# EFFECTS OF CUTTING WEIGHT VIA SAUNA ON FORCE PRODUCTION AND RATE OF FORCE DEVELOPMENT FOR THE OLYMPIC SNATCH PULL

**Brian R. Budd II and Randall L. Jensen**

**School of Health & Human Performance, Northern Michigan University, Marquette, Michigan, USA**

This study examined the effects of cutting weight on ground reaction force (GRF), rate of force development (RFD) for the snatch pull. Vertical jump (VJ) was also tested compared to normal conditions. Olympic male weightlifters (n=7) used sauna and food/water restrictions (SW) to achieve 1-2% body mass loss. Snatch pull peak vertical GRF, RFD and VJ height after SW didn't differ from control pulls (p >0.05). Mean (±SD) GRF for control = 2405 ± 381 N; while after cutting weight and sauna = 2241 ± 404 N. VJ control after pulls mean = 56.0 ± 9.7 cm. Vertical jump on the weight cut day after pulls mean = 58.0 ± 9.2 cm. GRF decreased by 12.7% and VJ increased by 3.4% after weight cutting compared to control; however, these performance variables were not significantly different from the control condition (p > 0.05).

**KEYWORDS:** ground reaction force, weightlifting, movement analysis, snatch.

**INTRODUCTION:** The Olympic snatch is a common weightlifting exercise performed recreationally and competitively, using strict form and strength to lift heavy weights from the ground to the floor overhead in one motion (IWF, 2015). In Olympic weightlifting athletes compete in different weight classes and many athletes have to cut weight in order to make weight in their desired class; and do so in order to be more competitive as lifting heavier weights in a lighter class can make for better placing (IWF, 2015). Athletes involved in Olympic weight-class sports (e.g. wrestling, boxing, and weightlifting) use weight loss by dehydration as a very common strategy prior to competition (Clark, Bartok, Sullivan, Schoeller, 2004).
In the sport of Olympic weightlifting athletes must weigh in two hours before competition providing little room for recovery (IWF, 2015). Methods used to cut weight usually consist of food and water restriction and also the sauna, causing dehydration and possibly leading to decreased muscle strength (Adams & Casa, 2013). Forms of voluntary dehydration that the athletes undergo include sweating in a sauna (Pettersson, Ekstrom, Bergor, 2013) or hot bath (Oppliger, Steen, Scott, 2003). However, these rapid weight-loss strategies are associated with negative effects. Short-term weight regulation alters a number of physiologic functions, such as thermoregulation (Sawka, Latzka, Matott, Montain, 1998), cardiovascular function, and metabolism, which are crucial to athletic performance (Fogelholm, 1994). The dehydrated state may lead to increased rates of glycogen breakdown in the exercising muscle, which, in turn, may contribute to earlier onset of fatigue in prolonged exercise (Jeukendrup & Gleeson, 2010). Hypo hydration appears to negatively influence muscular strength, power and high-intensity endurance (Judelson, Maresh, Anderson, Armstrong, Casa, 2007). The purpose of the current study was to determine if cutting weight (1-2% to mimic competition) has an effect on vertical ground reaction force, rate of force development, and vertical jump height compared to normal lifting conditions.

**METHODS:** Seven male collegiate Olympic weightlifting athletes were tested in this study; age = 20.0 ± 1.4 years. All subjects trained at the Olympic level at a University Olympic Training Site. Subjects completed a Physical Activity Readiness Questionnaire and gave informed consent prior to participating in the study. Approval for the use of human subjects was obtained from the university's Institutional Review Board (HS14-625) prior to starting the study. Subjects had performed no strength training within 24 hours of testing and both testing sessions were at the same time of day (morning).
Testing was done on two separate days and was done using two force platforms (OR6-7-2000); Advanced Mechanical Technology, Inc. [AMTI], Watertown, MA). The two force platforms were placed in the middle of a weightlifting platform so that each foot was on one

platform. Following zeroing of the force platforms to the athlete's body weight, ground reaction force data were collected at 1000 Hz, displayed real time, saved and analyzed using AMTI Net Force V2.0 software. Bio Analysis 2.0 (Framingham, MA) was used to further analyze the vertical ground reaction force and rate of force development data, along with Microsoft Excel.

The night prior to both testing days the athlete weighed in in order to calculate body mass (kg) lost while sleeping. Subjects then weighed in each morning before they did the snatch pulls. Day one of testing consisted of weigh in followed by a typical warm up (stretching, plyometrics) of the athlete's choice that they would do before training or competition. On this first day athletes ate or drank as they wished before doing the snatch pulls. After warming up the athlete performed three snatch pulls at 95%, 100%, and 105% 1RM snatch on the force platforms. Rest was 2 minutes between snatch pulls. Following the three snatch pulls athletes did three counter movement vertical jumps. For the vertical jump athletes performed three countermovement jumps touching a measuring tape and subtracting their height plus reach, height for the three jumps was averaged.

The second testing session occurred on a different day and consisted of the athlete cutting body mass (kg) as if for a competition. The athlete weighed in the night before and then weighed in again before cutting body mass (kg) in the sauna. Subjects did not eat or drink anything before the sauna to directly mimic cutting weight for a competition. None of the athletes ate or drank after the sauna before snatch pulls as well. Following morning weigh in athletes used a dry sauna to lose 1-1.5% more body mass than they had weighed that morning. Subject's time in the sauna varied and body mass loss and health of the subjects were closely monitored. Subject's body mass (kg) was checked after every 10 minutes in the sauna. After the 1-1.5% body mass loss was attained, the athletes warmed up and did three snatch pulls at the 95%-100%-105% with 2 minutes between pulls. This was followed by three counter movement vertical jumps.

The peak GRF and RFD values during the snatch pulls were recorded and used for comparison. Statistical analyses via SPSS version 22 consisted of a One-Way repeated Measures ANOVA to compare the different weight conditions. Two-Way Repeated Measures ANOVA was used to examine weight condition by % snatch RM; with Bonferroni's corrections for pairwise comparisons VJ height was also compared via a Paired T-Test. Alpha for all comparisons was set a *priori* at p=.05.

Effect sizes using partial eta$^2$ ($\eta_p^2$) were also obtained for each dependent variable using the formula: $\eta_p^2 = SS_{effect} / (SS_{effect} - SS_{error})$, where $SS_{effect}$ = effect variance and $SS_{error}$ = error variance. Interpretation of effect size was done using a scale for effect size classification based on F-values for effect size and were converted to $\eta_p^2$ using the formula: $F = (\eta_p^2 / (1 - \eta_p^2))^{0.5}$. Consequently, the scale for classification of $\eta_p^2$ was: 0.04 = trivial, 0.041 to 0.249 = small, 0.25 to 0.549 = medium, 0.55 to 0.799 = large, and .0.8 = very large (Comyns, Harrison, Hennessy, & Jensen, 2007).

**RESULTS:** Mean values for body mass (kg) at the different time conditions are displayed in Table 1. One-Way Repeated Measures ANOVA indicated that there were no differences between the morning weight control condition and the weight after the sauna ($p = 0.155$). However, the overall $\eta_p^2$ of 0.758 reflected the differences from the night weight to the weight after the sauna, which was significantly different ($p = 0.009$).

There were no significant differences ($p > 0.05$) for the snatch pull GRF; control mean = 2405 ± 382 N and after cutting body mass and sauna GRF mean = 2241 ± 404 N (see Table 2). The $\eta_p^2$ for % of 1RM and Sauna vs. Control situation was 0.118 and 0.073 respectively, indicating a small effect for both variables.

**Table 1: Mean (± SD) Body Mass (kg) for Control and Sauna Conditions**

| | Night wt. control (kg) | Morning body mass. control (kg) | Night body mass SW (kg) | Morning body mass SW (kg) | Body mass after sauna (kg) |
|---|---|---|---|---|---|
| Weight (kg) | 84.7 ± 22.1 | 85.1 ± 22.1 | 85.9 ± 22.6 | 85.3 ± 22.6 | 84.2 ± 22.3 |
| Percent loss from previous weight | 0% | .70% | 0% | .77% | 1.21% |

**Table 2: Mean (± SD) peak ground reaction force (N) during Sauna or Control condition for 95, 100, and 105% Snatch RM.**

| | 95% Snatch RM | 100% Snatch RM | 105% Snatch RM |
|---|---|---|---|
| Control (N) | 2380 ± 318 | 2405 ± 426 | 2429 ± 400 |
| Sauna (N) | 2221 ± 293 | 2236 ± 497 | 2266 ± 421 |

Similarly the RFD did not differ ($p > 0.05$) for the control = 15.4 ± 5.2 kN/s compared to after weight cutting = 13.4 ± 4.6 kN/s (see Table 3). For the vertical jump the control condition = 56.0 ± 9.7 cm while the weight cut day mean = 58.0 ± 9.2 cm. There was no difference across these conditions ($p > 0.05$). For the Sauna vs Control variable there was a medium effect size $\eta_p^2 = 0.419$; while for the % 1RM there was a small effect size = 0.107.

**Table 3: Mean (± SD) rate of force development (kN/s) during Sauna or Control condition for 95 and 100% Snatch RM.**

| | 95% Snatch RM | 100% Snatch RM |
|---|---|---|
| Control (kN/s) | 15.9 ± 5.2 | 14.8 ± 5.1 |
| Sauna (kN/s) | 14.0 ± 4.6 | 12.8 ± 4.6 |

**DISCUSSION:** Results of the current study indicate that cutting body mass of 1-2% does not decrease strength and did not decrease performance. Cutting weight in order to get into a lower weight class could benefit that athlete's chance of winning while not decreasing their strength or performance. There is minimal research with cutting body mass and the effects it has on anaerobic exercise. Previous research has postulated that the decrease in strength as a result of dehydration is caused by factors affecting the neuromuscular system (Adams & Casa, 2013). Of the available literature examining the effects of dehydration on muscle power for an endurance athlete, the reduction of 3-4% body mass reduces muscular power by about 3% (Judelson, Maresh, Farrell et al, 2007). Further research of a longer work out after the strength athlete has cut body mass needs to be done. A normal Olympic weightlifting competition lasts 2-3 hours; the snatch pulls in this research only took about 30 minutes after the sauna.

There is however an abundance of research on dehydration and cutting body mass in aerobic (endurance) activities. Fatigue toward the end of a prolonged sporting event may result as much from dehydration as from fuel substrate depletion (Maughan, Greenhaff, Leiper, 1997). Exercise performance is impaired when an individual is dehydrated by as little as 2% of body weight (Maughan et al, 1997). Losses in excess of 5% of body weight can decrease the capacity for work by about 30% for endurance activity (Maughan et al, 1997).

Sprinters are comparable to Olympic weightlifters as they both use a high amount of type II muscle fibers for speed and strength (Fry & Schilling, 2003). However sprint athletes are generally less concerned about the effects of dehydration than are endurance athletes. Nevertheless, the capacity to perform high-intensity exercise, which results in exhaustion

within a few minutes, is reduced by as much as 45% by prior dehydration corresponding to a loss of only 2.5% of body weight (Sawka, Young, Cadarette, Levine, Pandolf, 1985).
Vertical jump also took place within 30 minutes of sauna. Sauna bathing may also alleviate pain and improve joint mobility in patients (Hannuksela & Ellahham, 2001). The sauna can increase range of motion in Olympic athletes and help improve over all mobility. In a previous study sauna bathing was beneficial for relief of pain and increased mobility. The mobility was increased since tissues largely comprised of collagen (tendons, fasciae, and articular capsules) become more flexible when exposed to heat (Isomaki, 1988).

**CONCLUSION:** The results of the current study show that a body mass loss of 1-3% from diet and sauna slightly does not change the ground reaction force, rate of force development, or vertical jump. Losing 1-2% body mass does not have an effect on strength or performance which could make it beneficial for an athlete to lose 1-2% body mass for a competition to place higher. Further studies need to be done on longer training sessions and higher amount of body mass loss (4-5%) to see if strength and performance become affected.

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