# PHASE-SPECIFIC CHARACTERISTICS OF COUNTERMOVEMENT VERTICAL JUMPS AND CLUB HEAD SPEED CAPABILITY OF DIVISION II GOLFERS

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## Introduction

Countermovement vertical jumps (CMVJ) are often used to predict club head speed (CHS) in golfers of varying skill. Past studies have established relationships between some CMVJ metrics and CHS; however, the CMVJ is a complex motor skill that is highly dependent on experience level and execution (e.g. jump strategy and force application). The lack of consideration for these factors in past studies could provide false-positives for CHS predictability and limit the utility of CMVJ tests in golfers. In this study, we sought to: (a) identify CMVJ phase-specific characteristics that distinguish 'good' and 'poor' jumpers defined by reactive strength index (RSI = jump height divided by jump time) and (b) compare CHS between golfers that are 'good' and 'poor' jumpers based on the RSI criteria.

## Methods

Division II male and female golfers (n=18; age: 20±1 y; height: 171.4±4.7 cm; mass: 69.7±17.5 kg; experience: 11±5 y; personal best round: 66±2 strokes) completed the study. Participants completed 5 stock shot swings on a FlightScope Mevo+ in an indoor environment with their pitching wedge (PW), 6 iron (6i) and driver to determine CHS. On a separate day, 3 trials of a CMVJ were completed on a force platform. Vertical ground reaction force (GRF) data from the force platform was used to identify the unloading, eccentric yielding, eccentric braking and propulsion phases of the CMVJ. Rate of force development (RFD), vertical GRF, and phase times were computed for each of the respective phases. Jump height, jump time, center-of mass depth, vertical stiffness and vertical momentum were also assessed. Participants were then separated into 'good' (n=9; male=5, female=4) and 'poor' (n=9; male=5, female=4) jumpers based on a median RSI value of 0.32 from the sample. Dependent variables from the CMVJ and CHS were then compared between groups ('good' vs. 'poor') using an independent samples t-test ($p<0.05$) and differences between groups were evaluated using Cohen's D effect sizes (ES large > 0.80).

## Results and Discussion

'Good' jumpers exhibited significantly greater jump height ($p=0.047$; ES=1.04) and RSI scores ($p=0.005$; ES=1.64) compared to 'poor' jumpers with large-magnitude differences. Vertical GRF and RFD during the unloading, eccentric yielding and eccentric braking phases were all significantly greater in 'good' jumpers ($p<0.010$; ES>1.10) with large-magnitude differences. No statistical differences were observed for any other CMVJ metrics between groups ($p>0.05$). Furthermore, no statistical differences were observed between 'good' and 'poor' jumpers for CHS with PW ($p=0.852$), 6i ($p=0.783$), or driver ($p=0.938$). Our results suggest that the CMVJ can distinguish between with 'good' and 'poor' jumping ability and highlights the force application strategies related to CMVJ performance in Division II golfers. Conversely, no differences in CHS across clubs between the 'good' and 'poor' jumpers indicates that CMVJ ability may not be truly representative of CHS capability.

## Significance

The origin and application of a golfer's ability generate force and transfer energy to the golf club is often debated. Many practitioners frequently use CMVJ tests to identify CHS capability in golfers given the reported relationships between CMVJ performance and CHS. While this approach certainly practical, CMVJ performance is highly dependent on experience level and execution. The high variability in CMVJ ability across varying levels of golfers may not truly be representative of the relationship between CMVJ performance and CHS capability. Specifically, CMVJ tests are often over-simplified for ease of data collection and interpretation, but this does not allow for the identification of specific movement patterns (e.g. jump strategy and force application) so that appropriate extrapolation of data can be used to evaluate a golfers true CHS potential. We recommend the use other functional tests to eliminate any technical bias resulting from a lack of experience and that CMVJ ability, jump strategy and force application be evaluated to provide a comprehensive assessment to more accurately predict an individuals CHS capability.

**Table 1.** Club head speed (CHS) and countermovement vertical jump (CMVJ) metrics (mean±SD).

| | Good Jumpers (n=9) | Poor Jumpers (n=9) | p value (effect size) |
|---|---|---|---|
| PW CHS (mph) | 81.7±9.5 | 82.5±7.9 | 0.852 (0.09) |
| 6i CHS (mph) | 89.9±9.4 | 88.7±8.8 | 0.783 (0.13) |
| Driver CHS (mph) | 105.3±13.2 | 105.7±11.3 | 0.938 (0.04) |
| CMVJ Unloading GRF (%BW) | 64.54±6.84 | 49.66±14.12 | 0.012 (1.42) |
| CMVJ Unloading RFD (BW/s) | -2.22±0.84 | -1.10±0.47 | 0.003 (1.71) |
| CMVJ Eccentric Yielding GRF (BW) | 0.60±0.06 | 0.70±0.09 | 0.009 (1.43) |
| CMVJ Eccentric Yielding RFD (BW/s) | 4.58±0.77 | 3.28±1.27 | 0.019 (1.27) |
| CMVJ Eccentric Braking GRF (BW) | 2.05±0.11 | 1.86±0.24 | 0.050 (1.05) |
| CMVJ Eccentric Braking RFD (BW/s) | 5.68±0.81 | 4.26±1.59 | 0.029 (1.19) |