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## The Competition-Day Preparation Strategies of Strongman Athletes

Winwood, Paul W; Pritchard, Hayden J; Wilson, Daniel; Dudson, Mike; Keogh, Justin W L

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**Title:** THE COMPETITION DAY PREPARATION STRATEGIES OF STRONGMAN  
ATHLETES

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Dr Paul W Winwood

Toi Ohomai Institute of Technology

Windermere Drive

Tauranga 3143

Ph: 08002677659 x8580

Email: [paul.winwood@toihomai.ac.nz](mailto:paul.winwood@toihomai.ac.nz)

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**Authors:** Winwood, P. W<sup>1,2</sup>., Pritchard, H. J<sup>1,3</sup>., Wilson, D<sup>1,2</sup>. Dudson, M<sup>1,2</sup>. and Keogh, J. W. L<sup>4,1,5</sup>.

<sup>1</sup>Sport Performance Research in New Zealand (SPRINZ)

AUT Millennium Institute

AUT University, Auckland

New Zealand

<sup>2</sup>Toi Ohomai Institute of Technology

Department of Sport and Recreation

School of Applied Science

Tauranga

New Zealand

<sup>3</sup>Universal College of Learning

Department of Exercise & Wellness

Faculty of Health & Sciences

Palmerston North

New Zealand

<sup>4</sup>Bond University

Faculty of Health Sciences and Medicine

Gold Coast

Australia

<sup>5</sup>University of the Sunshine Coast

Cluster for Health Improvement

Faculty of Science, Health, Education and Engineering

Queensland

Australia

**Corresponding author:**

Dr Paul W Winwood

Toi Ohomai Institute of Technology

Windermere Drive

Tauranga 3143

Ph: 08002677659 x8580

Email: [paul.winwood@toiohoma.ac.nz](mailto:paul.winwood@toiohoma.ac.nz)

Abstract

This study provides the first empirical evidence of the competition day preparation strategies utilized by strongman athletes. Strongman athletes (n=132) (mean  $\pm$ SD: 33.7  $\pm$ 8.1y, 178.2  $\pm$ 11.1cm, 107.0  $\pm$ 28.6kg, 12.8  $\pm$ 8.0y general resistance training, 5.9  $\pm$ 4.8y strongman implement training) completed a self-reported 4-page internet survey on their usual competition day preparation strategies. Analysis of the overall group and by sex, age, body mass and competitive standard was conducted. Ninety-four percent of strongman athletes utilized warm ups in competition which were generally self-directed. The typical warm up length was 16.0  $\pm$ 8.9min and 8.5  $\pm$ 4.3min was the perceived optimal rest time before the start of an event. The main reasons for warming up were injury prevention, increase activation, and increase blood flow/circulation, temperature and heart rate. Athletes generally stated that; 1) competition warm ups were practiced in training, 2) dynamic stretching, foam rolling and myofascial release work were performed during warm ups, 3) rate of perceived exertion, speed of movement and training load (as a % 1RM) were ways of monitoring warm up intensity, 4) psychological arousal levels needed to increase or be maintained in competition, 5) cognitive strategies were utilized to improve competition performance, and 6) electrolyte drinks, caffeine and pre-workout supplements were commonly used supplements. This data will provide strongman athletes and coaches some insight into common competition day preparation strategies, which may lead to enhanced performances. Future research could compare different competition day preparation strategies in an attempt to further improve strongman competition performance and injury prevention.

## INTRODUCTION

In recent years the sport of strongman has surged in popularity both as a spectator sport and in the active number of competitors. The inclusion of strongman implements and associated strongman training exercises have also become an area of emphasis in the training programs of athletes (53, 60). Strongman is a sport that is similar to the sports of weightlifting, powerlifting, and Highland games where training is primarily focused on the improvement of maximal strength and power to improve competition performance (44, 45, 56). However, unlike the other weight lifting sports which have their standard required lifts to be performed in every competition, strongman competitions are unique in which events can be ever changing and are designed to challenge the athlete's functional strength, endurance, power, and cardiovascular ability. Such differences in the physiological demands of strongman compared to the other weight lifting sports suggest that strongman athletes may utilize unique competition day preparation strategies (i.e. specific warm up, cognitive, and nutrition strategies etc) to help improve competition performance.

In today's modern sporting environment warming up prior to competition is widely accepted as good practice, with athletes and coaches alike believing that warming up is essential for reducing the risk of injury (6, 58) and attaining optimal performance (14, 34). Over the past decade, extensive research has been conducted to better understand the physiological and neural mechanisms associated with the warm up and the subsequent performance changes following different types of warm ups (4, 5, 14, 34). The main outcomes associated with warming up are an increase in muscle temperature (39), muscle metabolism (19), muscle fibre conduction velocity (37),  $VO_2$  kinetics (38), and increases in muscle contractile performance (40). For detail on the physiological mechanisms and effects of warming up on performance, readers are referred to the review articles by Gowan et al. (34) and Fradkin et al. (14) (respectively).

Two major categories of warm up have identified in literature which include passive warm up and active warm up. Passive warm ups involve raising muscle or core temperature by some external means such as hot showers or baths, saunas and heating pads without depleting energy substrates (5). Active warm up involves exercise and is likely to induce greater metabolic and cardiovascular changes than passive warm up (4). The structure, intensity, duration, recovery duration, and specificity of the active warm up will depend on many factors, including the task to be undertaken, the physical capabilities of the athlete, the environmental conditions and also the constraints imposed by the organization of the event (4).

The warm period is also an opportunity for athletes to mentally prepare ('psych-up') for upcoming events and concentrate on the task/s ahead. A number of cognitive strategies typically utilized by athletes are preparatory arousal, imagery, goal setting, attentional focus and positive self-talk (46, 49). Researchers have found that 'psyching up' may increase muscular endurance (20, 30), muscular strength (51, 52), power (18, 21) and athletes task execution (22, 25). However, the effects of psyching up on task execution may be determined by the specific demands of the task (7). Brody and colleagues (7) found no significant differences in isometric elbow flexion force among 15 strength trained men when subjected to three preparatory conditions (psyching, reading aloud, mental arithmetic). Given the technical as well as tactical complexity of the sport of strongman, it is quite likely strongman athletes would utilise a number of cognitive strategies to improve competition performances.

Technological advances over the past decade have facilitated the emergence of new types of warm up strategies such as post-activation potentiation (PAP) techniques. Post-activation potentiation refers to the phenomena in which muscle characteristics are acutely enhanced as a result of prior voluntary contractions (48). A number of factors influence the level of potentiation including;

athletes strength levels and resistance training experience, the type of conditioning activity performed, the loads and number of conditioning sets performed and the rest period before the performance task (43). Post-activation potentiation was a pre-competition strategy (along with; appropriately designed warm-up, passive heat maintenance, remote ischemic pre conditioning, morning exercise and hormonal priming) that Kilduff and colleagues (28) suggested could optimize performance of short duration high intensity sports on competition day. Kilduff et al. (28) suggested that there is an additional window on the day of competition where performance can be acutely enhanced and proposed a theoretical timeline outlining how each conditioning strategy could be incorporated into athlete's pre-competition routine to enhance performance. Given that strongman athletes may have to compete over several hours or days it would be of great interest to determine what competition preparation strategies strongman athletes utilize during this time period.

Researchers have investigated the training (56) and tapering practices (54) of strongman athletes. While these studies provide insight into how strongman athletes train and periodize their training to prepare themselves for the physiological stresses of competition, no data exists in the scientific literature on the competition day preparation strategies these athletes employ. As strongman athletes may be at greater risk for injury during competition than training (55), it is important to determine what preparation strategies are utilized to minimize injury and optimize strongman competition performance. The purpose of this study was to determine a) what competition day strategies strongman athletes utilize and how they are implemented on the basis of the athletes sex, age, body mass and competitive standard and b) to determine if competition strategies differ between common strongman events (i.e. farmers walk, log lift/press and stone lifts/work). It was hypothesized that strongman athletes would perform specific warm ups prior to strongman events and utilise cognitive and nutritional strategies to improve competition performance, with only relatively minor differences between athletes of different sex, age, body mass and competitive standards.



## METHODS

### Experimental approach to the problem

A comprehensive strongman competition day preparation strategies survey was administered online and aimed at identifying the competition day strategies utilized by strongman athletes. The research hypothesis was that the majority of strongman athletes responding to the online survey would perform warm ups prior to strongman events and utilise cognitive and nutritional strategies to improve competition performance. *The competition day preparation strategies* survey created for this study was adapted from questions previously used with strongman athletes tapering practices (54), competition day preparation strategies of swimmers (33) and the performance strategies of US Olympians (46). A test retest reliability study performed with 64 strongman athletes demonstrated that online surveys can provide stable and reliable answers for most questions (57).

### Participant recruitment

Strongmen athletes were recruited through professional networks and multimedia methods similar to previously described procedures (54-56). Strongman athletes were sent a letter via 'Facebook Messenger' which contained an invitation to participate in the research and the link to the online survey. Presidents of the 'World Strongman Federation' and 'Strongman Corporation' emailed the survey link to their club members. Strongman clubs in New Zealand, Australia, Europe, USA and the United Kingdom were also contacted and asked to distribute the survey link to their club members. An information sheet outlining the objectives and purpose of the study was situated on the first page of the online survey. Participants were asked to indicate their consent by participating in the survey. The software used allowed participants to exit the survey at any time and complete at a later date, allowing participants to provide their data at the time most suitable to them. Surveygizmo.com was used to launch the electronic survey on the internet. The methods and

procedures used in this study were approved by the Institutional Review Board Committee (TRC 2017.056).

### Participants

Two hundred and fifty-four participants accessed the online survey, which included those that observed the survey, partially completed the survey, and the 132 (52%) that completed the survey. Participant inclusion criteria were male and female strongman athletes who were between 18 and 60 years old and had competed in at least one strongman competition. The criterion for a completed survey was that the participants completed the first two sections of the questionnaire on demographics/background information and warm up strategies.

### Research instrument

Strongman athletes completed a self-reported 4-page, 32-item, retrospective *Competition Day Preparation Strategies* survey (Appendix 1) created for this study based on questions previously used with strongman athletes (54), swimmers (33) and US Olympians (46). The competition day preparation strategies survey was pilot tested with research associates from various universities, and two strongman athletes to ensure its ease of use with this population. As a result of the pilot testing, the survey was modified by adding additional questions, as well as improving the wording of a small number of questions before it was made available for the main study.

The strongman competition day preparation strategies survey consisted of four main areas of inquiry; 1) demographics and background information; 2) warm up strategies; 3) cognitive strategies; and 4) other competition strategies. Background information included questions on age, gender, height, body mass, resistance training experience, strongman training experience, and competitive level. The warm up strategies section included questions pertaining to purposes of the

warm up, warm up length, training intensity and rest periods between sets and whether the warm up was self-directed or coach led. Warm up strategies were defined as “the physical preparation performed before the start of a strongman event/competition”. Participants were asked to detail their common/typical values for each question. The cognitive strategies section included questions on psych arousal and the use of previously defined cognitive strategies (e.g. positive self-talk, emotional control, automaticity, and goal setting) used in research (46, 49). Cognitive strategies were defined as "self-directed mental interventions used prior to or during the execution of a strongman event to enhance strongman competition performance" (50). The other competition strategies section included questions on other types of strategies performed (e.g. sports massage, stretching etc.), supplements and substances used, and nutritional strategies incorporated on competition day. Closed questions were used for Sections 1 and 3, with open and closed questions used for Section 2 and 4. For sections 2, 3 and 4, additional comments could be made by athletes for the majority of questions.

### Statistical analyses

Means and standard deviations were calculated for demographics, training, and warm up characteristics. Frequencies of responses were collated for questions related to warm up practices, cognitive and nutrition strategies and supplement/substance use of strongman athletes. Categorical and ordinal data were reported as both absolute numbers and percentage of responses.

Answers to open-ended questions and comments associated with closed questions were content analysed by investigators who were experienced with qualitative methods of sports science research and content analysis (54). During data analysis, investigators generated raw data and higher-order themes via independent, inductive content analysis and compared independently generated themes until consensus was reached at each level of analysis. At the point of development of higher-order themes, deductive analysis was used to confirm that all raw data themes were represented. In some

cases, the participants provided greater depth of information that represented more than one concept and hence responses contributed to more than one higher order theme.

Demographics and training experience were calculated for all participants. The subgroups of sex, age ( $\leq 30$  y and  $>30$  y), male body mass (lightweight  $<105$  kg and heavyweight  $\geq 105$  kg) and competitive standard (local/regional amateur, high level amateur, international level) were calculated based on those previously reported in strongman research for male athletes (55). The body mass classes of female participants (light to middle weight  $<80$  kg and middle to heavyweight  $\geq 80$  kg) were chosen post-hoc to allow for a similar sample size for group comparisons and reflect the approximate female body mass class divisions typically seen in strongman. A 2-tailed unequal variance *t*-test was used to determine if any statistical differences ( $p \leq 0.01$ ) existed in the demographics and training experience of the strongman athletes as a function of sex, age and body mass. A one-way ANOVA with Games Howell post hoc tests were used to determine if statistical differences existed among competitive standards. For data that did not follow normal distribution, the Mann Whitney and Kruskal Wallis (with Bonferroni post hoc pairwise comparisons) non-parametric tests were used (respectively).

Differences among the subgroups regarding the use of passive warm ups, post activation potentiation (PAP), practising competition warm ups in training and whether the athletes warmed up for every event were analysed with a Chi-square test. Repeated measures ANOVA with Bonferroni pairwise comparisons were used to determine if any statistical differences existed among strongman events (farmers walk, log lift/press and stone lifts/work) in regard to number of warm up sets, distance/repetitions performed, loads used (as a % 1RM) and rest periods utilized between sets. Significance was accepted at the  $p \leq 0.01$  level. All statistical analyses were performed using

SPSS 22.0 for Windows (SPSS Inc., Chicago, IL, USA) and higher order themes were generated using Microsoft Excel (version 9.0; Microsoft, Seattle, WA).

## RESULTS

### *Demographics, training characteristics and warm up length*

One hundred and thirty-two strongman athletes from 18 countries completed the survey. The majority of athletes were from the United States (61%), Australia (12%) and Canada (9%). Demographics and training experience of the participants (n = 132) are presented in Table 1. The strongman athletes were (mean  $\pm$ SD) 33.7  $\pm$ 8.1 y, 178.2  $\pm$ 11.1 cm, 107.0  $\pm$ 28.6 kg, and had 12.8  $\pm$ 8.0 y general resistance training experience. The average strongman implement training experience and years competing in strongman amongst all lifters was 5.9  $\pm$ 4.8 years and 5.4  $\pm$ 4.7 years, respectively. Strongman athletes indicated their typical warm up length was 16  $\pm$ 8.9 min and 8.5  $\pm$ 4.3 min was the mean time between the end of competition warm up and subsequent strongman event.

Subgroup analyses revealed that males had significantly greater resistance training experience (y) (14.6  $\pm$ 7.5 versus 7.0  $\pm$ 4.9), strongman training experience (y) (6.4  $\pm$ 4.7 versus 3.4  $\pm$ 2.0), and years competing in the sport of strongman (5.9  $\pm$ 4.5 versus 3.3  $\pm$ 1.9), than females. Differences were also observed among local/regional athletes who had significantly less ( $p \leq 0.01$ ) strongman training experience (3.6  $\pm$ 2.4 versus 7.2  $\pm$ 5.4) and years competing in the sport of strongman (3.1  $\pm$ 4.4 versus 7.2  $\pm$ 5.3) than international level athletes. Male and female athletes in the heavier body mass classes were significantly heavier than their lighter counterparts, and heavier male athletes were significantly taller (186.5  $\pm$ 8.4 versus 176.8  $\pm$ 6.0) than lighter male athletes.

*Please insert Table 1 about here*

*Warm up characteristics*

Ninety-four percent of strongman athletes indicated that they utilized a warm up in strongman competitions with 6% (n=8) of athletes indicated that they only sometimes warm up. Of the 132 strongman athletes in this study, 90% (n=119) indicated that their warm ups were self-directed while 8% (n=10) indicated their warm ups were coach led. The main reasons and purposes reported by strongman athletes for warming up are presented in Table 2. The three main themes emerging from the data were injury prevention, increase activation, and increase blood flow/circulation, temperature and heart rate.

*Please Insert Table 2 about here*

The competition warm up characteristics of strongman athletes are reported in Table 3. Eighty one percent of athletes indicated that they warmed up or sometimes warmed up for every strongman event during a single competition. The most common reason stated for warming up for every event were; the long rest times between events (athletes had to get warm again), injury prevention, and the technical aspect and loads associated with the events require practicing the specific movement patterns. Significant differences were observed between female body mass classes ( $\chi^2 = 9.47$ , degrees of freedom [df] = 2,  $p < 0.009$ ) with a higher percentage of lighter females (94% versus 47%) warming up for every event than heavier females.

The majority of athletes (71%, n=94) practiced their competition warm ups as part of their normal training. Differences that approached significance were observed for competition standard with a higher percentage of high level amateur athletes practicing competition warm ups (84%) as part of their normal training than local/regional level athletes (65%) and international level athletes (57%).

Athletes generally reported not using post activation potentiation (64%; n=84) or passive warm up techniques (77%, n=101) as part of their warm ups. Athletes (23%, n=31) that stated they utilized passive warm ups techniques on competition day or prior to competition provided information on the type of strategies they used. The most common strategies utilized were; warm up creams, saunas or spas, hot baths or showers, heated pads or heated car seats, car heaters and clothing (e.g. compression garments & warm clothing).

***Please Insert Table 3 about here***

*Strategies utilised in the warm up*

Strongman athletes reported what types of strategies they utilized to monitor exercise intensity during the warm-up. A summary of these responses is presented in Figure 1. Rate of perceived exertion, speed of movement and training load (as a %1RM) were the most common types of monitoring of exercise intensity during the warm-up. ‘Other’ types of strategies included answers associated with warming up by feel (e.g. mobility/range of motion, ease of movement and energetic preparedness).

***Please insert Figure 1 about here***

Strongman athletes reported what types of strategies they utilized in their warm-up. A summary of these responses is presented in Figure 2. Dynamic stretching, foam rolling, and myofascial release work were the most common types of strategies performed. ‘Other’ types of strategies included: muscle activation drills, breathing techniques, soft tissue mobilization tools, and traction.

***Please insert Figure 2 about here***

*Activities performed post warm up*

Strongman athletes reported what types of activities they performed following completion of the warm-up. A summary of these responses is presented in Figure 3. Walk around, listen to music and sit down were the most common types of activities performed. ‘Other’ types of activities included: visualization of events, eat food and drink fluids, keep warm and mobile, and lay down and talk to people.

*Please insert Figure 3 about here*

Strongman athletes reported average warm up information for the farmers walk, log lift/press and stone lifts/work events (see Table 4). Significant between exercise differences ( $p < 0.001$ ) were observed among the three strongman events for the number of warm up sets performed. A significant difference ( $p < 0.001$ ) was also observed between the log lift/press and stones lift/work with a higher number of repetitions typically performed in the log lift ( $2.8 \pm 1.1$  versus  $1.9 \pm 1.4$ ). No statistical differences were observed between loads used (%1RM) and rest periods utilized between sets.

*Please insert Table 4 about here**Why warm ups haven't worked*

Strongman athletes were asked to specify when warm ups haven't worked, what went wrong and why. A summary of their responses is presented in Table 5. Lack of time or time warming up, time



between warm up, and event and logistical issues were the most common themes reported by strongman athletes.

*Please insert Table 5 about here*

#### *Recovery between warm up and event*

Strongman athletes were asked had there been any circumstances that affected their recovery time between the end of their warm-up and the start of their event/s. Almost half of the strongman athletes (46%) reported that there were circumstances that affected their recovery time. The most common issues reported were; unexpected changes (i.e. the event started earlier or later than expected), logistical issues (i.e. number of competitors, order of competitors, and event planning issues), temperature (i.e. extreme hot or cold), dehydration and mental stress/distractions.

#### *Cognitive strategies*

Strongman athletes reported what they felt they needed to do regarding psych arousal level to improve strongman competition performance. A summary of these responses is presented in Figure 4. The majority of athletes reported that they needed to increase or maintain psych arousal levels. The most common themes reported by strongman athletes were; immediately increase psych arousal prior to lifting and stay calm and collected when not lifting to conserve energy. Athletes that chose 'other' reported that they increased and reduced psych arousal levels throughout the day and psych arousal levels were dependant on the event.

*Please insert Figure 4 about here*

Strongman athletes reported numbers on a psych up level scale (with 1 being totally relaxed to 10 being totally psyched up) which they believed was best for their optimal strongman competition performance. A summary of these responses is presented in Figure 5. The majority of athletes reported numbers at the higher end of the scale with '8' being the most commonly reported number. Athletes provide comments on their psych arousal levels. The most common themes reported by athletes were; psych arousal was vitally important for successful competition performance, but too much psych arousal can lead to losing focus, poor technique and increase risk of injury.

*Please insert Figure 5 about here*

Strongman athletes were asked to indicate their use of each cognitive strategies (i.e. always use, sometimes use, never use) prior to strongman competition events. A summary of these responses is reported in Figure 6. The most common cognitive strategies always used by the majority of strongman athletes were attentional control, goal setting, mental imagery, preparatory arousal, emotional control and positive self-talk.

*Please insert Figure 6 about here*

### *Nutritional Strategies*

Strongman athletes were asked to indicate their use of nutritional strategies associated with competition day. A summary of these responses is reported in Table 6. The most common nutrition strategies utilized by strongman athletes included a focus on carbohydrate intake (i.e. the use of simple sugars, fruit, high carbohydrate meals/snacks, glucose tablets, and pre-event carbohydrate loading), specific meal characteristics (i.e. easily digested foods, high energy foods, eating between events, eat when hungry, preloading, liquid form, small and regular, and pre-prepared

snacks/meals), protein intake (i.e. protein bars, protein shakes, and high protein intake) and fluid and electrolyte intake.

***Please insert Table 6 about here***

#### *Supplements and Substance Use*

Strongman athletes were asked to indicate which supplements/substances they generally use on competition day. A summary of their responses is reported in Figure 7. Electrolyte drinks, caffeine and pre-workout supplements were used by the majority of athletes. Athletes that chose ‘other’ reported using glucose drinks, tablets or powder, whey protein drinks or powder and intra-workout supplements.

***Please insert Figure 7 about here***

#### *Additional information given by strongman athletes*

Strongman athletes were asked if there was any additional information on their competition day preparation that would like to add. A summary of their responses is presented in Table 7. Other strategies, nutrition/hydration/supplements and equipment/clothing were the most common themes presented.

***Please insert Table 7 about here***

## DISCUSSION

Literature on competition day preparation strategies utilized by strength athletes is limited. The current study is the first to document the competition day preparation strategies employed by strongman athletes. The majority of strongman athletes indicated that they utilized a warm up (average length  $16.9 \pm 8.9$  min) in strongman competitions and that their warm ups were self-directed.. The three main reasons for warming up were injury prevention, increase activation, and increase blood flow/circulation, temperature and heart rate. The majority of athletes practiced their competition warm ups as part of their normal training and warm ups were event specific. Rate of perceived exertion, speed of movement and training load (as a %1RM) were the most common methods utilized to monitor warm up intensity and dynamic stretching, foam rolling, and myofascial release work were common types of strategies utilized in the warm up. The majority of strongman athletes reported that they needed to increase or maintain psych arousal levels for competition and utilized a range of cognitive strategies with attentional control, goal setting, mental imagery, preparatory arousal, and emotional control being the most common. Nutritional and supplement strategies were used by the majority of strongman athletes. The findings support the initial hypothesis that the majority of strongman athletes responding to the online survey performed specific warm ups prior to strongman events and utilized cognitive and nutritional strategies to improve competition performance.

Ninety-four percent of strongman athletes indicated that they utilized a warm up in strongman competitions and the typical warm up length was  $16 \pm 8.9$  min. Researchers have suggested that a warm up for improving short-term performance in aerobic (running, cycling and swimming) and team sports (football and rugby) should be approximately 10 to 20 minutes with an exercise intensity below  $60\% \text{VO}_{2\text{max}}$  (4), or if less than 15-minutes, the warm up should have an aerobic portion with 4-5 activation race/event pace efforts (33). Such warm ups are likely to cause minimal

phosphate depletion, maximise the increase in muscle temperature and significantly improve short term performance (4). Further research is needed to investigate the effectiveness of different types of strength specific warm ups for the strength sports and how these may differ to the recommendations for aerobic and team sports.

The main reasons strongman athletes reported for warming up were injury prevention, increase activation, and increase blood flow/circulation, temperature and heart rate. Researchers have demonstrated that warm ups can reduce the risk of injury (6, 58), increase muscle temperature (36) and neuromuscular function (39, 40) and stimulate changes in the mechanisms underlying both anaerobic and aerobic metabolism (8, 26). Muscle temperature related mechanisms associated with the warm up may have the strongest associations with performance improvements. Researchers have demonstrated that a 1°C increase in muscle temperature enhances subsequent performance by 2-5%, depending on the type and velocity of contractions (3, 39, 42), with the magnitude of muscle temperature response being positively related to movement velocity (42). However, if central temperature increases, too high this positive relation ceases and performance becomes impaired (42). This potential for overheating may be a particular concern in strongman, especially for competitors in the heavyweight classes when competing in a hot and humid conditions as a result of their propensity to generate and maintain core temperature due to the exceedingly high body mass and body mass to surface area ratio (1).

In the current study only 23% (n = 31) of strongman athletes utilized passive warm up techniques. Such a result is surprising considering that passive warm up techniques have been shown to improve dynamic force of short to intermediate duration (<10 sec to 5 min) (5). It may be that some passive warm up techniques (i.e. hot showers, baths, saunas) may be impractical for the majority of these athletes (5). Passive warm up techniques such as warm up creams and heating pads may be more

useful especially in colder competition environments to help athletes better prepare for the active warm up. The use of heating pads could be useful to be used between the end of the warm up and competition event (i.e. recovery duration). Researchers have shown significant improvements in sprint cycling peak ( $\uparrow 9.6\%$ ) and relative power output ( $\uparrow 9.1\%$ ) compared to the control group when heating pads were worn during the recovery duration (12).

The length of the recovery duration is important to optimize competition performance. The recovery duration needs to be long enough ( $>5$  min) for the resynthesis of PCr stores (9) and short enough ( $<15$  min) so that muscle temperature does not drop significantly (41). Strongman athletes in this study fell within this optimal duration, reporting that  $8.5 \pm 4.3$  min was the optimal mean time between the end of competition warm up and subsequent strongman event. This time period may likely provide the greatest ergogenic effect on their strongman performance.

Interestingly, the majority of strongman athletes (64%) reported not using post activation potentiation techniques as part of their warm up. While research has demonstrated that it is possible to enhance mechanical power and performance of an explosive activity utilizing PAP (48), research is needed to establish how the mechanisms of PAP and fatigue interact under different conditions before athletes can effectively apply PAP to improving acute strongman competitive performance.

Strongman athletes reported that they used rate of perceived exertion (RPE), speed of movement and training load (as a % 1RM) as ways of monitoring their exercise intensity during the warm-up. Researchers have demonstrated that RPE is a reliable method to quantify various intensities of resistance training (10). Interestingly, relatively few athletes (18%) reported using heart rate as a way of monitoring warm up intensity. While heart rate is a common method of monitoring exercise intensities during endurance training (16), heart rate has been described as a relatively poor method

of evaluating high intensity exercise such as resistance training (13). Rate of perceived exertion, speed of movement and training load may be more valid strategies for strongman athletes for quantitating warm up intensity for various strongman events.

The majority of strongman athletes reported using dynamic stretching, foam rolling, and myofascial release work as strategies performed in the warm up. Researchers have demonstrated that these strategies are effective for improving range of motion and joint mobility (2, 35), which may be beneficial for strongman events such as the log lift and stone lift. While the effect of these strategies on performance is not clear, such strategies may help reduce the feeling of post exercise fatigue (23) and relieve acute sensations of muscle tightness which may be beneficial for strongman athletes competing in a number of events over long time periods.

In the current study 81% of strongman athletes reported that they warmed up or sometimes warmed up for every strongman event during a single competition. While no literature has investigated repeated competition warm ups among the strength sports (i.e. strongman, Highland Games, weightlifting and powerlifting) the use of half time re-warm up strategies has been shown to enhance performance parameters in soccer players (11, 61). Given the longer rest times between events and the technical aspects and loads associated with strongman competition events, re-warming up and practicing the specific movement patterns of each event may provide further ergogenic benefits by priming neural pathways and increasing neuromuscular activation (15).

Differences in warm up were observed among the farmers walk ( $2.7 \pm 1.0$ ), log lift/press ( $3.8 \pm 1.2$ ) and stones lift/work ( $2.2 \pm 1.3$ ) for the number of sets performed and between the log lift/press and stones lift/work ( $2.8 \pm 1.1$  versus  $1.9 \pm 1.4$ ) for the number of repetitions performed. Such differences may give insight into the unique technical and physiological demands of each

strongman event (59) and the preparation needed for each event. Strongman athletes reported that warm ups can also be influenced by a number of factors including; the amount of time given to warm up, logistics (i.e. number of competitors, space/venue, how the competition and events are planned, and implement types i.e. adjustable/nonadjustable) and temperature (i.e. extreme hot or cold).

While warm ups physiologically prepare athletes they also provide valuable time for athletes to mentally prepare (psych-up) for competition and allow athletes to obtain the appropriate activation state (5). Psyching up has been defined as the use of self-directed cognitive strategies designed to enhance physical performance (50). The majority of strongman athletes in this study reported that they needed to increase or maintain psych arousal levels. Athletes reported that psych arousal was vital for successful competition performance and needed to be immediately increased prior to lifting and decreased when not lifting to conserve energy. Conversely, athletes reported that too much psych arousal can lead to losing focus, poor technique and increased risk of injury.

Strongman athletes identified the most common cognitive strategies always used were attentional control, goal setting, mental imagery, preparatory arousal, emotional control and positive self-talk. These cognitive strategies were reported to be utilized by US Olympians in practice and competition and were reported to enhance the display of muscular strength (46). Such findings suggest that strongman athletes utilize a number of effective cognitive strategies to optimize strongman competition performance.

Nutritional strategies were also utilized by strongman athletes to optimize strongman competition performance. One of the most important factors to optimize competition performance through nutrition is to ensure caloric intake offsets energy expenditure (31). Meeting caloric needs may be



difficult for strongman athletes who are engaged in intense physical activities over prolonged periods. It has been recommended that athletes who are involved in high volume intense training need greater amounts of carbohydrate (complex carbohydrates and concentrated carbohydrate drinks/supplements) and protein in their diet to meet macronutrient needs (29). The use of carbohydrates before, during and in-between events may enhance carbohydrate availability (47), while protein can be beneficial for increasing the rates of protein synthesis, decreasing the rate of protein degradation and aiding in the improved recovery from exercise (29).

In addition to ensuring appropriate carbohydrate availability throughout the day (47), it is also critical that athletes consume a sufficient amount of water and/or sports drinks (containing glucose and electrolytes) during exercise in order to maintain hydration status (29). The amount of hydration needed can be influenced by temperature, humidity, exercise intensity and the athletes sweat response to exercise (32). Based on the high body mass and body mass to surface area ratio of heavier strongman athletes, strongman competitors may require large intakes of water and/or sports drinks when competing in hot and humid environments.

Stimulants such as caffeine and pre-workout drinks were reported to be commonly used supplements by strongman athletes. Pre-workout drinks contain a combination of key ingredients such as creatine monohydrate, amino acids, betaine, selected botanicals and plant extracts, carbohydrates, and caffeine, which may elicit a synergistic effect on acute exercise performance and subsequent training adaptations compared to single ingredients alone (24). A review of caffeine and sports performance by Goldstein and colleagues (17) found that caffeine enhanced several different modes of exercise performance including endurance, high-intensity team sport activity, and strength-power performance, however its effect on sport performance can be influenced by the condition of the athlete as well as the intensity, duration, and mode of exercise. Caffeine is also

commonly used and accepted among athletes for its ability to promote wakefulness, enhance focus and concentration and to prevent the central perception of fatigue (27). Given the unique and physiological demands strongman athletes endure on competition day it is quite likely strongman athletes utilize these supplements as strategies to positively affect cognitive and physical performances.

### PRACTICAL APPLICATIONS

This article serves as the first comprehensive description of the competition day preparation strategies strongman athletes employ. The information in the current study will serve to help strongman athletes, strength athletes, coaches, and sports scientists in achieving the optimum physiological and cognitive states for competition.

To warm up successfully, strongman athletes should perform event specific warm ups between 15 to 20 min to increase blood flow, temperature, heart rate and muscular activation. The use of dynamic stretching, foam rolling, and myofascial release work can be included in the warm up to assist mobility. Strongman athletes should also complete number of progressively heavier sets of the upcoming strongman event in order to practice the specific techniques required in the upcoming event and to have the appropriate level of psych arousal. Rate of perceived exertion, speed of movement and training load (as a % 1RM) can be used to monitor warm up intensity.

It is recommended that athletes utilize a number of cognitive strategies including attentional control, goal setting, mental imagery, preparatory arousal, emotional control and positive self-talk to enhance strength performance. The use of caffeine or pre-workout drinks may assist in the enhancement of cognitive function and improved exercise performance.

Caloric intake needs to offset energy expenditure, eating carbohydrates and proteins before, during and in-between events may enhance carbohydrate availability and assist in the improved recovery from exercise. Temperature, humidity, exercise intensity and sweat response to exercise will influence an athlete's hydration status, consuming sufficient amounts of water and/or sports drinks throughout the competition day may help to maintain hydration status.

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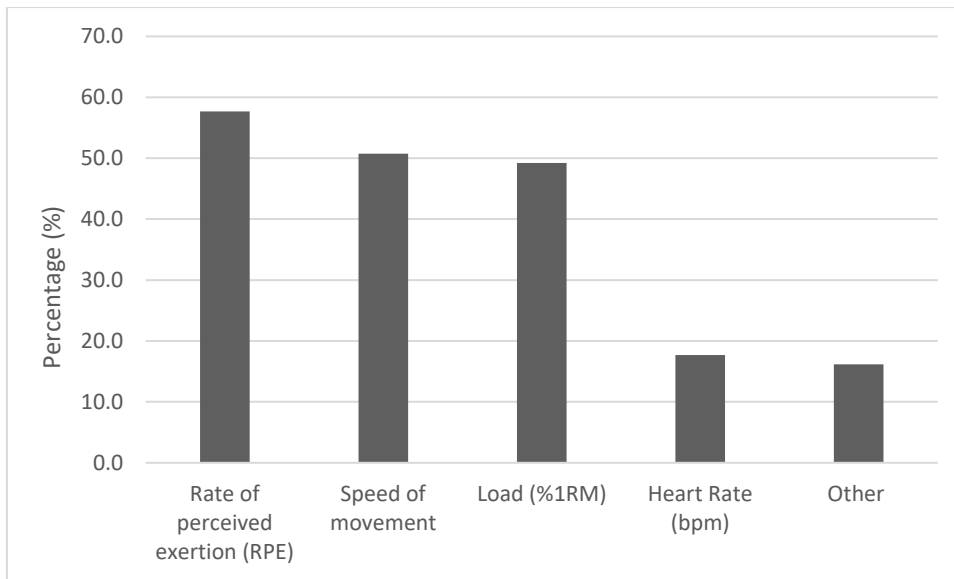
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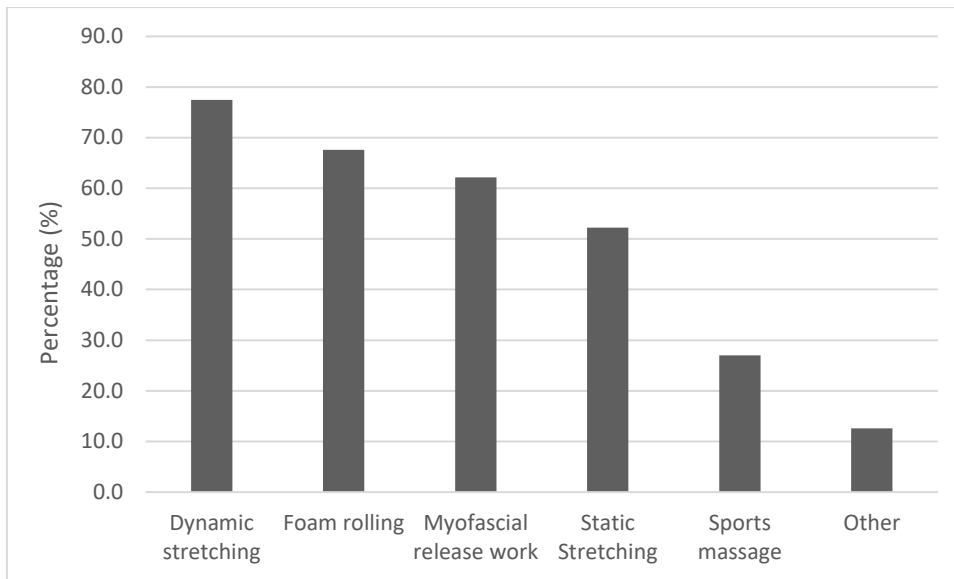
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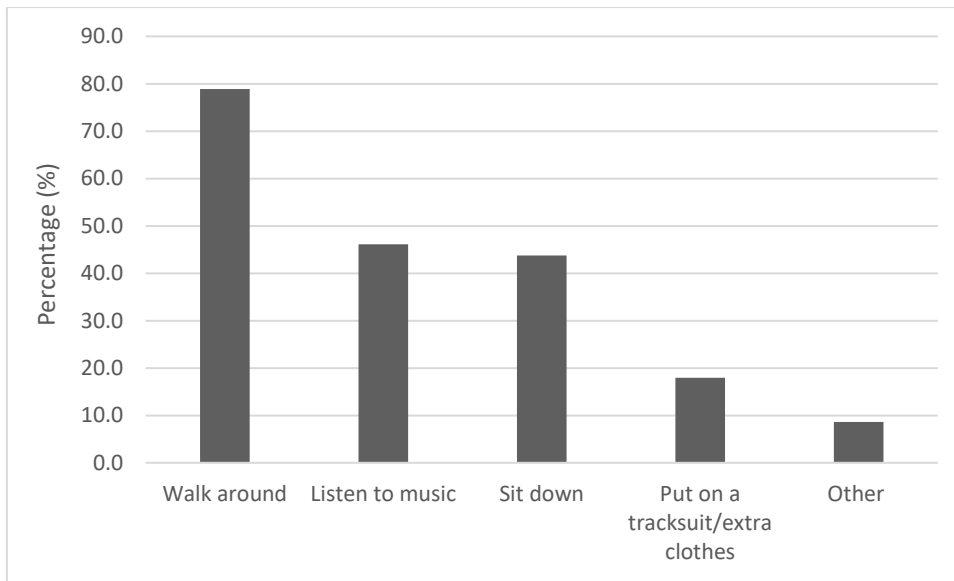


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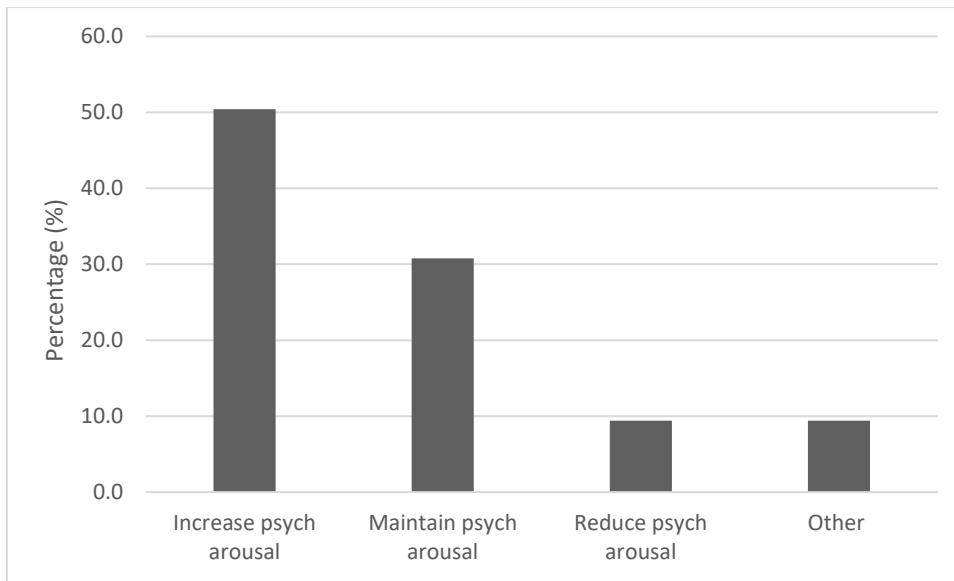




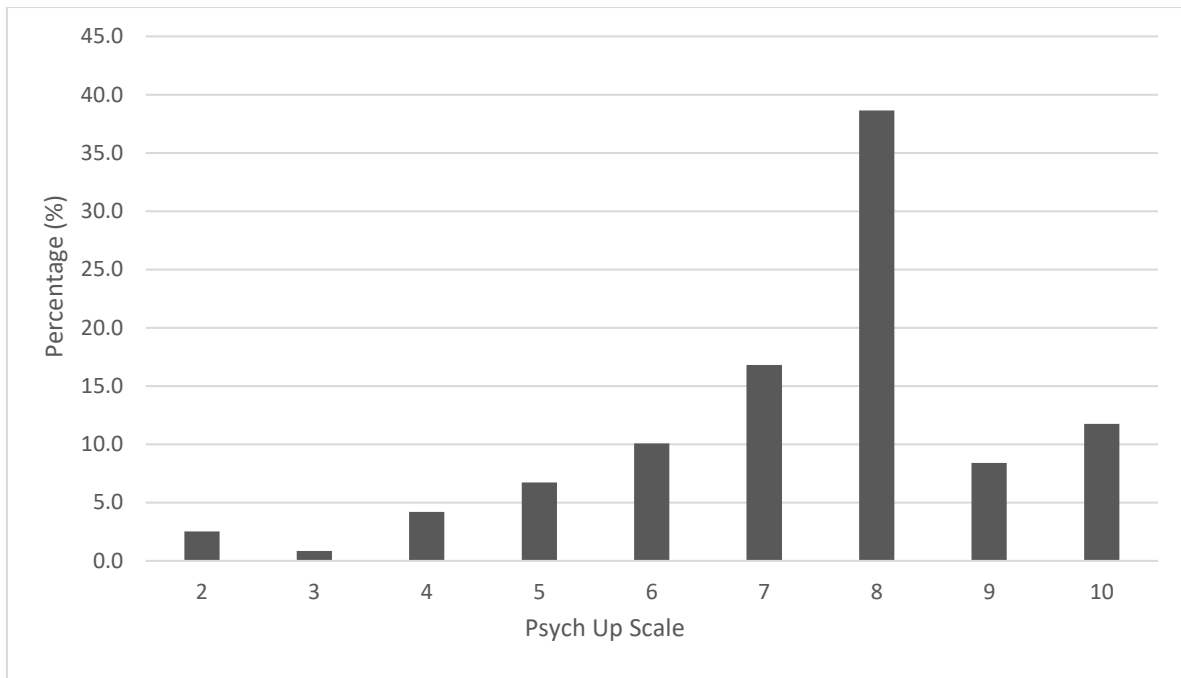
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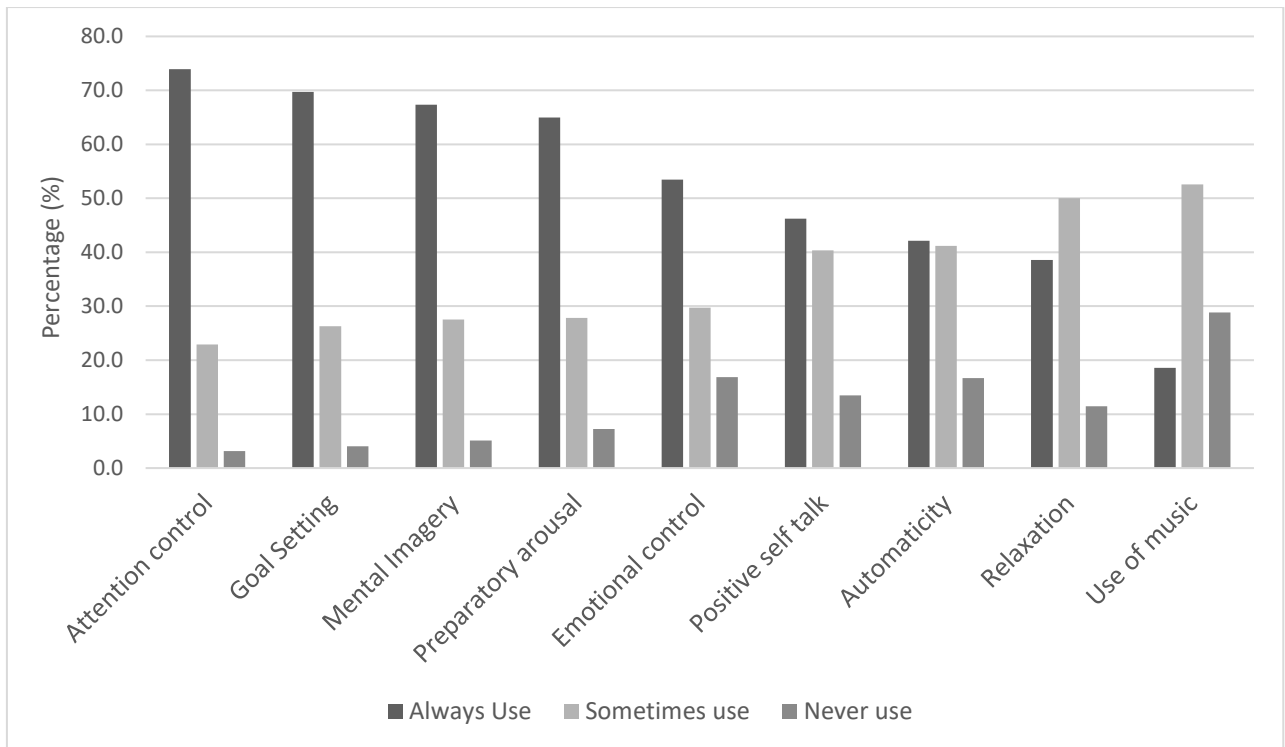
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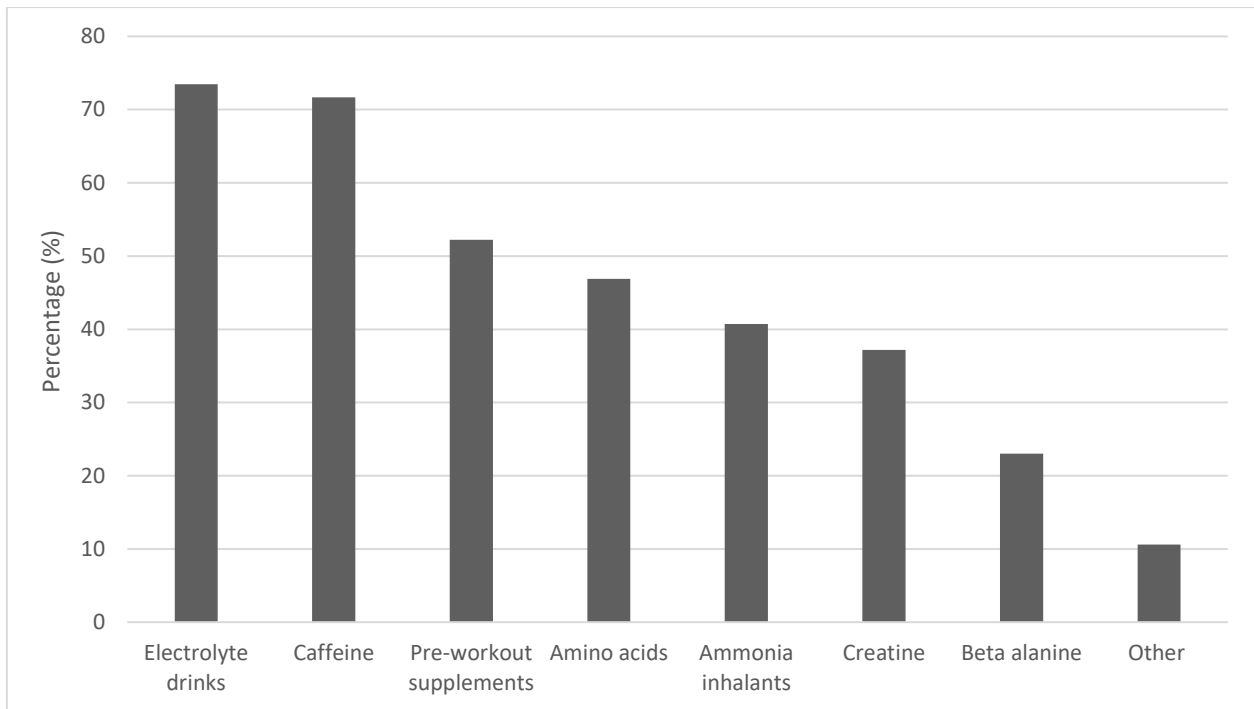
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**Table 1:** Demographics, training experience and warm up length (mean  $\pm$ SD) for strongman athletes (n = 132).

|  | Sex                              |                  | Body Mass                      |                        |                               |                    | Age                          |                      | Competitive standard        |                                 |                             |                              |
|--|----------------------------------|------------------|--------------------------------|------------------------|-------------------------------|--------------------|------------------------------|----------------------|-----------------------------|---------------------------------|-----------------------------|------------------------------|
|  | All strongman athletes (n = 132) | Male (n = 98)    | Female (n = 34)                | Male (n = 98)          |                               | Female (n = 34)    |                              | $\leq 30$ y (n = 51) | $> 30$ y (n = 81)           | Local/regional amateur (n = 34) | High Level amateur (n = 61) | International Level (n = 37) |
|  |                                  |                  |                                | $\leq 105$ kg (n = 43) | $> 105$ kg (n = 55)           | $< 80$ kg (n = 17) | $\geq 80$ kg (n = 17)        |                      |                             |                                 |                             |                              |
| <i>Demographics</i>                          |                                  |                  |                                |                        |                               |                    |                              |                      |                             |                                 |                             |                              |
| Age (y)                                      | 33.7 $\pm$ 8.1                   | 33.2 $\pm$ 7.8   | 34.0 $\pm$ 7.1                 | 31.8 $\pm$ 6.2         | 34.7 $\pm$ 9.7                | 35.1 $\pm$ 7.5     | 33.9 $\pm$ 7.0               | 26.2 $\pm$ 3.0       | 37.8 $\pm$ 6.0 <sup>†</sup> | 31.3 $\pm$ 5.5                  | 33.9 $\pm$ 8.3              | 34.8 $\pm$ 7.9               |
| Height (cm)                                  | 178.2 $\pm$ 11.1                 | 182.4 $\pm$ 8.8  | 166.4 $\pm$ 8.6 <sup>†</sup>   | 176.8 $\pm$ 6.0        | 186.5 $\pm$ 8.4 <sup>†</sup>  | 163.4 $\pm$ 6.5    | 168.2 $\pm$ 6.2              | 178.0 $\pm$ 11.2     | 178.4 $\pm$ 11.3            | 180.2 $\pm$ 10.1                | 176.5 $\pm$ 11.3            | 179.3 $\pm$ 12.1             |
| Body mass (kg)                               | 107.0 $\pm$ 28.6                 | 115.6 $\pm$ 25.3 | 82.1 $\pm$ 16.0 <sup>†</sup>   | 92.5 $\pm$ 8.3         | 132.0 $\pm$ 19.8 <sup>†</sup> | 70.5 $\pm$ 5.8     | 94.2 $\pm$ 13.7 <sup>†</sup> | 106.8 $\pm$ 29.3     | 107.1 $\pm$ 26.5            | 107.5 $\pm$ 24.3                | 103.0 $\pm$ 26.8            | 113.5 $\pm$ 31.0             |
| <i>Training Experience</i>                   |                                  |                  |                                |                        |                               |                    |                              |                      |                             |                                 |                             |                              |
| Resistance training experience (y)           | 13.0 $\pm$ 8.0                   | 14.6 $\pm$ 7.5   | 7.0 $\pm$ 4.9 <sup>†</sup>     | 13.6 $\pm$ 5.8         | 15.8 $\pm$ 9.2                | 7.3 $\pm$ 4.5      | 6.6 $\pm$ 4.9                | 8.4 $\pm$ 4.4        | 15.3 $\pm$ 8.0 <sup>†</sup> | 12.6 $\pm$ 5.8                  | 12.5 $\pm$ 7.7              | 13.0 $\pm$ 9.3               |
| Strongman experience (y)                     | 5.9 $\pm$ 4.8                    | 6.4 $\pm$ 4.7    | 3.4 $\pm$ 2.0 <sup>†</sup>     | 5.8 $\pm$ 3.6          | 7.3 $\pm$ 6.0                 | 4.1 $\pm$ 2.5      | 2.9 $\pm$ 1.4                | 3.6 $\pm$ 2.0        | 6.9 $\pm$ 4.9 <sup>†</sup>  | 3.6 $\pm$ 2.4 <sup>*004</sup>   | 5.9 $\pm$ 4.1               | 7.2 $\pm$ 5.4                |
| Years competing (y)                          | 5.4 $\pm$ 4.7                    | 5.9 $\pm$ 4.5    | 3.3 $\pm$ 1.9 <sup>†,002</sup> | 5.3 $\pm$ 3.4          | 7.1 $\pm$ 6.4                 | 3.8 $\pm$ 2.2      | 2.8 $\pm$ 1.5                | 3.3 $\pm$ 2.0        | 6.4 $\pm$ 4.7 <sup>†</sup>  | 3.1 $\pm$ 4.4 <sup>*</sup>      | 5.4 $\pm$ 3.7               | 7.2 $\pm$ 5.3                |
| <i>Warm Up</i>                               |                                  |                  |                                |                        |                               |                    |                              |                      |                             |                                 |                             |                              |
| Warm up length (min)                         | 16.9 $\pm$ 8.9                   | 17.1 $\pm$ 8.9   | 16.3 $\pm$ 9.2                 | 15.3 $\pm$ 8.7         | 18.4 $\pm$ 8.8                | 15.6 $\pm$ 9.3     | 17.1 $\pm$ 9.2               | 16.9 $\pm$ 9.4       | 16.9 $\pm$ 8.7              | 13.7 $\pm$ 6.4                  | 17.8 $\pm$ 9.1              | 18.4 $\pm$ 10.1              |
| Optimal time between warm up and event (min) | 8.5 $\pm$ 4.3                    | 8.7 $\pm$ 4.5    | 7.7 $\pm$ 3.7                  | 9.0 $\pm$ 5.5          | 10.0 $\pm$ 5.9                | 8.4 $\pm$ 3.8      | 7.8 $\pm$ 3.2                | 8.1 $\pm$ 4.3        | 8.7 $\pm$ 4.4               | 7.6 $\pm$ 3.9                   | 8.2 $\pm$ 4.6               | 9.7 $\pm$ 4.2                |

<sup>†</sup>significantly different to other level of variable p =  $\leq 0.001$  unless specified.

\*Local/regional amateur significantly different (p =  $\leq 0.001$ ; unless specified) to International level

**Table 2:** Main reasons and purposes of the warm up reported by strongman athletes (n = 132).

| Higher-order themes  | Responses | Selected raw data representing responses to this question  |
|--|-----------|--|
| Injury prevention  | 57        | <p>“To prevent injury and a good warm up helps me actually lift more.”</p> <p>“I feel less likely to injure myself on deadlift and overhead events if I "grease the groove" a bit.”</p>  |
| Increase activation*   | 51        | <p>“Warm up muscles and get blood flow to prevent injury.”</p> <p>“Getting the body ready to move and the nervous system primed to perform.”</p> <p>“Fire up the muscles used for the lift and to get a feel for the weight/implement.”</p> <p>“Main focus is to activate muscles and get blood flow.”</p>           |
| Increase blood flow/circulation, temperature^ and heart rate | 50        | <p>“Mainly, I perform warm ups to get my blood flowing, joints and muscles warm and to feel the weight of the implement.”</p> <p>“Increase blood flow &amp; lubrication to the muscles and joints, to prepare them for the work ahead.”</p> <p>“Warm up muscles joints tendons etc and elevate heart rate.”</p>      |
| Increase mobility/flexibility                                | 46        | <p>“Mobility/flexibility to keep everything ready to perform.”</p> <p>“Loosening of muscles and increased ROM of joints.”</p> <p>“Flexibility/stretching and working through tough range of motions.”</p>  |
| #Movement familiarization                                    | 40        | <p>“Loosen up, get a feel for the weight, practice the general movements.”</p> <p>“Warm up the muscles, work up to the weight of the event and get use to the piece of equipment.”</p> <p>“Get a feel for specific implement I'll be using.”</p> <p>“All equipment is different and has a different feel to it.”</p> |
| Psychological factors  | 21        | <p>“Gain confidence with the feel of the implements and blood flow.”</p> <p>“To prepare internal environment, behavior, and decision-making strategies related to event.”</p> <p>“...reduce competition stress and mentally prepare for the lifts to come”</p> <p>“Loosen up and get mentally in the zone.”</p>      |
| Improve performance  | 14        | <p>“Better performance in event competition.”</p> <p>“To successfully set myself up to perform at my very best while reducing the risk of injury.”</p>   |
| Miscellaneous  | 5         | <p>“Routine helps me ground myself in unknown situations.”</p> <p>“To determine if I have anything going on in the body which seems abnormal and may need additional time/work.”</p> <p>“Depends on events, weather.”</p>  |

Key: \* includes CNS and muscle activation; ^ includes muscle and body temperature; # includes strongman implement familiarization and load familiarization

N.B. In some cases, the participant provided information that represented more than one concept and their response contributed to more than one higher-order theme.



**Table 3:** Competition warm up characteristics of strongman athletes (n = 132).

|                                      | Sex                              |               | Body Mass       |                  |                  |   | Age             |                | Competitive standard |                                 |  |                              |
|--------------------------------------|----------------------------------|---------------|-----------------|------------------|------------------|---|-----------------|----------------|----------------------|---------------------------------|--|------------------------------|
|                                      | All strongman athletes (n = 132) | Male (n = 98) | Female (n = 34) | Males (n = 98)   |                  | Females (n = 34)  |                 | ≤30 y (n = 51) | >30 y (n = 81)       | Local/regional amateur (n = 34) | High Level amateur (n = 61)                                    | International Level (n = 37) |
|                                      |                                  |               |                 | ≤105 kg (n = 43) | >105 kg (n = 55) | <80 kg (n = 17)   | ≥80 kg (n = 17) |                |                      |                                 |  |                              |
| <i>Warm up for every event</i>       |                                  |               |                 |                  |                  |   |                 |                |                      |                                 |  |                              |
| Yes                                  | 73 (55%)                         | 49 (50%)      | 24 (71%)        | 19 (44%)         | 30 (55%)         | 16 (94%)  | 8 (47%)         | 27 (53%)       | 46 (57%)             | 14 (41%)                        | 35 (57%)   | 24 (65%)                     |
| Sometimes                            | 34 (26%)                         | 29 (30%)      | 5 (15%)         | 13 (30%)         | 16 (29%)         | 1 (6%)  | 4 (24%)         | 13 (25%)       | 21 (26%)             | 14 (41%)                        | 15 (25%)   | 5 (14%)                      |
| No                                   | 24 (18%)                         | 19 (19%)      | 5 (15%)         | 10 (23%)         | 9 (16%)          | 0 (0%)  | 5 (29%)         | 10 (20%)       | 14 (17%)             | 6 (18%)                         | 11 (18%)   | 7 (19%)                      |
| <i>Use PAP</i>                       |                                  |               |                 |                  |                  | 9.47 <sup>(a)</sup> 2 <sup>(b)</sup> p = 0.009 <sup>(c)</sup> |                 |                |                      |                                 |  |                              |
| Yes                                  | 46 (35%)                         | 36 (37%)      | 10 (29%)        | 19 (44%)         | 17 (31%)         | 6 (35%)   | 4 (24%)         | 20 (39%)       | 26 (32%)             | 11 (32%)                        | 21 (34%)   | 14 (38%)                     |
| No                                   | 84 (64%)                         | 61 (62%)      | 23 (68%)        | 23 (53%)         | 38 (69%)         | 10 (59%)  | 13 (76%)        | 30 (63%)       | 54 (67%)             | 23 (68%)                        | 40 (66%)   | 21 (57%)                     |
| <i>Use passive warm ups</i>          |                                  |               |                 |                  |                  |   |                 |                |                      |                                 |  |                              |
| Yes                                  | 28 (21%)                         | 24 (24%)      | 4 (12%)         | 8 (19%)          | 16 (29%)         | 3 (18%)   | 1 (6%)          | 15 (29%)       | 13 (16%)             | 6 (18%)                         | 15 (25%)   | 7 (19%)                      |
| No                                   | 101 (77%)                        | 71 (72%)      | 30 (88%)        | 32 (60%)         | 39 (71%)         | 14 (82%)  | 16 (94%)        | 34 (67%)       | 67 (83%)             | 27 (79%)                        | 46 (75%)   | 28 (76%)                     |
| <i>Practice competition warm ups</i> |                                  |               |                 |                  |                  |   |                 |                |                      |                                 |  |                              |
| Yes                                  | 94 (71%)                         | 71 (72%)      | 23 (68%)        | 28 (65%)         | 43 (78%)         | 10 (59%)  | 13 (76%)        | 34 (67%)       | 60 (74%)             | 22 (65%)                        | 51 (84%)   | 21 (57%)                     |
| No                                   | 34 (26%)                         | 25 (26%)      | 9 (26%)         | 13 (30%)         | 12 (22%)         | 5 (29%)   | 4 (24%)         | 15 (29%)       | 19 (23%)             | 12 (35%)                        | 9 (15%)  | 13 (35%)                     |
|                                      |                                  |               |                 |                  |                  |   |                 |                |                      |                                 | 12.50 <sup>(a)</sup> 4 <sup>(b)</sup> p = 0.014 <sup>(c)</sup> |                              |

The results are expressed in 2 ways, with the first value being the total number of occurrences and the second number (in parentheses) the percentage of total occurrence. (a) Chi square value (b) Degrees of freedom (c) p value. Discrepancies appear for participant numbers when data were not reported by strongman athletes.

**Table 4:** Strongman athletes reported average warm up information for the farmers walk, log lift/press and stone lifts/work events

|   | Farmers walk<br>(n = 100) | Log lift/press<br>(n = 100) | Stone lifts/work<br>(n = 100) |
|---|---------------------------|-----------------------------|-------------------------------|
| Number of warm up sets                  | 2.7 ± 1.0*†               | 3.8 ± 1.2†                  | 2.2 ± 1.3                     |
| Distance (m)# or<br>Repetitions per set | 9.4 ± 7.3 m               | 2.8 ± 1.1†                  | 1.9 ± 1.4                     |
| Load used (as a% 1RM)                   | 66.6 ± 11.1               | 68.8 ± 10.0                 | 68.8 ± 10.0                   |
| Rest period between sets (min)          | 3.4 ± 1.5                 | 3.3 ± 1.3                   | 3.5 ± 2.4                     |

\*Significantly ( $p < 0.001$ ) different to Log lift/press

†Significantly ( $p < 0.001$ ) different to Stone lifts/work.

#For the farmers walk a number of athletes (n=37) did not specify an actual distance covered in a set. Instead the majority of these athletes stated their warm up distances were half of the specified competition distance (60%, n=22). Eleven athletes stated their warm up distance was the full length of the specified farmers walk event.

**Table 5:** Why warm ups haven't worked (n = 81)

| Higher-order themes             | Responses | Selected raw data representing responses to this question  |
|---------------------------------|-----------|--|
| Lack of time or time warming up | 33        | <p>“Not enough notice to start warming up. Not enough sets done.”</p> <p>“Not enough time to warm up due to time and number of people that need to warm up.”</p> <p>“Distractions can cut warm ups short or make them otherwise incomplete.”</p>   |
| Time between warm up and event  | 18        | <p>“Too much time between warm up and event starting.”</p> <p>“I was either cooled down or not recovered by the event start because I started either too early or too late on warm ups.”</p>   |
| Logistical issues               | 17        | <p>“Contest warm ups are very limited, and often we don't have sufficient time to be fully prepared, or we have to share the same log for warm ups with many other athletes.”</p> <p>“There are some competitions that do not allow the exact implement to be used in the warm-up.”</p> <p>“If the space for the competition is so limited that there is nowhere and no equipment to warm up, as happens sometimes in big convention centers like at the Olympia.</p> <p>“No adjustable implements.”</p> |
| Over exertion                   | 13        | <p>“Tired myself out with too much in my warm up.”</p> <p>“Went too heavy and too long.”</p> <p>“Jumps too big weight wise.”</p>   |
| Technique/Injury                | 10        | <p>“Lack of equipment, space or time - led to body being poorly prepared and injured my back.”</p> <p>“I have had warmups on deadlifts go wrong. Usually I am forgetting to focus on an important cue like bracing.”</p> <p>“Did warm rear delts and tore bicep on axle clean.”</p>  |
| Mental preparedness             | 8         | <p>“In the cases where warm-ups haven't worked, there may have been an underlying injury, or the mind wasn't in the right state (not focused, worried about other competitors, feeling sick).”</p> <p>“As long as there is time, space, and equipment available, most often a lack of focus caused by a suboptimal emotional state is the culprit in my experience.”</p>   |
| Cold weather                    | 2         | <p>“If very cold outside, no adjustable implements, not enough time.”</p>  |
| Miscellaneous                   | 14        | <p>“Buildup of fatigue from weeks prior.”</p> <p>“I choose wrong exercises.”</p> <p>“To be honest I barely warm up. I make it realistic to competition. The truth is you don't know if a warm up is guaranteed.”</p>   |

N.B. In some cases, the participant provided information that represented more than one concept and their response contributed to more than one higher-order theme. # Logistical issues refer to: equipment availability and access, warm up space and number of athletes competing.

**Table 6:** Nutritional strategies utilised throughout strongman competition (n = 107).

| Higher-order themes          | Responses | Select raw data representing responses to this question   |
|------------------------------|-----------|---|
| Carbohydrate intake          | 83        | <p>“Eat some simple sugars between events (i.e. gummy worms/sugary candy or fruit).”</p> <p>“Fruit is my go-to on day of competition.”</p> <p>“Focus on a steady supply of small, easily digested doses of simple and complex carbs.”</p> <p>“Glucose tablets after every event.”</p> <p>“Carb loading the night before.”</p> <p>“Easy digesting carbs and protein.”</p>  |
| Meal characteristics         | 83        | <p>“During a long contest I will snack on light, easily digestible foods.”</p> <p>“Lots of food.”</p> <p>“Hydrate with water, consume small quantities of protein (usually whey isolate) and carbs (banana, granola bar, powder, etc) between events if time allows and my stomach is agreeable.”</p> <p>“Generally just aim to eat whatever keeps hunger at bay”</p> <p>“I can't stand the feeling of food in my stomach when I train or compete, so I make sure to have liquid calories with me.”</p> <p>“Eat regularly small amounts.”</p> |
| Protein intake               | 61        | <p>“Protein bar if I feel hungry.”</p> <p>“I like easy to digest foods and my protein drink.”</p> <p>“I go with a high carb, high protein meals on comp days.”</p>  |
| Fluid and electrolyte intake | 32        | <p>“Lots of sodium and fluids.”</p> <p>“Electrolytes, such as sodium, will help keep nervous system and muscles firing.”</p> <p>“I sip on an electrolyte/carbohydrate drink throughout the day.”</p>  |
| Fat intake                   | 16        | <p>“Avoid fatty foods that will sit heavy in your stomach (I often have eggs for breakfast, but never on contest day, as I always throw them up).”</p> <p>“usually a high carb, moderate protein and low-fat meal”</p> <p>“Keep my fats and carbs high.”</p>  |
| Miscellaneous                | 29        | <p>“I struggle to keep food down”</p> <p>“My normal daily meals are the same”</p> <p>“This varies for each event. Some events can happen on a full stomach and some would make a mess.”</p>   |

N.B. In some cases, the participant provided information that represented more than one concept and their response contributed to more than one higher-order theme.

**Table 7:** Additional information given by strongman athletes (n = 37)

| Higher-order themes             | Responses | Selected raw data representing responses to this question  |
|---------------------------------|-----------|--|
| Other Strategies                | 10        | <p>“At larger events I use noise-cancelling headphones to relax and regroup. It is a great break from all the loud cheering and event noise.”</p> <p>“A comfy fold up chair could be useful. Having a crappy place to sit between events could be detrimental physically and mentally.”</p> <p>“Bring a friend, coach or family member to keep you in the game. Someone that will tell you what it is up and not what you want to hear.”</p> <p>“Always have a physio handy, it is good to strap up any tender or sore muscles before events.”</p> |
| Nutrition/hydration/supplements | 8         | <p>“I have a decent sized breakfast that focuses on protein and fat with some carbs as well to keep me satiated throughout the first event.”</p> <p>“I make sure I drink an extra gallon of water the day before. With electrolyte powder mixed in to ensure I'm well hydrated.”</p> <p>“I never drink coffee, but the competition day this is the first. My breakfast is ham or bacon.”</p> <p>“Coffee right up to the beginning of the show...pre-workout after 1-2 events.”</p>   |
| Equipment/clothing              | 6         | <p>“It's very important to have all your equipment and support gear ready and prepped and know right where it is and when you'll need it. Stress and rushing on event day is toxic.”</p> <p>“Clothing is usually loose fitting and a number of layers. Usually a compression type base layer on bottoms, with shorts and track bottoms over the top.”</p>  |
| Sleep                           | 4         | <p>“Early night and have a min of 8 hours sleep before comp.”</p>  |
| Energy conservation             | 4         | <p>“Save your energy for the competition.”</p> <p>“I minimize my energy expenditure between events”</p>  |
| Sun protection                  | 2         | <p>“Sun protection is important for outdoor events, I like to have glasses, hat, and sunblock ready.”</p>  |
| Miscellaneous                   | 10        | <p>“I think everyone is different, there is no cookie cutter method to be successful. Utilize trial and error to you find a method that works for you that allows you to obtain your goals.”</p> <p>“The biggest barriers on the day include: Long wait times between events, the length of a competition day performing maximally - weaker as the day goes on.”</p> <p>“Most of this at a high level is dictated by the needs of the competitor at that moment.”</p>  |

N.B. In some cases, the participant provided information that represented more than one concept and their response contributed to more than one higher-order theme.

# Appendix 1: **Competition Day Preparation Strategies of Strongman Athletes Survey**

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## An Invitation

Hello strongman athletes. My name is Dr Paul Winwood and I have a passion for research and improving our understanding and knowledge of the sport of strongman. I invite you to take part in an exciting research project. The survey is called 'Competition Day Preparation Strategies of Strongman Athletes'.

The purpose of this study is to help improve our understanding of the competition day preparation strategies employed by strongman athletes. The information will benefit strongman athletes in regard to improving our understanding and knowledge of competition day strategies that are utilized to enhance strongman competition performance. We would be very grateful if you could take the time to fill out this survey. Please know that your participation is entirely voluntary and you will not be disadvantaged by not participating. We will seek to publish a summary of the findings of the study in a scientific journal, like the Journal of Strength and Conditioning Research. This research continues from our recent published research on the tapering practices of strongman athletes: [https://www.researchgate.net/profile/Paul\\_Winwood](https://www.researchgate.net/profile/Paul_Winwood)

You have been identified (through the use of Facebook and the internet) as a potential participant in this research because you are a strongman competitor, competing in strongman competitions at regional, national or international levels. Only strongman competitors who meet these criteria are eligible to participate in this study.

The on-line survey will take approximately 10 to 15 minutes for you to complete. The questions give you the opportunity to elaborate on the preparation strategies you utilize on strongman competition days. We would like you to answer as many questions as you can as your knowledge and experience in this field is important to us. We want to learn from your experience. The types of questions you will encounter will include; drop down boxes, check boxes, ranking, and text questions. You are asked to please select or tick which boxes are relevant. For text box questions please type your answer in.

An academic publication summarizing the study findings will be sought. The study data set will only be used for the purpose for which it has been collected. No individual's will be identified and only summary data will be reported.

You will complete the survey anonymously as only a participant number will be associated with your answers. The researchers will not be able to identify you as a participant. There are no costs to you to participate in this research except for your time. The survey link will be active for a period of three months. During this time you are welcome to consider the invitation to take part in this research. By completing the questionnaire you have consented to participate in this research project. This also means that you have read and understood all the information

contained in the participant information letter and have clarified any details prior to starting the research project.

The findings of the research will be made available once the report is complete on Research Gate. [https://www.researchgate.net/profile/Paul\\_Winwood](https://www.researchgate.net/profile/Paul_Winwood). If you would like to know more about this research please contact: Dr Paul Winwood, Toi Ohomai Institute of Technology, Faculty of Community Wellbeing and Development, Tauranga, New Zealand, paul.winwood@toiohomai.ac.nz. This research was approved by the Toi Ohomai Research Committee (TRC 2017.056) and is supported by the World Strongman Federation (WSF) (Research colleague and General Secretary of WSF; Vladislav Redkin; wsfstrongman@hotmail.com).

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## **Demographics & Background Information**

### **1) What is your gender?**

Male

Female

### **2) What is your age?**

Answer Range:  <18 to  >65

### **3) What is your height (cm)?**

Answer Range:  <150 to  >215

### **4) What is your body mass (kg)?**

Answer Range:  <50 to  >215

### **5) What country are you from?**

Answer Range:  Afghanistan to  Zimbabwe

**6) How many years of general resistance training experience do you have?**

Answer Range: ( ) 1 to ( ) >50

**7) How many years of strongman implement training experience do you have?**

Answer Range: ( ) 1 to ( ) >35

**8) How many years have you been competing in the sport of strongman?**

( ) Never competed (Disqualified – End of survey)

( ) <1 to ( ) 35

**9) What is the highest level of strongman competition you have competed at?**

( ) Local/Regional Amateur

( ) High Level Amateur (i.e. National, Arnold etc)

( ) International Level Athlete

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## **Warm Up Strategies**

**For this section of the survey warm up strategies refer to the physical preparation you perform before the start of a strongman event/competition”.**

**10) Do you utilize warm ups in strongman competitions?**

( ) Yes

( ) No

( ) Sometimes - Please elaborate:

---



**11) Are your warm ups 'self-directed' or 'coach led'?**

- Self directed
- Coach led
- Other - Please specify: \_\_\_\_\_

**12) What are the main reasons and purposes for your warm-up/s?**

\_\_\_\_\_

**13) On average how long would you consider your normal warm ups to be (to the nearest 5 minutes)? Please explain why your warm up is this length in the comments box.**

Answer Range:  5 min to  60+ min

**Comments:**

**14) Do you warm up for every event in the strongman competition? Please explain why (or why not) in the comments below.**

- Yes
- No
- Sometimes

**Comments:**

**15) How do you monitor exercise intensity in your warm-ups? Please choose all answers that are relevant to you and feel free to comment on your answer/s below.**

- Load (as a % 1RM)
- Heart Rate (bpm)
- Rate of perceived exertion (RPE)
- Speed of movement
- Other - Please specify: \_\_\_\_\_

**Comments:**

**16) What length of time (to the nearest minute) between the warm-up and the start of your event do you feel is the optimal recovery period? Please explain your answer in the comments box.**

Answer Range: ( ) 1 min to ( ) >30 min

**Comments:**

**17) Do you use post activation potentiation (PAP) techniques (i.e. using very heavy loads in your warm up before an explosive event or the use of plyometrics before a heavy lifting event) in your warm ups to help enhance your force and power production? Please provide an example of a PAP technique you utilize and comment on why you use (or not use) PAP techniques.**

( ) Yes

( ) No

**Comments:**

**18) Do you use passive warm up techniques (i.e. use of saunas, spa's, heating pads etc) prior to your physical warm ups? Please comment on your answer and state what passive warm up techniques you utilize (if any).**

( ) Yes

( ) No

**Comments:**

**19) Has there been any circumstances that have affected your recovery time between the end of your warm-up and the start of your event/s? If yes, please specify in the comments box.**

( ) Yes

( ) No

**Comments:**

**20) Do you practice using your competition warm-up in your normal training sessions? Please comment on why/or why not.**

Yes

No

**Comments:**

**21) Following completion of your warm-up, what do you typically do before an event? Choose all answers that are relevant to you.**

Sit down

Walk around

Listen to music

Put on a tracksuit/extra clothes

Other - Please specify: \_\_\_\_\_

**Comments:**

**22) Currently nothing is documented about how strongman athletes warm up for various strongman events. Could you please specify your typical warm up details for the three strongman events listed below?**

Note: Distance, Repetitions and Load are open text questions to allow you flexibility to briefly state what you do.

Typical warm up details for the Farmers Walk (Note: please specify in comments box how the details may change for max weight, set distance etc).

**Number of warm up sets**

Answer Range:  1 to  >10

**Distance covered per set:** \_\_\_\_\_

**General Load Used (as a %1RM):** \_\_\_\_\_

**Average rest period between sets (min)**

Answer Range:  1 to  >10

**Any further comments regarding warming up for the farmers walk?:**

\_\_\_\_\_

**Typical warm up details for the Log Lift. (Note: please specify in comments box how the details may change for reps versus max weight).**

**Number of warm up sets**

Answer Range: ( ) 1 to ( ) >10

**Distance covered per set:** \_\_\_\_\_

**General Load Used (as a %1RM):** \_\_\_\_\_

**Average rest period between sets (min)**

Answer Range: ( ) 1 to ( ) >10

**Any further comments regarding warming up for the log lift?:**

\_\_\_\_\_

**Typical warm up details for the Stone Lift. (Note: please specify in comments box how the details may change for set weight stones versus stone loading at a certain weight etc).**

**Number of warm up sets**

Answer Range: ( ) 1 to ( ) >10

**Distance covered per set:** \_\_\_\_\_

**General Load Used (as a %1RM):** \_\_\_\_\_

**Average rest period between sets (min)**

Answer Range: ( ) 1 to ( ) >10

**Any further comments regarding warming up for the stone lift?:**

\_\_\_\_\_

**23) When warm ups haven't worked, what went wrong and why?**

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## **Cognitive Strategies**

**For the purpose of this survey, Cognitive strategies are defined as "self-directed mental interventions used prior to or during the execution of a strongman event to enhance strongman competition performance".**

**24) Do you feel you need to increase, reduce or maintain your psych arousal level to improve your strongman competition performance? Please explain your answer in the comments box.**

**For the purpose of this study psych arousal is defined as "a mental and emotional state that prepares your body for action"**

- Increase psych arousal
- Reduce psych arousal
- Maintain psych arousal
- Other - Please specify: \_\_\_\_\_

**Comments:**

**25) On a scale of 1 to 10 (with 1 being totally relaxed to 10 being totally psyched up) what number do you believe is best for your optimal strongman competition performance? Please briefly explain your answer.**

**Note: For the purposes of this study 'to psych up' means to get oneself into a state of psychological readiness for an action.**

- 1     2     3     4     5     6     7     8     9     10

**Comments:**

**26) Does the way in which you currently warm-up before your events help you to mentally focus on the upcoming event and perform optimally? Please explain your answer.**

Yes

No

Sometimes: \_\_\_\_\_

**Comments:**

**27) From the list below please indicate your use of each cognitive strategies (i.e. always use, sometimes use, never use) prior to strongman competition events and briefly comment on each strategy.**

**a. Positive Self talk: Internal encouraging/motivating dialogue**

Never use

Sometimes use

Always use

**Comments:**

**b. Emotional Control: Controlling emotions in difficult/competitive situations**

Always use

Sometimes use

Never use

**Comments:**

**c. Automaticity: performing skills such that they seem automatic or occurring without conscious effort (i.e. performing your warm ups for your events automatically without much conscious thought)**

Always use

Sometimes use

Never use

**Comments:**

**d. Goal Setting: setting outcome-related goals or objectives**

- Always use
- Sometimes use
- Never use

**Comments:**

**e. Mental Imagery: imagining or visualizing sport movements and or tactics prior to participation**

- Always use
- Sometimes use
- Never use

**Comments:**

**f. Preparatory arousal: maintaining an optimal level of physiological and psychological arousal specific to the demands of the task at hand**

- Always use
- Sometimes use
- Never use

**Comments:**

**g. Relaxation: implementing methods to remain calm in the face of challenge or pressure**

- Always use
- Sometimes use
- Never use

**Comments:**

**h. Attention control: maintaining focus on the task at hand**

- Always use

Sometimes use

Never use

**Comments:**

**i. Use of music: utilization of music to ‘psych up’ or ‘relax’**

Note: please state what kind of music you listen to (e.g. rock, classical, heavy metal Jazz etc) within the comments box

Always use

Sometimes use

Never use

**Comments:**

**28) Do the types of cognitive strategies you use change for different events and/or the level of competition? If yes please explain why.**

Yes

No

Sometimes

**Comments:**

---

## **Other Competition Strategies**

**29) Please indicate if you use any of the following strategies as part of your warm up and briefly state why you use the strategy/s in the comments box.**

Sports massage

Foam rolling

Myofascial release work (i.e. use of lacrosse/cricket ball etc in tight muscles)

Dynamic stretching

Static Stretching

Other - Please specify: \_\_\_\_\_



**Comments:**

**30) From the list below please indicate which supplements/substances you generally use on competition day. Please briefly state why you use the supplements and how they help you.**

Energy drinks

Electrolyte drinks

Pre-workout supplements

Caffeine

Beta alanine

Creatine

Amino acids

Ammonia inhalants

Other - Please specify: \_\_\_\_\_

**Comments:**

**31) What nutritional strategies do you utilize to help maintain your strength and energy levels throughout the competition?**

\_\_\_\_\_

**32) Is there anything other information on your competition day preparation that you haven't covered that you would like to add?**

\_\_\_\_\_

\_\_\_\_\_

**Thank you for taking our survey. Your response is very important to us.**