

# Plyometrics & Speed: Review of the Literature (1) – September 2021

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This week I thought I would provide some insight from several research papers on certain aspects of plyometrics and sprint performance.

## Paper 1 - Which measures of Drop Jump performance best determines sprinting speed? (2011)



This paper reviewed several different jump tests with a focus on Drop jump (height achieved post landing), ground contact time during the drop jump and an integrated metric known as the Reactive Strength Index (RSI) which is calculated in this case using drop jump height (cm) divided by time on the ground (sec).

### RSI = Djh/GCT

The paper confirmed from previous studies that RSI had a low correlation with sprinting performance and that drop jump height had the highest correlation.

One of the potential problems with RSI is that a client can manipulate their ground contact time to augment their RSI at the sacrifice of vertical height achieved. There is more to be gained in reducing GCT by 0.1 of a second than there is by jumping higher in this test, for example:

- 30cm jump/0.20GCT = 150 RSI

- 35cm jump/0.25GCT = 140 RSI
- 29cm jump/0.18CGT = 161 RSI

Why this is problematic is that we know from the research by Clark & Weyland (2014, 2017) that the greater the impulse into the ground the faster the athlete can sprint (taking into account the kinematic factors of top speed sprinting). So an athlete can be so fast off the ground that they don't apply appropriate force to the ground and this isn't beneficial or correlated to improved sprint performance.

GCT is important (elite athletes have to apply their force in <100ms) and so a way around this training/testing protocol to allow the athlete to focus on both jump height and CGT is to have them have to jump back onto a certain box height AND have them focus on minimising their GCT. If they are too fast and don't generate the required force then they won't make it back onto the opposing box – great immediate biofeedback to the athlete.

## **Paper 2 - Effects of Vertically and Horizontally Orientated Plyometric Training on Physical Performance: A Meta-analytical Comparison (2021)**





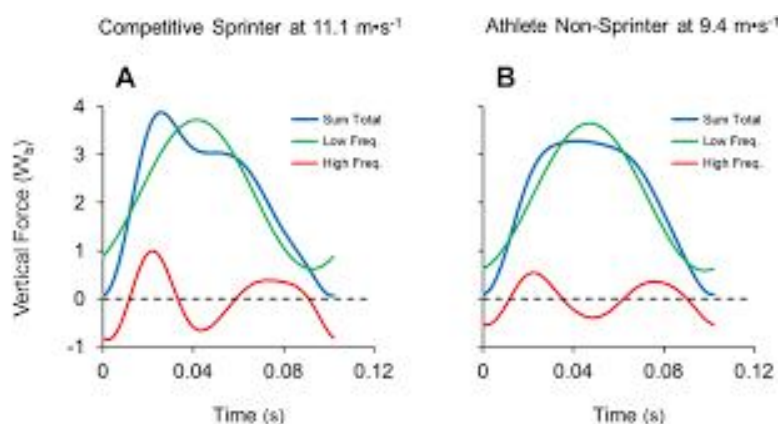
VPT = Squat Jumps & Counter Movement Jumps

HPT = Standing Long Jumps, Standing Triple Jumps, Multiple jumps (single and double leg), sled pushing/pulling.

This paper reviewed a combination of plyometric activities (Horizontal (HPT) & Vertical (VPT) and how they affected both vertical and horizontal plyometric jumping and sprint tests. What the review found was that HPT is equally effective in improving Vertical performance as VPT but VPT did not significantly improve Horizontal performance.

So the common specificity viewpoint that if you are a vertical athlete you need to only perform vertical training doesn't hold up. For athletes who have a combination of both vertical and horizontal performance requirements, the use of HPT will provide the most effective performance outcomes (both horizontally and vertically) for these athletes.

### **Paper 3 - Acute Effects of Plyometric Intervention—Performance Improvement and Related Changes in Sprinting Gait Variability (2015)**

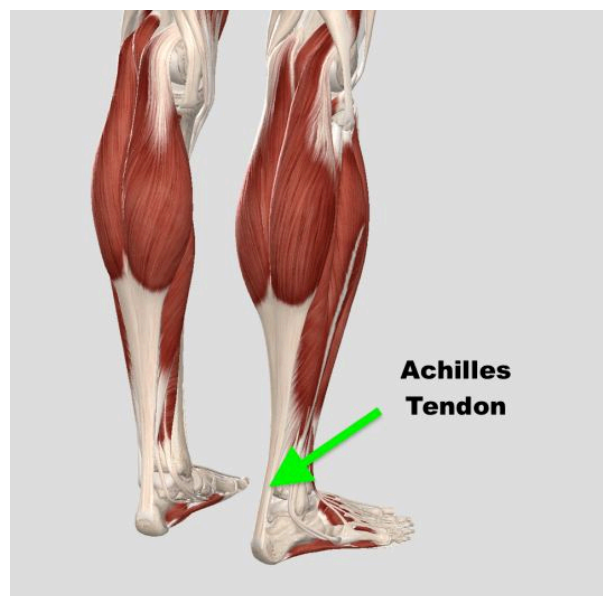


This paper evaluated the performance changes in subjects (sub elite 100m sprinters – Ave 10.89sec) after an intensive 2 week plyometric program that included up to 250 jumps per session.

The results included improvements across the board (horizontal, vertical jumps and sprint performance). Of note, the athletes' 20m sprint performance improvement was due to an increase in cadence (4.31Hz to 4.39Hz) accompanied by a reduction in Ground Contact Time. Stride length remained the same.

As long as the athlete has a background in plyometrics this is certainly a short term “Peaking” strategy to optimise your athletes' explosive power and sprint acceleration/velocity performance leading up to a major performance.

#### **Paper 4 - Relationship between Achilles Tendon Stiffness and Ground Contact Time during Drop Jumps (2018)**



This paper researched the potential relationship between Achilles tendon stiffness (ATS) and several standard jumping tests (Squat Jump, Countermovement jump, Drop jump (measuring GCT)).

What this study found was that there was a significant correlation between Achilles tendon stiffness & ground contact time but no correlation between ATS and squat jump or counter movement jump.

If we relate this to sprint performance, we know from previous research that Squat jumps/CMJ are high correlated to sprint velocity but the reasons are different than for improvements in GCT (other factors such as force generation & overcoming gravity at ground contact seem to be more important). Whilst having a high ATS assists with reducing GCT which is a key attribute in elite sprinting performance (allowing for greater cadence and increased stride length).

The practical outcomes of this study are that sprint athletes should include both traditional power movements into their training routines (squat jump/CMJ) as well as activities that look to increase ATS (heavy strength training improves tendon stiffness) to continue to reduce GCT during sprint performance.

## Paper 5 - Effects of a sand running surface on the kinematics of sprinting at maximum velocity (2011)



For those of you who have been involved in T&F for a long time, may remember the spate of beach sprinters who made the successful transition to T&F sprinting in the 1990's - what all these sprinters were reknown for was their incredibly high sprint cadence.

The results of this study reinforces why these athletes had such a high cadence whilst sprinting as it was due to the changing physical demands when sprinting on soft sand.

When sprinting on sand the athletes tended to 'sit' during the ground contact phase of the stride. This action was characterized by a lower center of mass, a greater forward lean in the trunk, and an incomplete extension of the hip joint at take-off.

Due to the lack of Ground Reaction Forces (GRF) being applied back up the body with each ground contact (Due to the sand giving way at each foot strike) the athlete can't rely on the GRF to propel them to their next step like they would on an athletics track. Also they can't remain high because of the absorption effect of each ground contact and there is little benefit in pushing off as the ground gives way leading to an inefficiency in power generation.

As such these athletes need to focus on speeding up their stride rate to compensate for the reduction in stride length and lack of "free force" generated from the GRF at each ground contact.

Whilst the technical limitations of this form of sprinting are not great long term for any sprint athlete, if you have an athlete that has below average cadence ( $<4.3$  strides/sec) then if you have the opportunity to have them sprint regularly on soft sand, this is a great way of having them have to focus on this particular attribute which may help them improve overall sprint performance when back on the athletics track.

If you like this content, check out my second Speed & Plyometrics Review of the Literature:

<https://fatchfitness.com/review-of-the-literature-2-september-2021/>

For an excellent review of the available literature on plyometrics you can't go past an excellent overview from Strength & Conditioning Research ([Plyometrics](#)).

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