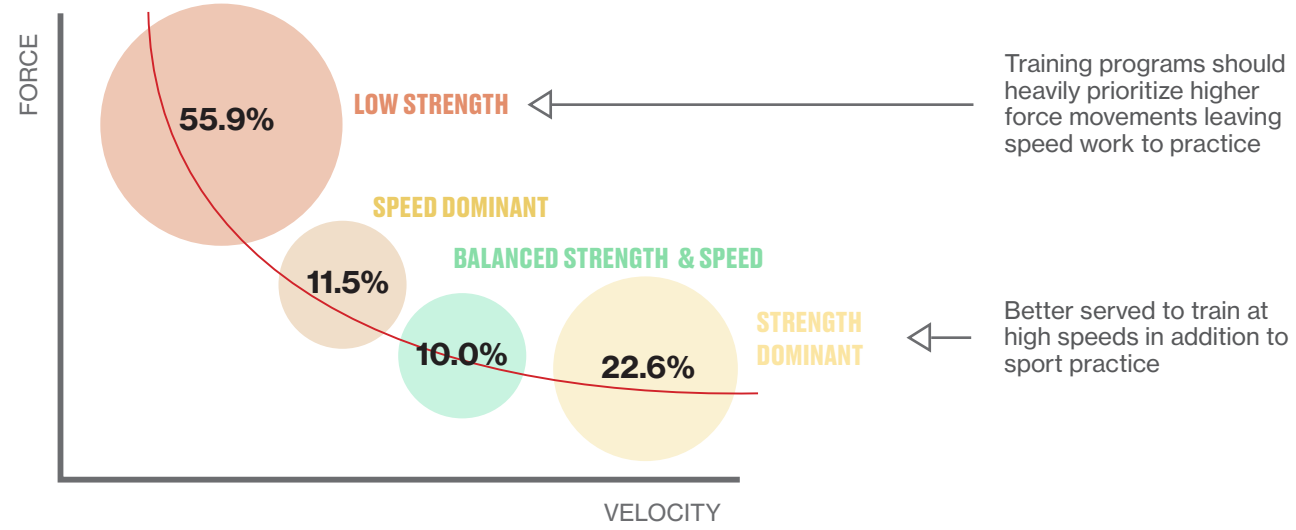
First, we found that 55.9% of athletes fell into the category of strength deficit. These athletes need to build their foundational strength before beginning to truly develop speed and power.

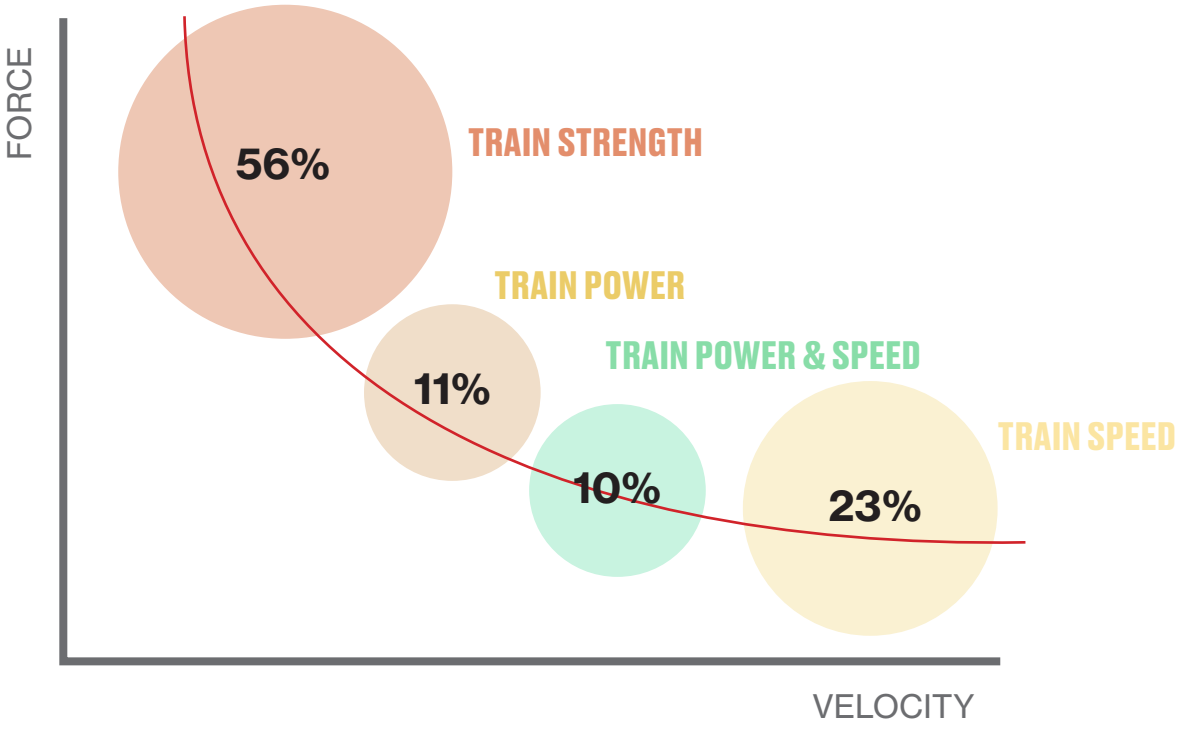
If we look at the remaining individuals that possess at least the required foundational strength (>50th power percentile, 44.1% of the total), we see that 77% of this group have imbalances of either strength or speed. Over half fall into the Strength Dominant category (22.6% of the remaining 44.1%). This means that over half of the individuals above baseline levels of strength need to work on speed instead of continuing to work on strength.

If these individuals continue to train at high forces and low speeds, they will not be able to reach new levels of speed and power production. In addition, they may actually run the risk of getting slower and therefore actually decrease their performance. There is even a risk of injury if they do not possess the required power and speed for their sport.

Moreover, the fact that the smallest cohort in this retrospective research were individuals with high strength and speed (only 10%) supports the hypothesis that very few people above baseline strength are training properly to achieve the balance they need for their sport.

Implications





In order to optimize training, athletes should train along the force-velocity spectrum according to the classification they fall into. Low Strength athletes should work at the top of the force-velocity spectrum with high-force, low-velocity movements in order to continue to improve force production. On the contrary, athletes classified as Strength Dominant should work at the low end of the force-velocity spectrum, utilizing low-force, high-velocity movements.

If these athletes continue to train with a generic program, many will not get the correct training stimulus they need and will stagnate in their athletic development.

Due to the fact that strength training in the high-force, low-velocity spectrum is, in general, over-emphasized, this work highlights the particular need for more specific mid-velocity to high-velocity training. When you consider that strength gains are relatively long lasting compared to gains in speed and power, this gives further evidence that power and speed training specific to the athlete's need is an important consideration with program design and should be monitored and adjusted continuously along with other considerations such as sports practice, competition, and overall program periodization.

Summary

A retrospective data analysis of males between 20-30 years old utilizing Proteus 3D Resistance recorded power and acceleration metrics shows that 77% of individuals that possess above baseline levels of strength have an imbalance of strength vs speed. Individuals with these imbalances should train specifically on the force-velocity spectrum where they are least proficient in order to continue to improve performance. It is critical that training programs are personalized to see optimal performance improvements.

Core Rotational Performance Lags Behind the Upper Body and Lower Body in Strength Development

Performance of rotational core movements showed a greater proportion of individuals that lacked baseline strength development as compared to the lower body and upper body in the same group.

by Will Waterman, PT, DPT, OCS, PRT, COMT, CSCS

Abstract

Data collected on the Proteus Motion system was utilized to measure the difference in the performance of power and acceleration of athletes. Performance was categorized into 1 of 4 classifications: Low Strength, Strength Dominant, Speed Dominant, or High Strength and Speed. Movements were tested across 3 body regions and scores were averaged in order to assess the performance of the upper body, lower body, and core respectively. Results showed that the core shows a much larger percentage of individuals that need foundational strength training (63.0%) vs the upper body (55%) and lower body (58%). There are also much fewer that fall into the strength dominant classification for the core (13%) vs the upper body (22.5%) and lower body (22%) and a higher proportion of individuals that fall into the speed dominant classification (14%) vs the upper body (11.8%) and lower body (11%). This indicates a lack of foundational and high-level strength development in rotational core movements compared to the upper body and lower body. Training programs should include measurements of rotational core movements as well as an increase in training volume, load, and frequency to minimize the gaps in performance, reduce injury risk, and improve overall outcomes.

Introduction

Historically, strength and power testing have been limited by resistance technology requiring movements to be performed in one plane. This is primarily due to the overwhelming majority of implements creating resistance in only one plane in a single vector. Additionally, the majority of assessments are in the sagittal plane due to the ease of performing and proliferation of these testing methods.

You will find the majority of strength and power testing consisting of upper body horizontal pushing movements like the bench press, med ball chest toss, or push-ups. For the lower body,

vertical jump and broad jump testing is most common. Upper body pulling movements are not tested as frequently but are often assessed with horizontal movements like rows or vertical movements like pull-ups. It is rare to see coaches test rotational movements, but they will sometimes utilize med ball throws for distance.

Because testing is difficult and time-consuming, many coaches simply stick to simple tests of the upper body and lower body to assess athletic potential and performance. We wanted to compare performance in the presumably under-measured and under-trained rotational core movement pattern compared to more commonly tested and trained movements in the upper body and lower body to see if performance was equivalent or if there was a gap that should be addressed.

Methods

To investigate these differences across different body areas, Proteus analyzed all males from 20-30 years old across all of our locations who performed the same standardized test (Cressey Performance Test) from September 1, 2021, to Aug 31, 2022. This is an ideal test for evaluating performance of rotational sports. It was specifically designed for baseball players but is also used with Tennis, Golf, MMA, and other athletes.

The test consists of the following movements: (17 total), 5 reps each, at max effort, performed in the standing position, on the left and right unless otherwise noted:

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- **PNF D2 Flexion**
- **PNF D2 Extension**
- **Static Start Straight Arm Trunk Rotation**
- **Counter Movement/Plyo Straight Arm Trunk Rotation**
- **Lateral Bound**
- **Counter Movement Vertical Jump (not performed unilaterally)**
- **Full Body Rotational Shot Put**

We then grouped these movements into 3 body region groups:

Upper Body Movements

- **Single Hand Horizontal Push**
- **Single Hand Horizontal Pull**
- **PNF D2 Flexion**
- **PNF D2 Extension**

Lower Body Movements

- **Lateral Bound**
- **Counter Movement Vertical Jump**

Core Movements

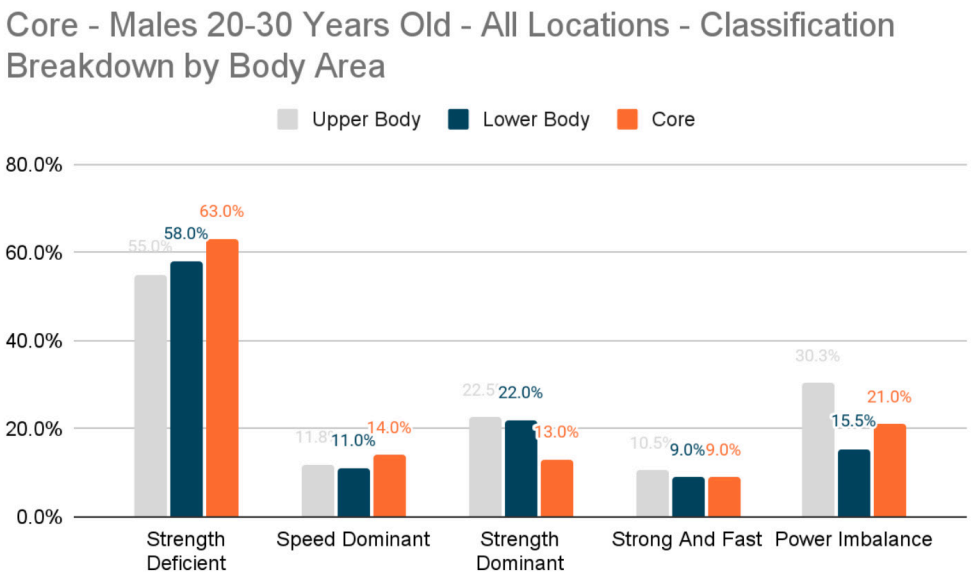
- **Static Start Straight Arm Trunk Rotation**
- **Counter Movement/Plyo Straight Arm Trunk Rotation**

Categorization

We then categorized athletes into 4 specific classifications based on their overall average percentile rankings for each body region in both power and acceleration among all males between 20-30 years old. Below are the criteria for these classifications:

LOW STRENGTH	SPEED DOMINANT	STRENGTH DOMINANT	STRENGTH & SPEED
Individuals that fall below the 50% baseline of power production	Individuals that possess baseline power (>50 percentile) but have a significantly higher amount of speed production over strength (>5 percentile points acceleration over power)	Individuals that possess baseline power (>50 percentile) but have a significantly higher amount of power production over speed (>5 percentile points power over acceleration)	Individuals that possess baseline power (>50 percentile) and have a balanced amount of speed and strength production (<5 percentile points difference between power and acceleration)

Results



The core shows the greatest number of individuals falling into the Strength Deficient classification at 63% while the lower body and upper body have 58% and 53% respectively. Simultaneously, the core has the lowest number of individuals falling into the Strength Dominant classification at 13%, while the upper body and lower body each have around 22%. All regions have roughly the same amount of individuals who fall into the High Strength and Speed classification, while in Speed Dominant the core displays a slightly higher proportion at 14% while the upper body and lower body each have 11.8% and 11% respectively.

Discussion

The core shows a much larger percentage of individuals that need foundational strength training, with 63.0% falling into this classification. In addition, for those that possess foundational strength (above 50th percentile in power), there are much fewer that fall into the Strength Dominant classification at only 13%. You also see a higher proportion of individuals fall into the speed dominant category at 14%, further indicating the lack of strength development. This highlights the inherent difficulty in developing foundational strength in rotational core movements as it is a very difficult movement to load with traditional equipment and techniques compared to the more uniplanar movements in the upper body and lower body.

This is an expected finding as it is very easy currently to train the upper and lower body regions with high orce, low-velocity exercise interventions such as squats, bench press, rows, etc. Doing that type of foundational loading on rotational core movements, particularly in a standing position, is difficult without 3D Resistance, which has only recently been introduced. This is primarily due to the limiting factor that most resistance training equipment cannot provide resistance across the entire ROM, but instead only loads at particular points in the range.

Proteus's 3D Resistance solves this problem, by providing resistance evenly across the entire ROM, perfectly mirroring the direction of movement with resistance. This allows Proteus to plug a major hole in the majority of athletes' training programs, something that this data supports.

Summary

A retrospective data analysis of power and acceleration metrics in males between 20-30 years old utilizing Proteus 3D Resistance shows that performance in rotational core movements lags behind the upper and lower body in foundational strength development. This is likely due to the difficulty in properly loading these movements with traditional equipment as compared to the lower body and upper body. Training programs should include measurements of rotational core movements as well as an increase in training volume, load, and frequency to minimize the gaps in performance, reduce injury risk, and improve overall outcomes.

One Dimensional Performance Does Not Translate to 3D Movements

Performance with traditional sagittal plane movement testing did not translate to frontal and transverse plane movement proficiency when looking at historical Proteus data.

by Will Waterman, PT, DPT, OCS, PRT, COMT, CSCS

Abstract

Data collected on the Proteus Motion system was utilized performed to measure the difference in the performance of power and acceleration of athletes. Performance was categorized into 1 of 4 classifications: Low Strength, Strength Dominant, Speed Dominant, or High Strength and Speed. Results showed that performance in the sagittal plane was much more biased towards strength compared to the frontal and transverse planes (3D movements), with fewer individuals falling into the Strength Deficit category (52%) vs 3D movements (58%) and more individuals falling into the Strength Dominant category in the sagittal plane (26%) vs 3D movements (21%). Furthermore left to right imbalances were more frequently present in 3D movements (31%) vs traditional sagittal plane movements (19%).

When assessing athletic performance with movement patterns in the sagittal plane, performance does not translate to other planes. This highlights the importance of assessing movement patterns in all planes and indicates why testing with traditional equipment in the sagittal plane with uniplanar, single vector resistance will not give an accurate assessment of athlete performance outside of those planes. Since most sports contain a large mix of movement patterns in all planes, assessment in all planes should be performed to optimize performance, training efficiency, athletic preparedness, and safety.

Introduction

Historically, strength and power testing have been limited by resistance technology, requiring movements to be performed in one plane. This is primarily due to the overwhelming majority of implements creating resistance in only one plane in a single vector. Additionally, the majority of assessments are in the sagittal plane due to the ease of performing and proliferation of these testing methods.need to focus on different aspects of training.

You will find the majority of strength and power testing consisting of upper body horizontal pushing movements like the bench press, med ball chest toss, or push-ups. For the lower body, vertical jump and broad jump testing is most common. Upper body pulling movements are not tested as frequently but are often assessed with horizontal movements like rows or vertical movements like pull-ups. It is rare to see coaches test rotational movements, but they will sometimes utilize med ball throws for distance.

Because testing is difficult and time-consuming, many coaches simply stick to simple sagittal plane tests for the sake of efficiency and hope this will translate toproficiency in the other planes. We wanted to compare performance in the sagittal plane to movement patterns in other planes to see if performance was equivalent or if there is indeed a gap between traditional sagittal plane testing and 3D testing.

Methods

To investigate these differences across planes, Proteus analyzed males from 20-30 years old across all of our locations who performed the same standardized test (Cressey Performance Test) from September 1, 2021, to Aug 31, 2022. This is an ideal test for evaluating performance of rotational sports. It was specifically designed for baseball players but is also used with Tennis, Golf, MMA, and other athletes.

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- **Lateral Bound**
- **Counter Movement Vertical Jump (not performed unilaterally)**
- **Full Body Rotational Shot Put**

We then placed these movements in 2 groups:

Traditional/Sagittal Plane

- **Single Hand Horizontal Push**
- **Single Hand Horizontal Pull**
- **Counter Movement Vertical Jump (not performed unilaterally)**

3D Movements Frontal Plane

- **Lateral Bound**

3D Movements Transverse Plane

- **PNF D2 Flexion**
- **PNF D2 Extension**
- **Static Start Straight Arm Trunk Rotation**
- **Counter Movement/Plyo Straight Arm Trunk Rotation**
- **Full Body Rotational Shot Put**

Categorization

We then categorized athletes into 4 specific classifications based on their overall average percentile rankings for each plane in both power and acceleration among all males between 20-30 years old. Below are the criteria for these classifications:

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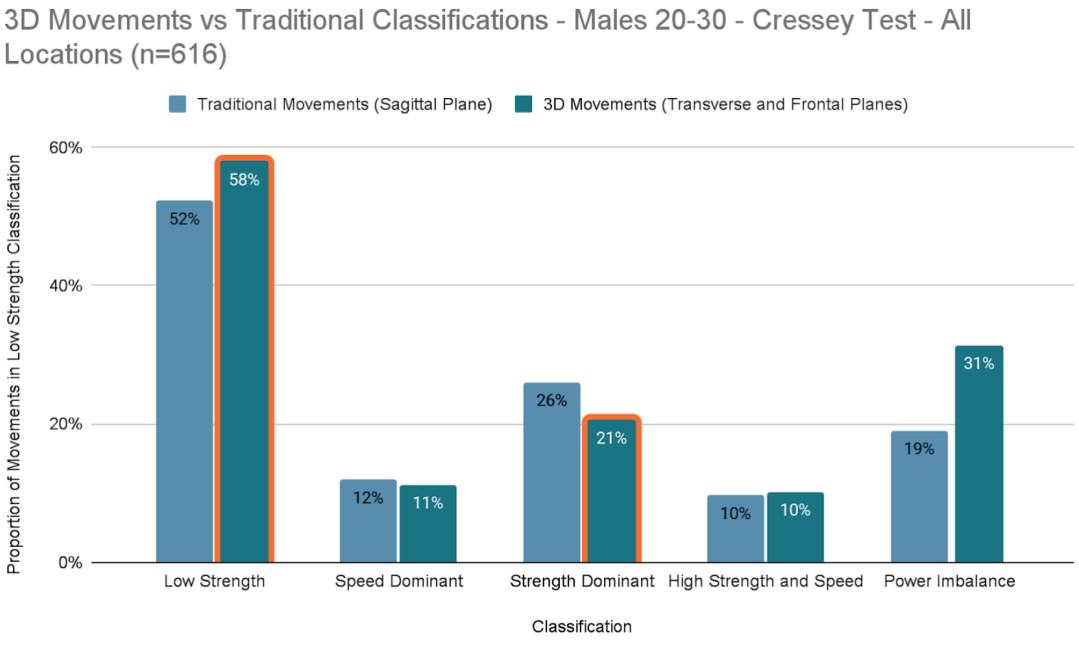
Results

A total of 616 tests were analyzed for a total of 52,360 reps (616 tests x 17 movements x 5 reps each). For sagittal plane movements, 52% of individuals fell into the Low Strength classification, 26% fell falling into the Strength Dominant classification category, and 19% possessed imbalances from left to right. For 3D movements,58% of individuals fell into the Strength Deficit classification, 21% into the Strength Dominant category, and 31% possessed a power imbalance from left to right. The sagittal plane had 12% fall into Speed Dominant while 3D movement had roughly equivalent at 11%. Both sagittal plane and 3D Movements had 10% of individuals fall into the classification of High Strength and Speed.



Discussion

Traditionally testing one's ability in strength and speed has been limited to sagittal plane movements. These result highlight that the performance profiles of sagittal plane movements do not perfectly mirror those of the frontal and transverse planes in the same group of athletes. Failing to recognize those differences and train those movement patterns individually along the proper points on the force-velocity curve leaves a lot of room for improvement.

In general, the sagittal plane is more proficient in strength, with fewer individuals falling into the Low Strength category (52% vs 58% for 3D movements) and more falling into the Strength Dominant category (26% vs 21% for 3D movements). This is likely due to the fact that sagittal plane movements are prescribed in training programs at a much higher rate as they are very easy to perform and easy to load with typical training equipment.

Frontal and transverse plane movements are harder to load yet are just as, if not more important to sports performance than proficiency in the sagittal plane. Sports are rarely played in a straight line in the sagittal plane and injuries often occur in frontal and transverse plane movements such as when cutting and pivoting. If these "3D movements" were easier to load and train, there would likely be more training specificity and therefore, improved outcomes and preparedness in these less trained movements.

Furthermore, power imbalances are present at a much higher rate in 3D movements (31%) vs sagittal plane movements (19%). Imbalances can lead to decreases in performance but also an increase in injury risk. Considering the fact that most sports rely on high levels of unilateral performance in the frontal and transverse planes (which are also the planes that have higher rates of injury), the significance of the gap in the current lack of measurement and training in these planes is highlighted.

3D Resistance eliminates this gap by making measurements in 3 dimensions possible, highly efficient, and easier to train and load.

Summary

A retrospective data analysis of power and acceleration metrics in males between 20-30 years old utilizing Proteus 3D Resistance shows that performance in sagittal plane movements does not translate to a similar performance in frontal and transverse plane movements. Sagittal plane movements display a higher bias towards strength and lower amounts of power imbalance than 3D movements. This is likely due to the increase in testing, monitoring, loading, and training frequency. Training programs should include measurements of 3D movements as well as an increase in training volume, load, and frequency to minimize the gaps in performance, reduce injury risk, and improve overall outcomes.