Skill-based conditioning Vs. plyometric training in team sports

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Plyometric training

- Popular form of physical conditioning of healthy individuals
- Aimed at improving conditioning capacities that require the fast development of muscular force
- Involves performing bodyweight jumping-type exercises and throwing medicine balls (and some derivations) using the so-called stretch-shortening cycle (SSC) muscle action
- The SSC enhances the ability of the neural and musculotendinous systems to produce maximal force in the shortest amount of time, prompting the use of plyometric exercise as a bridge between strength and speed
- Plyometric training has been extensively used for augmenting dynamic athletic performance (i.e. jumping, throwing, sprinting)
Effects of plyometric training (in brief)

- Earliest studies examined the effects on jumping performance (mostly vertical jumps).
- The focus later evolved and studies frequently investigate effects on throwing, kicking, sprinting, and agility performances.
- Also, plyometric training has the potential to improve biomechanical technique and neuromuscular control during high-impact activities like cutting and landing.
- To reduce the risk of lower-extremity injuries.
- To induce bone and musculo-tendinous adaptation.

Skill-based conditioning

- Another popular training method in contemporary sports (mainly sport/games).
- Based on the postulate that the greatest improvement in performance occurs when the stimulus of training mimics real-game (i.e., real-sport) metabolic and technical demands.
- Aimed at the simultaneous improvement of fitness and skills, which is particularly important in young athletes.
- Includes various sport-specific exercises performed in “sport-specific environment.”
Effects of skill-based conditioning

1. When compared to „traditional exercises“ skill-based conditioning resulted in:
   - Similar improvement in aerobic endurance as traditional aerobic exercises
   - Similar improvement in 10-m speed, agility as traditional speed-agility training

2. When „non-compared“ to traditional exercises:
   - Significant improvement in 5 and 10-m sprint
   - Significant improvement in jumping, and agility performances

What is important

- Most team-sports (football, basketball, volleyball, handball, etc.) involve activities that involve stretch-shortening cycles (volleyball: spiking and jumping).
- It is reasonable to expect that team-sport skill conditioning could result in training effects similar to those seen as a result of plyometric conditioning.
- But, studies rarely examined the concurrent effects of Skill-based conditioning vs. Plyometric conditioning in development of „important conditioning capacities“ (jumps, throws, sprints, etc.)
- This question is particularly important as it comes to differences between young and „older“ athletes

Herein

- We will present findings of two studies
  - Both studies included female volleyball players
  - First one examined „18+“ players
  - Second one examined „<18“ players
  - In both studies we compared effects of plyometric vs. Skill-based conditioning
  - In both studies experimental programs were applied as „an addition“ to standard volleyball training (5-7 sessions weekly)
    - Throughout 12 weeks (3 months)
    - Twice a week
    - 30-60 min each session (plyo or skill-based)
    - Done at the beginning of the season (after summer break)
Study 1: +18 players


Methods (most important)

- 41 highly skilled female volleyball players (1st division), all older than 18 years
- Divided into plyometric group (n=20) and skill-based group (n=21)
- Plyometric- and skill-based conditioning were performed as an addition to the regular technical and tactical volleyball training

Measures

- Body height and body mass
- Sprinting 20 meters - S20M
- Vertical countermovement jump - CMJ
- Standing broad jump - SBJ
- Medicine ball toss - MBT
Testing 1 12 weeks training Testing 2

Testing 1 12 weeks training Testing 2

Training programs
Results

Table 1: Descriptive statistics (Means ± Standard Deviation) for pre- and post-training results in each group; results of two-way analysis of variance for main effects (Group and Time) and interaction (Group × Time) and pre-to-post training differences in percentages (%).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre</th>
<th>Post</th>
<th>% Change</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m²)</td>
<td>25.2 ± 2.1</td>
<td>22.8 ± 1.5</td>
<td>-11%</td>
<td>23.9 ± 2.0</td>
<td>25.4 ± 2.2</td>
<td>21.9 ± 1.8</td>
<td>24.7 ± 2.3</td>
<td>22.3 ± 1.6</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>98 ± 9</td>
<td>92 ± 8</td>
<td>-6%</td>
<td>96 ± 7</td>
<td>100 ± 8</td>
<td>94 ± 7</td>
<td>98 ± 8</td>
<td>92 ± 7</td>
</tr>
<tr>
<td>Hip (cm)</td>
<td>106 ± 9</td>
<td>99 ± 8</td>
<td>-7%</td>
<td>104 ± 8</td>
<td>109 ± 9</td>
<td>102 ± 8</td>
<td>106 ± 9</td>
<td>100 ± 8</td>
</tr>
<tr>
<td>Skinfold (mm)</td>
<td>7.8 ± 2.1</td>
<td>6.5 ± 1.9</td>
<td>-21%</td>
<td>8.0 ± 2.3</td>
<td>7.5 ± 1.8</td>
<td>7.2 ± 1.9</td>
<td>8.2 ± 2.4</td>
<td>7.0 ± 1.7</td>
</tr>
</tbody>
</table>

Note: * indicates statistical significance at p < 0.05.
Most important finding

- Both training programs resulted in improvements in jumping and throwing capacities, but the changes induced by plyometric training were larger than those achieved by skill-based conditioning.
- Is this expected, and why?

Sprinting

- Plyometric training is known to be effective for sprint performance (rugby, tennis).
- But there are also reports that similar improvements in sprint can be achieved by skill-based conditioning (soccer).
- However, it seems that similar results of training modalities may be a result of differences in testing length (soccer study investigated 40m sprint).
- CONCLUSION: In +18 volleyball players plyometric conditioning improves sprint (but skill-based conditioning doesn’t).
Jumping and throwing

- Improved in both groups
- When observed independently we may conclude
  - Plyometric training is effective
  - Skill-based training is effective
  - When observed concurrently…

Indeed

- Plyometric conditioning is known to be effective for jumping and throwing (even in similar participants such as female soccer and volleyball players)
- Skill-based conditioning did not improve jumps and throws in volleyball (but these studies were shorter: 8 weeks vs. 12 weeks)
Where to seek for a difference between plyometric and skill-based conditioning?

- There are some "physiological" and "real-world" explanations, but we will present it later.
- For a moment the most important idea is (was) [copied-pasted from the article]
- It is likely that the skill-based conditioning program did not result in changes of higher magnitude because of the players' familiarity with volleyball-related skills.
- Namely, in this study we included senior players (+18 years of age), which could have resulted in a low impact of the skill-based conditioning and consequently did not result in adequate training stress. Therefore, in future studies, the influence of plyometric and skill-based conditioning should be evaluated in younger and less experienced volleyball players.
- Also (non copied-pasted): What would happen if they have trained volleyball only (without additional exercise)?

Study 2: <18 players

Methods (most important)
- Participants were divided in 3 groups
  - Plyometric (n=13) ... but we will talk about it later
  - Skill-based conditioning (n = 17)
  - Control (n = 17)

Variables (measures)
- Body mass and height
- Calf girth
- Calf skinfold
- Corrected calf girth (calf girth „minus“ calf skinfold → indicator of musculature)
- Countermovement jump (CMJ)
- 20 m sprint (SPRINT20M)
- Medicine ball toss from a laying position (MEDBALL)
- Sit-and-reach flexibility (ST.AND.REACH)
What was different?

- Control group
  - Volleyball training only (10 hours per week)

- Plyometric group
  - Volleyball training (10 hours per week) + 2 sessions weekly of plyo (30-60 min)

- Skill based group
  - Volleyball training (10 hours per week) + 2 session weekly of skill-based conditioning (30-60 min)

- Basically: is more also the better?
Results
Main findings

- Plyometric training resulted in positive anthropometric changes.
- The changes in jumping and throwing were positive for all 3 groups, but plyometric training induced most evident changes.
- Additional skill-based conditioning did not contribute to improvement of conditioning capacities (when compared to volleyball training alone).

Plyometric training induced positive changes in body build

- Generally, plyometric training was rarely studied with regard to changes in anthropometrics.
- Possible explanations:
  - Plyometric is applied for other purposes.
  - Authors examined but did not find changes and therefore did not present it.
- Our results indirectly confirmed positive changes in body composition (i.e., decrease in skinfold and increase in corrected girth).
- Such changes, together with maintenance of body mass at the baseline level, indicate positive changes in body composition (i.e., an increase in lean body mass and decrease of fat mass in Junior Female Volleyball Players).
Plyometric training improved sprinting, jumping and throwing capacities

- Main physiological explanations:
  - Elongation of the Achilles tendon and a consequent increase in the amount of stored elastic energy → jumping
  - Stimulation of an increased number of muscle units and higher (neural) firing frequency → jumping, sprinting, throwing
  - Improved joint proprioception → sprinting
  - Alltogether resulted in „fast production of force“

Skill-based conditioning „did not contribute“ to improvement in conditioning capacities

- Main explanation
  - Lack of training intensity due to lack of control over training intensity

In brief:
- The proper adjustment of training intensity is crucial in achieving exercise goals
- Adjustment is dependent on „controllability“ (you cannot adjust if you cannot control)
- Monitoring the single-session intensity of skill-based conditioning is inaccurate
- Intensity during skill-based conditioning depends on the partner and/or opponent’s performance, which is hardly controllable

Conclusion (of the 2nd study)

- Plyometric training is effective for junior volleyball players
- Skill-based conditioning is not effective
- Note that we did not observe changes in sport-specific skills!
Let's put it together

In general

- 12-week plyometric training is „equally effective“ for „senior“ and „junior“ female volleyball players

<table>
<thead>
<tr>
<th></th>
<th>% changes</th>
<th>SEN</th>
<th>JUN</th>
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</thead>
<tbody>
<tr>
<td>Jumping</td>
<td></td>
<td>8-28%</td>
<td>17%</td>
</tr>
<tr>
<td>Throwing</td>
<td></td>
<td>23%</td>
<td>29%</td>
</tr>
<tr>
<td>Sprinting</td>
<td></td>
<td>8%</td>
<td>6%</td>
</tr>
</tbody>
</table>

In general

- Skill based conditioning is similarly effective for JUN and SEN

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<th>JUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jumping</td>
<td></td>
<td>3-18%</td>
<td>9%</td>
</tr>
<tr>
<td>Throwing</td>
<td></td>
<td>9%</td>
<td>8%</td>
</tr>
<tr>
<td>Sprinting</td>
<td></td>
<td>1%</td>
<td>0%</td>
</tr>
</tbody>
</table>
In general

- 12-week plyometric training is "equally" for senior and junior female volleyball-athletes
- Skill based conditioning is similarly effective for JUN and SEN
- But, plyometric is more effective than skill-based for both groups

<table>
<thead>
<tr>
<th>SKILL BASED</th>
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</tr>
</thead>
<tbody>
<tr>
<td>SEN</td>
<td>JUN</td>
</tr>
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<td>Jumping</td>
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<td>Sprinting</td>
<td>1%</td>
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<table>
<thead>
<tr>
<th>PLYOMETRIC</th>
<th>% changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEN/JUN</td>
<td></td>
</tr>
<tr>
<td>Jumping</td>
<td>8-28%</td>
</tr>
<tr>
<td>Throwing</td>
<td>25%</td>
</tr>
<tr>
<td>Sprinting</td>
<td>8%</td>
</tr>
</tbody>
</table>

But, there is BUT!
But, there is BUT!

Methods (most important)
- Participants were divided in 3 groups:
  - Plyometric (n=16)
  - Skill-based conditioning (n=17)
  - Control (n=17)

Remember this?

But, there is BUT!

The original number of participants (starting) was
- Plyo: 16; Control: 18; Skill-based: 18

At the end of the study we observed only those who participated at >80% training sessions (PLYO: 13, SKILL-BASED: 17, CONTROL: 17 players), meaning that drop-out rates were:
- 20% for plyometric
- 6% for control and skill-based groups

We did not study it specifically, girls did not report injuries, etc.
But … it is indicative, don’t you think?

In conclusion

- Plyometric training performed twice-a-week as an addition to regular volleyball training in 12-week period will improve “explosive capacities”
- There is no evidence that plyometric training is “differentially” effective for different age groups
- When performed under “similar” conditions (i.e. not specifically tailored)
- There is no evidence that additional skill-based conditioning performed twice-a-week is effective for development of jumping, throwing, and sprinting capacities in female volleyball players
- But, caution is needed when it comes to “ills”
- It is indicative that drop-out rates were much higher in plyo-thhan in skill-based conditioning (studied in junior age)
- What happened with volleyball skills, still have to be evaluated
Thank you for your attention!