Today’s Presentation

• An overview of some of the elements involved with athlete development
• Discuss some of the underlying basics for helping program development for performance, and recovery.
Challenges of Athlete Development

- Athlete development is still in its early evolutionary phase, as the interface between science and sports has been tenuous.

- If often times starts with a single professional interested in his or her athletes and wants to do the best they can for them.

- Thus, a program is started and can develop

- Buy-in and alignment of the different shareholders are vital for success

- All participants in a program must have the three “Cs”
  - Credentials, Competence and Commitment

The Athlete Composite

- Ultimately, we are concerned with the athlete first and the composite they bring to the sport.

- The composite dictates the level at which an athlete can ultimately compete.

- The athlete composite is constantly changing due to daily positive influences (e.g., proper training and nutrition) and negative influences (e.g., injury and fatigue).

- We compete with the athlete composite in a game against ourselves (e.g., golf or gymnastics) or against an opponent (e.g., soccer, tennis, American football, or wrestling)
Factors Impacting Athlete Development: ‘Mutable and Largely Non-Mutable Characteristics

Largely Nonmutable Characteristics

- Height
- Limb lengths and ratios
- Hand size
- Foot size
- Arm wingspan
- Tendon and ligament lengths
- Origin and insertion points of tendons and ligaments
- Number of skeletal muscle fibers
- Type of skeletal muscle fibers (slow- versus fast-twitch)

Mutable

Aspects of each of the different physiological systems:

- Nervous
- Muscular
- Cardiovascular
- Digestive
- Endocrine
- Skeletal
- Integumentary and exocrine
- Immune and lymphatic
- Renal and urinary
- Reproductive
- Respiratory

Genotype sets the stage, and training and behavior determine the phenotypic expression of the athlete’s genetic inheritance.
The Player Development Team

- **Strength and Conditioning/Sport Performance/Sport Science**
  (accredited certifications)

- **Athletic Training**
  (accredited certifications and licenses)

- **Physical Therapy**
  (accredited DPT degree and licenses)

- **Sport Psychology/Sociology**
  (certification)

- **Sport Nutrition**
  (accredited, registered dietitian and sport nutrition certifications)

- **Sport Coach**

- **Sport Science/Sport Analytics**
  (accredited certifications)

- **Exercise and Sport Science Advisor**
  (professor/educator; university resource)

- **Sport Medical Professional**
  (licenses)

Factors affecting sport performance

- Nutrition
- Conditioning
- Sleep
- Injury
- Coaching
- Psychology
- Social
- Academics
- Work
- Environment

How do we address the needs of the athlete?

Must start evaluating who are your athletes.

Performance is related to both growth and development over time and is also bounded by the inherent genetic endowment of the individual. Furthermore, performance has an acute temporal element: On a given day in a competition, the individual can bring all the elements of player development together to win the race, make the winning shot, or throw the winning pass in a game.

Adapted from Developing the Athlete (Human Kinetics)
Athlete Development

Types of Athlete Composites

Training takes this athlete to an even higher elite status

Training density is a concern
Readiness to Train

- **Physical Preparedness:** The SCCs reported that incoming freshman athletes generally lack sufficient lower extremity strength, overall flexibility, and core strength. They also noted deficiencies in proper Olympic lifting techniques.

- **Psychological Preparedness:** According to the responses, many athletes do not possess the mental toughness required to handle the demands of collegiate sports training.

- **Nutrition and Recovery Knowledge:** There is a notable deficiency among incoming athletes regarding their understanding of proper nutrition and recovery principles.

- **Implications for High School Training:** Despite advancements in high school training programs to mimic collegiate or professional intensities, there appears to be a gap in the actual preparedness of athletes for college-level competition and training.


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Individualization- Impacting the Athlete Composite

- Testing and Evaluation
- Physical Training
- Monitoring
- Sports Medicine Interfaces
- Recovery/Preparation
Tests and training and sports practices and competition data collection must be valid and reliable and clear methods

1. Descriptive Statistics
2. Inferential Statistics
3. Predictive Modeling
4. Machine Learning and AI
5. Time Series Analysis
6. Network Analysis
7. Bayesian Statistics

Application and Communication

We Use Individual and Sports Analytics

• To correctly consult with athletes and parents to place the athlete in the right sport and position.

• Athleticism is important with multiple sports during youth, but some sports do require early skill set development.
Needs Analysis of the Sport helps to determine training, testing and monitoring needs.

Player Profiles and Training Potential Targets

Player Profile: Jane Doe
Personal Information:
- Age: 20
- Height: 6'2"
- Weight: 160 lbs
- Position: Middle Blocker
- Year: Junior
- Major: Kinesiology

Athletic Background:
- Previous Experience: Played volleyball since age 12, two years on the high school varsity team, and now in her third year with the college team.
- Achievements: High school all-state team, currently holds the record at her college for most blocks in a season.

- Then, choosing test profiles for trainable
  metrics for mutable characteristics...many
  to choose from
  - Kinetic isometrics
  - 1 RM strength profiles
  - Peak Power (W)
  - Neural testing
  - Heart Rate Variability
  - Velocity of Movement
  - CMJ/SJ
  - Landing Force
  - CV measures
  - Index Numbers
  - Sports-specific tests
  - POMS
  - Cognitive Function
  - Blood markers
Testing Human Machine

- Data quality and integrity
- Overemphasis on quantitative analysis
- Privacy concerns
- Interpretation and application
- Accessibility and cost
- Ethical considerations
- Potential for over-analysis
- Individualized approach
- Integration with existing practices
- Long-term consequences

Testing Must Be Done with Research Quality

- Validity
- Reliability
- Time of day
- Arousal conditions
- Instrument calibration
- Hydration status
- Testing Instructions
- Familiarization
- Athlete and Coach Understanding

(photo from Dr Kraemer’s Laboratory)
College Woman’s Volleyball Player Test Results

**Vertical Jump** (28 inches):
Average for Collegiate Players: 22-24 inches
Excellent: 28-30 inches
Estimated Percentile: 75th to 90th percentile

**Block Jump** (30 inches):
Average for Collegiate Players: 24-26 inches
Excellent: 30+ inches
Estimated Percentile: 90th to 95th percentile

**5-10-5 Shuttle Run** (4.5 seconds):
Average for Collegiate Players: 4.5-5.0 seconds
Excellent: 4.0-4.4 seconds
Estimated Percentile: 50th to 75th percentile

**Broad Jump** (8 feet):
Average for Collegiate Players: 7-7.5 feet
Excellent: 8+ feet
Estimated Percentile: 75th to 90th percentile

**1 RM Bench Press**: 135 lbs
0.84 times her body mass.

**1 RM Squat**: 225 lbs
1.41 times her body

**1 RM Power Clean**: 155 lbs
0.97 times her body mass.

Example Tests

- **Strength**
  - 1RM squat, bench press, power clean, deadlift, seated row
- **Power**
  - Vertical jump, force plate jumps, body mass movement 1 m sec,
  - standing long jump
- **Agility**
  - pro agility, shuttle types
- **Body Composition**
  - lean muscle mass, somatotype, etc
- **Aerobic** – 300 m shuttle, 1.5 mile
- **Anaerobic** – repeat sprints, Wingate
- **Speed**
  - 10, 40, etc 100

Advanced testing

- VO2 Max Testing:
- Isokinetic Dynamometry:
- Force Plate Analysis:
- Motion Analysis Systems:
- Heart Rate Variability (HRV) Monitoring:
- Biochemical Monitoring: Tests blood, VIt D, urine, or saliva for markers such as lactate, hormones, and enzymes that indicate stress, recovery status, and metabolic function.
- Neuromuscular Testing: (EMG).
- Functional Movement Screening (FMS):
- Altitude Simulation and Response:
- Sleep Analysis: Monitors sleep patterns and stages to assess recovery using wearable technology.
- Inertial Movement Analysis:
Developing Workouts

The Size Principle

Orderly Recruitment from low to high threshold motor units
Different patterns of EEG Cortical brain activation reflect the different neurological demands of the load lifted.

50% 75% 100% of 1 RM


Cortical Brain is sensitive to different loads...

- We have shown in our prior work that the cortical brain is sensitive to the different workouts related to the “acute program variables”
Factors that Influence of Training on Skeletal Muscle Fibers

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Impact on Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Muscle Fibers</td>
<td>Limits the absolute size of intact muscle</td>
</tr>
<tr>
<td>Type of Muscle Fibers</td>
<td>Impacts function and repair and recovery</td>
</tr>
<tr>
<td>Type I</td>
<td>Are made up of heavy protein bands (e.g., Z lines, non-contractile proteins), made for repeated activation, peak force low</td>
</tr>
<tr>
<td>Type II</td>
<td>Light protein bands, higher amounts of contractile proteins, made for intermittent activation, high peak force</td>
</tr>
</tbody>
</table>

Fiber Growth Mechanisms

<table>
<thead>
<tr>
<th>Type I Muscle Fibers</th>
<th>Type II Muscle Fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasis on the reduction in degradation of muscle proteins with less emphasis on synthesis</td>
<td>Emphasis on the increase in protein synthesis and less importance on the reduction of degradation of muscle proteins</td>
</tr>
<tr>
<td>Rapid attainment of cell size maximum and resistance to muscle size gains</td>
<td>Explains some Type II preferential cell hypertrophy</td>
</tr>
<tr>
<td>SLOWER RECOVERY with Damage (Why?)</td>
<td>FASTER RECOVERY with Damage (WHY?)</td>
</tr>
</tbody>
</table>
TRAINING ZONES

Light sets of 12-15 RM

Moderate 3 sets of 8-10 RM

Heavy 3-5 sets of 3-5 RM

Activated Muscle Tissue (Size Principle in Action)

Many Periodization Approaches

We like Flexible Non-Linear Periodization
The primary tenant of conjugate periodization lies in using concentrated periods of accumulation for a specific ability followed by a restitution period for that ability.

No matter what the periodization approach it is the sequencing of the workouts for the INDIVIDUAL athlete that makes the difference.

Thus flexible non-linear periodization and be used for any type of sequencing.

Example Development Program for Maximal Strength

Many athletes need to focus on core strength development in the major muscle groups, as metrics show they are weak.

Strength and training density improves muscle and tendon stiffness.

Tissue density is the key to optimal training programs for injury prevention and kinetic chain dominance in a sport.
Personalized recovery plans can help prevent performance decrements associated with chronic stress.

Recovery Process

- Highly specific as to what was stressed and what is in need for recovery physiologically and psychologically.
- Individualized
- Workout or Competition
- Monitoring metrics
- Interventions
Recovery Metrics and Interventions

Recovery Metrics and Analytics

• Validity of the technique must be known
• Reliability of the measurements under the conditions of use
• Acceptability of the metric by coaches and individual team members for its use

Types of Interventions

• Nutritional
• Mechanical
• Therapeutic
• Medical

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Professionals in the different areas of expertise, all with
The 3 Cs
Credentials
Competence
Commitment
THANK YOU

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