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HOW COACHES USE STRONGMAN IMPLEMENTS IN STRENGTH AND CONDITIONING PRACTICE

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Abstract

This article describes how strongman implements, which we defined as “any non-traditional implement integrated into strength and conditioning practice” are currently utilised by coaches to enhance athletic performance. Coaches (mean ±SD 34.0 ±8.2 y old, 9.8 ±6.7 y general strength and conditioning coaching experience) completed a self-reported 4-page survey. The subject group included coaches of amateur (n = 74), semi-professional (n = 38) and professional (n = 108) athletes. Eighty-eight percent (n = 193) of coaches reported using strongman implements in the training of their athletes. Coaches ranked sleds, ropes, kettlebells, tyres, sandbags and farmers walk bars as the top six implements used, and anaerobic/metabolic conditioning, explosive strength/power and muscle endurance as the three main physiological reasons for its use. The strongman implements were typically used in combination with traditional exercises in a gymnasium-based setting. Future research need to evaluate the performance benefits of such training practices in controlled studies.

Key Terms: weight training, resistance training, periodisation, power, variation

Introduction

Strongman implement training to enhance sport performance is becoming increasingly utilised amongst strength and conditioning practitioners [1-5] despite the paucity of research addressing this type of training. Strongman type exercises are total body movements performed in multiple planes. Hence, they may better replicate sporting movements and place greater demand on the body's core musculature than other resistance training approaches. Such a contention is supported by the findings of McGill and colleagues [6], where exceedingly high degrees of core and hip abductor activation in many common strongman exercises were reported.

Hedrick [3] suggested that in many sporting situations, athletes encounter dynamic resistance (e.g. changing resistance in the form of an opponent) as compared to constant resistance (such as machines or free weights). Strongman implements like water-filled kegs may give the opportunity for athletes to train against a dynamic resistance rather than a constant resistance typical of a barbell or dumbbell [7]. It has been proposed that incredible levels of strength and muscular development can be achieved by combining common weight training exercises such as the squat and deadlift with the lifting of heavy, awkward, hard to manage objects such as beams, barrels, logs, sandbags or kegs [8].

While several strength and conditioning practitioners have made some suggestions on what strongman implements could be incorporated in strength and conditioning programmes of non-strongman athletes [3, 4, 9, 10], very little research has examined how strongman training techniques are actually used. To date, only two studies have investigated strongman implements in strength and conditioning practice [1, 11]. While these studies give valuable insight into the difficulty in personalising strongman training loads with large groups of

athletes, and how strongman competitors train for strongman competitions (respectively), no research has examined how strength and conditioning coaches incorporate strongman implements into the training of their athletes. Thus, strength and conditioning coaches have little empirical evidence on which to inform the potential inclusion of strongman implement training within their programming practice. Such studies have been conducted into other areas of strength and conditioning practice, with published surveys examining the resistance training practices of strength and conditioning coaches in hockey [12], baseball [13], basketball [14], rowing [15], United States high schools [16] and the National Football League (NFL) [17]. These studies offer a source of collective ideas that others can compare and incorporate into their own strength and conditioning practice.

Therefore, the purpose of this study was to describe how strongman implements are currently utilised by strength and conditioning coaches to enhance athletic performance. Coaches will benefit from such an analysis by gaining some insight of how to best incorporate strongman implement training into their athletes' resistance training programmes. In addition, the knowledge gained may help guide future research on the efficacy of strongman implements on muscular function and performance.

Methods

Approach to the problem

A comprehensive strongman implements use survey was administered online and aimed at identifying how strength and conditioning coaches used strongman implements in their athlete's strength and conditioning programmes and why these implements were used. The research hypothesis was that the majority of coaches responding to the survey would

integrate strongman implements into their athlete's strength and conditioning programmes and coaches would have a variety of reasons for its use.

Participants

Two hundred and twenty strength and conditioning coaches (211 male and 9 female) ((mean ±SD) 34.0 ±8.2 y old, and 9.8 ±6.7 y general strength and conditioning coaching experience) gave informed consent to participate in this study. The participants included coaches of amateur (n = 74), semi-professional (n = 38) and professional (n = 108) athletes. In order to protect the confidentiality of the coaches, no participant's details were associated with the survey. This study was approved by the AUT University ethics committee. In order to meet ethical approval, all questions in the survey were answered on a voluntary basis. As a result, the numbers of coaches responding to each specific question items varied. Participant response numbers are indicated in the results section.

Participant recruitment and inclusion criteria

Coaches were recruited through professional networks and multimedia. The professional networking site **'**LinkedIn' was the primary method used to recruit the coaches. A variety of coaches from specific competitions (i.e. National Football League (NFL), National Rugby League (NRL), Super Rugby, National Basketball League (NBA) and Major League Baseball (MLB)) were targeted. Identified coaches were sent a letter via email. The letter contained an invitation to participate in the research and the link to the online survey. 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. Surveygizmo.com was used to launch the electronic survey on the internet.

Inclusion criteria were met if participants were identified as being a strength and conditioning coach, were working or had recently worked as a strength and conditioning coach, and had an active e-mail address. Five hundred coaches who met those criteria were sent an invitation to participate in this study. Of those invited to participate, 276 participants (55%) accessed the online survey, which included those that observed the survey, partially completed the survey and the 220 (44%) that "completed" the survey. The criterion for a completed survey was that the participant must have completed at least the first three of four sections of the questionnaire.

Research Instrument

Coaches completed a self reported 4-page retrospective survey. The *Strongman implements used in practice* survey was created for this study based on surveys used with rowers and strongman competitors [11, 15]. The original strongman implements survey was pilot tested with University Professors, and strength and conditioning coaches to ensure its ease of use with this population. As a result of pilot testing, the survey was slightly modified including clarifying and improving the wording of a small number of questions before it was available for the main study.

The strongman implement survey consisted of four main areas of inquiry including; background information, resistance training, periodisation and strongman implement use. Background information included questions on age, strength and conditioning coaching experience, type of sport and level of athlete coached, membership to professional bodies and academic qualifications. The resistance training section included questions pertaining to training lengths and frequency and strongman implement use. Participants were requested to detail their common/typical values for each training question. The periodisation section

included questions on where strongman implements were used in the periodised plan and what physiological responses were sought. The strongman implement use section, included questions on how strongman implements were used in professional practice. Open and closed questions were used for Sections 1 and 4, with closed questions used for Sections 2 and 3.

The survey required the coaches to provide a description of how they integrate strongman implements in their strength and conditioning practice. A strongman implement was defined as "any non-traditional implement integrated into strength and conditioning practice". Based on this definition, training implements such as tractor tyres, farmers walk bars, sleds, sandbags, kegs, steel logs, stones, ropes and kettlebells were all considered to be strongman implements. Traditional training was defined as "standard exercises performed in the gym by regular weight trainers and strength athletes" (e.g. squat, bench press, power clean, etc.). In order to minimise the limitation that coaches who use strongman implements could have been more likely to complete the survey, all coaches were asked to fill in the survey regardless of whether they used strongman implements.

Statistical Analyses

Means and standard deviations were calculated for the participant characteristics and strongman implement use. Frequencies of responses were collated for questions related to strongman implement use. Categorical and ordinal data were reported as both absolute numbers and as a percentage of total responses. Scores for ranked questions were determined by weighted calculation in Surveygizmo; items that were ranked first scored higher than the following ranks, so that the total score was the sum of all weighted ranks. Weighted calculation was based on the number of options represented. For example, for the 5-option

question the weighted sum for the option that was placed in the first position was worth 5-points. The second option chosen was given a score of 4-points and so forth.

Answers to open-ended questions were content analysed by investigators who were experienced with qualitative methods of sports science research and content analysis. 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.

Results

Background Information

Two hundred and twenty strength and conditioning coaches (211 male and 9 female) from 19 countries; United States of America (n = 69, 31%), Australia (n = 52, 24%), United Kingdom (n = 45, 21%), New Zealand (n =18, 8%), various (n = 36, 16%) completed the survey. The coaches listed thirty-eight sports as their primary emphasis with rugby league, American football, rugby union, basketball, baseball and soccer the most common.

Coaches reported possessing a variety of certifications, the most common being the certified strength and conditioning specialist (CSCS) (n = 85); Australian Strength and Conditioning Accreditation (ASCA) (n = 35); USA Weightlifting (USAW) Accreditation (n = 21); United Kingdom Strength and Conditioning Accreditation (UKSCA) (n = 20); and Accredited Strength and Conditioning Coach (ASCC) (n = 17). The majority of strength and

conditioning coaches (n = 205) had a degree as their highest level of education. The most common highest degrees were masters (n = 101), bachelors (n = 84) and 13 respondents indicated completing a doctorate.

Strongman Implement Use

Eighty-eight percent (n = 193) of coaches reported using strongman implements in the training of their athletes. Sled pulling/pushing, ropes, kettlebells, tyres, sandbags and farmers walk bars were ranked the top six implements used by coaches (see Figure 1).

Insert Figure 1 about here

Why and How Strongman Implements Are Used

Coaches (n = 193) ranked anaerobic/metabolic conditioning, explosive strength/power and muscle endurance as the three main physiological reasons of why they used strongman implements in their athletes training (see Figure 2). Of the 193 coaches who reported using strongman implements, 149 coaches (77%) described why and how they used (i.e. training emphasis, reps/distance/time, sets, loading, rest and movement velocity) strongman implements in the training of their athletes (see Table 1). A variety of themes were presented which included grip strength, explosiveness, triple extension, hip drive, and core work and stability.

Insert Figure 2 and Table 1 about here

The two main reasons coaches used strongman implements in the training of their athletes (see Figure 3) were to help transfer gym based strength gains into more functional strength,

and add variation to their athletes training programmes. Coaches provided other reasons (that were not mentioned in Figure 3) of why they use strongman implements in the training of their athletes. A summary of these responses is presented in Table 2.

Insert Figure 3 and Table 2 about here

Coaches who reported that they did not use strongman implements in the training of their athletes (n = 27) provided reasons or made specific comments of why they chose not to incorporate strongman implements in the training of their athletes. A summary of these responses is presented in Table 3. The two main reasons reported were: more effective ways of training and lack of equipment.

Insert Table 3 about here

Where Strongman Implements Are Used

Coaches (n = 193) described the most common environment in which strongman implements were used in the training of their athletes (see Figure 4). Strongman implements combined with traditional exercises in a gym based setting was the highest ranked score. Fifty percent of coaches reported that their athletes trained inside with strongman implements.

Insert Figure 4 about here

When Strongman Implements Are Used

Ninety nine percent (n = 217) of coaches reported using some form of periodisation in their athletes training. Of the 193 coaches who reported using strongman implements, 87% of

coaches used them in the general preparation phase, 61% used them in the specific preparation phase and 40% used them in the competitive phase. Sixty nine percent of coaches (n = 133) reported that the general preparation phase was the main phase in which they used strongman implements. Only 7% of coaches reported that the competitive phase was the main phase in which they used strongman implements.

The frequency that strongman implements were used in resistance training by coaches can be observed in Figure 5. Once per week was the most commonly reported frequency (29%) by coaches for the use of strongman implements.

Insert Figure 5 about here

Effectiveness of Strongman Implement Training

Coaches evaluated the effectiveness of strongman implement training for their athletes. Forty-nine percent of coaches believed they had achieved good results, 32% believed they had achieved excellent results and 17% believed they had achieved average results from strongman implement training. Of the 193 coaches who use strongman implements in the training of their athletes, 118 coaches (61%) provided elaborative comments about the perceived effectiveness of strongman training on increasing their athlete's performances. A summary of these responses is presented in Table 4.

Insert Table 4 about here

Disadvantages of Strongman Implement Training

Coaches (n = 118) provided responses to strategies they used to overcome the challenges of using strongman training techniques that allowed the individualisation of training loads when

dealing with large groups of athletes. A summary of these responses is presented in Table 5. Fifty four coaches found that choosing different sizes of equipment or using equipment that was adjustable (i.e. kettlebells, sleds, farmers walk bars) was the best strategy to overcome the difficulties in individualising load. Coaches (n = 104) provided responses to what other disadvantages they found with using strongman implements compared to traditional training methods. A summary of these responses is presented in Table 6. Forty-one coaches believed the logistical demands made strongman implementation difficult.

Insert Table 5 and Table 6 about here

Additional Information

Coaches (n = 193) were asked if they had any difficulty acquiring and storing strongman implements. Thirty five percent of coaches said they had difficulty acquiring strongman implements and 50% said they had difficulty storing strongman implements. Seventy six percent of coaches believed strongman implement training carried the same risks as traditional training, while 12% believed strongman implement training put their athletes at greater risk of injury than traditional training. Thirty-four coaches answered the last question of the survey which allowed them an opportunity to provide additional data or make specific comments regarding the survey. These responses are detailed in Table 7.

Insert Table 7 about here.

Discussion

This is the first survey identifying how strength and conditioning coaches utilise strongman implements in their athlete's strength and conditioning programmes. The majority of coaches (88%) used strongman implements for performance enhancement in the training of their athletes. The three main reasons were; to transfer gymnasium-based strength gains into more functional strength; add variation; and, place greater demands on the core musculature.

The sled (pulling/pushing) was ranked by coaches as the most commonly used strongman implement followed by ropes, kettlebells, tyres, sandbags and farmers walk bars (respectively). Resisted sled pulls using loads of 5 kg and 13% body mass have been shown to improve acceleration performance among rugby players [18] and recreational athletes [19] however, research on heavy sled pulling is very limited [20]. Hunter and colleagues [21] suggested that athletes who wish to increase sprint performance should direct most of their training effort into producing a high horizontal ground reaction impulse (GRI), not vertical GRI, thereby allowing both a long step length and high step rate. The use of sleds may help athletes improve the ability to generate greater sprint momentum over short sprints which is of considerable importance in collision sports that necessitate players bumping off or running through opponents [22, 23]. In the present study coaches reported that sled pulls were used to develop explosiveness and acceleration capabilities through increased leg and arm drive.

Ropes were used by coaches (75%) to provide shoulder and core work, grip strength and sport specific conditioning. Tug of war, climbs, slams, pulls and battling ropes were rope exercises used by coaches in their athletes' resistance training programmes. The variety of exercises and movement patterns described by coaches demonstrates the versatility of ropes as a conditioning tool to help develop various functional qualities.

Kettlebells were used by coaches to enhance explosive triple extension, hip, trunk and shoulder mobility, and core stability of their athletes. Researchers [24, 25] have demonstrated that kettlebells can provide a sufficient stimulus to increase both power and maximum strength in recreationally trained men. While kettlebells were not as effective as weightlifting in increasing maximal strength [24] it has been reported that common kettlebell exercises (e.g. kettlebell swing) have a considerable horizontal force component, which could have important implications for the majority of athletes whose sport requires fast and/or powerful horizontal movements [26]. Given the unique training stimulus produced (under very light loading i.e. 12-16 kg), kettlebell training may have some benefits over traditional and weightlifting movements (e.g. ease of teaching, limited space, cost and less intimidating).

Coaches used tyres to develop explosive drive, triple extension and metabolic conditioning in their athletes. Researchers indicated that the tyre flip consists of a first pull, second pull, transition and push phase [27]. This would appear quite similar to the weightlifting movements as well as jumping in terms of the explosive coordinated triple extension of the ankle, knee and hip joints Coaches may find these similarities important because weightlifting movements and vertical jumping are specific to many athletic skills [28]. However, coaches using the tyre flip may be need to exercise some caution as recent research found the tyre flip was responsible for the highest number of bicep injuries among strongman athletes [29].

Sandbags were used by coaches to enhance functional strength, postural control and hip power and rotation of their athletes. While no scientific evidence exists as the effectiveness of sandbag training for these outcomes, advocates of sandbag training [30, 31] have proposed that the unpredictable resistance provided by sandbags forces the body to continually adjust position to maintain stability during functional movement patterns, which may help generate beneficial and event-specific neurological training adaptations.

Coaches ranked anaerobic/metabolic conditioning, explosive strength/power and muscle endurance as the three main physiological reasons of why they used strongman implements in their athlete's training. Researchers have provided biomechanical and physiological data supporting the contention that strongman events could prove useful in improving strength and power, anaerobic conditioning (through adaptations in lactate production and clearance mechanisms and tolerance levels) and for increasing energy expenditure [20, 27, 32].

Different training protocols elicit different mechanical, hormonal, and metabolic stresses on the system and result in varying responses [33-35]. This variety in acute stresses placed on the body was reflected in the wide range of strongman exercise prescription used by coaches with a range of loads (10% to 100% 1RM), distance/reps/time (13 m to 29 m, 7 to 15 reps, 17 to 63 sec) and rest periods (78 to 115 sec) for the top six implements utilised in this study. Regardless of the primary physiological adaptation the coaches were trying to elicit with these exercises, over 70% of coaches instructed their athletes to perform the strongman exercises as fast as possible. An exception to this was the farmers walk, where a slow to moderate speed was instructed by many coaches (73%). The unique challenges provided by this exercise (i.e. gait loading pattern and core strength) may explain the difference in tempo for this exercise.

Eighty-one percent of coaches in this study perceived that strongman implements were good to excellent at eliciting performance gains in their athletes. The coaches also reported that the strongman exercises were useful to include in the overall strength and conditioning programme as they provided improved motivation and enjoyment, power and speed gains, and resulted in greater transference to actual sporting performance than traditional training

approaches. However, longitudinal training interventions using strongman implements are needed to substantiate such claims.

Strongman implements were used both indoors and outdoors (50% each) by coaches and in a variety of ways. Coaches reported that the main ways they used strongman implements were in conjunction with traditional exercises in a gym based setting and combined with running conditioning on the field. Such results demonstrate that strongman implements are not used in isolation but are integrated to help supplement a variety of strength and conditioning goals.

Ninety nine percent (n = 217) of coaches in this study reported using some form of periodisation in their athlete's training. This suggests that coaches design their training to emphasise particular adaptations with the goal of increasing physical performance. The majority (69%) of coaches reported that the general preparation phase (pre-season) was the main phase in which they used strongman implements. This result was reflected in the number of sets (4-6 sets) per exercises which indicates the high training volumes associated with this phase [36]. The most common frequency that strongman implements were used in resistance training by coaches in this study was once a week (29%), with large variances being reported in the frequency of use (i.e. once a month to more than three times a week). The large variances in frequency of use in this study may be due to the wide range of sports, athlete levels, specific training modalities being developed, and coaches' education and experience with strongman implements.

The three main themes that emerged from coaches who did not use strongman implements in their athletes training were; a lack of equipment, there were more effective ways of training, and, strongman implement training was not specific to their sport. Additionally, over a third of coaches in this study reported that they had difficulty in acquiring strongman implements.

One disadvantage of using strongman implements with large groups of athletes is the inability to personalise load [1]. Coaches used a variety of strategies to minimise this problem which included; monitoring volume and intensity, or pairing and grouping athletes. Using different sizes of equipment or equipment that was adjustable (i.e. kettlebells, sleds, farmers walk bars) was the main strategy used to overcome difficulties in individualising load.

Coaches reported other disadvantages of strongman implement training. The main disadvantage was the logistical demands of strongman implementation. This included; the cost of equipment, the setting up of equipment, weather; the lack of facilities; and, storage space. The perceived increased risk of injury associated with strongman training was another theme reported. While the majority of coaches (76%) believed strongman implement training carried the same risks as traditional training, researchers have reported that strongman implement training poses almost twice the risk of injury compared to traditional training approaches when equated for training exposure [29]. Furthermore, the high lumbar loads experienced during strongman training could lead to injury [6], especially if performed by athletes with insufficient training experience or if improperly progressed over time. Coaches should therefore endeavour to ensure that the competitive element among athletes is not overly emphasised, as this may see them overlook technique in the strongman lifts.

Conclusions

It seems that strongman implements are commonly used by the majority of coaches in their strength and conditioning practice. The authors acknowledge the limitation that the true prevalence of strongman use in strength and conditioning practice may not be as high as our numbers suggest, as coaches who use strongman implements may have been more likely to fill in the survey. However, the purpose of this study was to provide the first description of

how strength and conditioning coaches are currently using strongman implements in non-strongman athletes' training programmes.

Coaches reported that strongman implements were useful tools for enhancing physiological and psychological performance factors in their athletes. Coaches used strongman implements both indoors and outdoors and in a variety of ways. Coaches reported that strongman implements were used to supplement traditional training programmes; however, the logistics of strongman implementation can be difficult. Strength and conditioning coaches can use the results of this survey as a review of strength and conditioning practices and as a possible source of new ideas to diversify and improve their training practices. Future research should investigate the chronic effects of strongman implement training on physiological and psychological performance parameters.

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Figure Legends

Table Legends

Table 1: How strength and conditioning coaches used the top six most common strongman implements (n = 149).

Exercise	Main themes on training emphasis	Reps or distance or time	Sets per session	Loads kg/%BW/%1RM	Rest (sec)	Coaches additional comments	Speed the exercise is performed (% of coaches)
Sled Pushing/ Pulling (n = 135)	Strength, speed, power, muscular endurance, leg and arm drive, acceleration, explosiveness, metabolic conditioning, directional force, reduce axial loading.	23.0 ±11.0 m 17.3 ±7.9 sec	5 ±3	68.0 ±44.3 kg 60.9 ±38.9 %BW	115 ±65 sec	"Load depends on the implement being used, where on the force/velocity curve we're working, and the surface we're moving the implement on. Rest will also vary."	Fast/explosively 70% Moderate 24% Slow 6%
Ropes Climbs/pulls Battling ropes Tug of war (n = 112)	Strength, endurance, power, speed, sports specific, upper body conditioning, low impact conditioning, interval training 1:1 work/rest ratio, shoulder and core work, isometric strength, grip strength.	11.1 ±6.7 reps 13.5 ±2.1 m 37.3 ±20.1 sec	6 ±5	45 ±32.8 kg 37.5 ±3.5%BW Heavy rope (1.5 to 2 inch thick)	77 ±65 sec	"Sets of 20 for 5-10 different movements, bursts of 30sec for power, up to 2 minutes for endurance and mental toughness." "Loading depends on if working on strength, power or muscular endurance."	Fast/explosively79% Moderate 16% Slow 5%
Kettlebells Swings/ Variations (n = 98)	Strength, power, endurance, explosive triple extension, hip thrust and conditioning, hip, trunk and shoulder mobility, grip strength, core work and stability.	15.0 ±10.3 reps 38.3 ±19.7 sec	4 ±2	23.6 ±9.1 kg	78 ±46 sec	"Reps / time dependent on skill execution." "Tabata workout - end of session finisher."	Fast/explosively 73% Moderate 27%

Tyres Flips (n = 98)	Power, strength, endurance, explosive drive from low set, triple extension, hip drive, sport specific, metabolic conditioning.	7.2 ±4.6 reps 18.0 ±7.6 m 63.4 ±46.1 sec	4 ±2	151.1 ±74.6 kg 63.6 ±21.2 %1RM	107 ±58 sec	"Bodyweight for speed flips (metabolic), double bodyweight (power), triple bodyweight (strength)." "Tire - 100kg+ (men) & 60kg (women)."	Fast/explosively 78% Moderate 20% Slow 2%
Sand Bags Throws/ Carries/Clean and jerk/ Get ups (n = 93)	Power, strength, endurance, postural control, functional strength, hip power & rotation, grip work.	10.2 ±5.7 reps 34.4 ±7.2 sec 29.4 ±12.3 m	4 ±2	21.4 ±8.0 kg	80 ±58 sec	"Uneven weight which replicates working against another body." "Used for off-set loads to improve function of obliques, QL, etc." "Foot placement in various positions due to the unstableness of the gravel in the bag."	Fast/explosively 71% Moderate 24% Slow 6%
Farmers Bars Walks/Carries (n = 85)	Total body strength, grip strength, gait loading pattern, trunk, knee, ankle and shoulder conditioning, dynamic core strength and stability, foot speed.	29.1 ±11.5 m 58.6 ±54.6 sec	5 ±4	58.7 ±31.4 kg	109 ±67 sec	"70-80% 1RM or based on times e.g. if cannot complete distance within a certain time, weight may be too great." "Load depends on athlete size and gender."	Moderate 57% Fast/explosively 28% Slow 15%

Table 2: Other reasons for strongman implements use not previously mentioned (n= 98).

Higher-order themes	Responses	Select raw data representing responses to this question
Functional movements	19	"Makes athletes move and deal with strength patterns in different ways."
Competition	15	"Allows you to create competition in the off-season."
Stability	12	"Greater recruitment of core kinetic chains and the resulting stability the athlete gains."
Metabolic conditioning	10	"Strongman training is great for developing lactate tolerance."
Motivation/confidence	9	"I believe it gives athletes confidence to lift and carry objects they don't normally expect to move."
Enjoyment	8	"Incorporating them into training in a competitive way helps to increase intensity of sessions and freshen the athletes with a different 'fun' stimulus."
Grip strength	8	"Great for my baseball guys to develop forearm and hand grip strength to better swing a bat."
Psychological/mental toughness	8	"Gives my athletes the ability to continue to work hard in the face of fatigue."
Athlete learning and development	8	"Reduced time spent learning movements leading to more time spent developing practical strength." "Athletes work together as a team."
Neurological stimulus	6	"Variety in movement planes can assist with stimulating muscle fibers not usually recruited."
Intensity	5	"Very mentally challenging requires 100% effort every single rep."
Training economy	5	"Greater benefits for total body adaptation. Combination of strength and anaerobic work capacity developed simultaneously."
Miscellaneous	27	"Easy to assess areas of weakness as the exercises utilize full body activation, any flaws show up relatively quickly." "When competing in a sport, the body will not always experience forces in a uniform manner, or through a set range. Developing "fringe" abilities helps athletes handle perturbations more effectively." "Minimal eccentric work, which means no soreness post training."

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: Why strongman implements are not used (n=27).

Higher-order themes	Responses	Select raw data representing responses to this question
Lack of equipment	9	"I don't have specific strongman implements in my facility at this time."
More effective ways of training	9	"Better gains can be obtained through other methods."
Not specific to the sport	6	"I don't necessarily see it as an important component of cricket specific training."
Limited lifting history	6	"I work with younger athletes and strongman variants may be too advanced for these athletes."
Lack of space	3	"Lack of availability of space."
Time constraints	3	"Time and facilities."
Miscellaneous	4	"The risk is greater than the reward." "The majority of my athletes are young females; as such they are intimidated by this type of training."

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 4: Elaborative comments about the perceived effectiveness of strongman training on increasing athletes' performances (n = 118).

Higher-order themes	Responses	Select raw data representing responses to this question
Improved motivation/enjoyment	20	"For the athletes the variation from traditional conditioning training has been mentally stimulating."
Uncertain of benefits	16	"Difficult to monitor thus difficult to quantify how much of the athlete's improvement is down to using strongman equipment."
Power and speed gains	17	"They are more powerful and able to unload all their force on the object." "It has worked well for increasing bat speed."
Transfer to actual movements	15	"Superior transfer of skills and strength from gym to sport."
Functionality/specificity	13	"A sled push mimics the drive in a rugby scrum due to body position and knee drive. High correlation into sport."
Effective part of programme	12	"Strongman training is a great tool to add to the tool box."
Variety	11	"It provides variation to training programmes from both a physiological and psychological perspective for athletes."
Strength gains	10	"Strongman training exercises have helped greatly with conditioning and leg strength of my athletes."
Injury reduction	9	"Allows repeated high intensity sessions without the risk of contact." "Injuries due to over lifting and bad techniques have been drastically reduced."
Metabolic conditioning	8	"I generally use strongman implements for creating variety at various stages during the season so the metabolic conditioning aspect from this type of training has elicited heart rates in a desired range for my athlete."
Mental toughness	7	"It tends to place athletes in less comfortable environment than a gym setting. Mental strength is required to get through."
Core	6	"Using strongman implements has helped my athletes involve their core more.
Miscellaneous	38	"Helps promote body awareness producing/reducing forces in less scripted way." "Impossible to know for sure but players seem to retain/steal ball better in contact, stronger over ball." "Both psychological and physiological benefits from this method of training."

N.B. In some cases, the participant provided information that represented more than 1 concept and their response contributed to more than 1 higher-order theme.

Table 5: Strategies to overcome difficulties in individualising load (n = 118).

Higher-order themes	Responses	Select raw data representing responses to this question
Equipment	54	"Create kegs that are different weights, decide weights on apparatus by bodyweight 1x bodyweight or 2x bodyweight." "Use implements that are scalable (i.e. kettlebells, sleds and climbing ropes)." "We have used two different sized tractor tires and have also used different sized weight plates for our plate punches."
Monitor volume and intensity	47	"Use lighter equipment but getting the stronger athletes to increase the intensity of the exercise through means of more reps, longer duration, unilateral work, and smaller base of support."
Pair or group athletes	29	"Pairing a stronger athlete with a weaker athlete (or male and female athlete together)." "Split athletes into groups, we use first team forwards, first team backs, and then academy as our base line for three training groups."
Planning	6	"Break the athletes into smaller groups, have groups work out at a different time slot."
Regulate usage	4	"If someone has a good training age and can perform the variance of exercises with excellent form then I allow them to perform the exercise(s)."
Miscellaneous	8	"Weighted vests work well as a handicap system." "I don't really try to personalize these workouts."

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 6: Disadvantages of using strongman implements compared to traditional training methods (n=104).

Higher-order themes	Responses	Select raw data representing responses to this question
Logistical demands makes implementation difficult #	41	"$, storage and logistics of implementing event into training." "Requires space to train. If you have to train outside weather can interfere."
Increased risk of injury	20	"Guys get so caught up in the competitive element that they can forego technique. Also given the multi-planar effect some can find it hard to control the implements as they get tired." "Some exercises may be more dangerous than barbell counterparts (e.g. logs require more lumbar hyperextension than military press, tire flips and stone lifts usually require more lumbar flexion than conventional deadlifts).
Negative impact on movement mechanics	18	"Improper mechanics can be hidden and learned quickly and become habit forming. Athlete must have some base level general weight room coordination and skill to begin strongman training."
Athletes lack knowledge to ensure effective implementation	13	"Athletes have less experience with movements and therefore have to spend extra coaching time to get techniques correct."
Impacts on session efficiency	12	"Having to monitor every athlete for correct technique can extend session time much longer than desired."
Difficulty in achieving buy in of athletes	8	"Apprehension of athletes."
Cost	8	"The cost of new equipment."
Exercises lack specificity	5	"Lack of eccentric contraction minimal knee flexion and hip extension with most exercises."
Miscellaneous	8	"The basics (squat, deadlift, bench) can be overlooked."

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 demands refer to: equipment availability, facility capability, storage, time to set up and space.

Table 7: Comments (n=34).

Higher-order themes	Responses	Select raw data representing responses to this question
Exercise selection and programming	12	"I identify a quality that needs to be developed, Identify a modality that best develops that capacity, and then look to implement it with my time, facility, and professional constraints. For now, unconventional implements fit that bill for the development of certain physical qualities within the team I currently work with."
Risk and coach responsibility	4	"Strongman training doesn't have to be inherently dangerous; a skilled coach knows how to teach the exercises and create programs that work around any pitfalls of strongman training." "I think things like tire flips/ car deadlifts, axle anything is for show. They look fun but the risk versus benefit ratio is way off. The coach must make responsible decisions for his population that will help build the athlete rather than use these implements as novelty for fun or to break their athletes down."
Motivation and fun	3	"Strongman exercises are a great way to get athletes excited about working out. They see strongman competitions on TV and are motivated themselves to compete against one another whether it's flipping tires, holding chains out to their sides or pushing a sled in a relay race."
Mental toughness	2	"Strongman sessions can sort the men out from the boys especially in mental toughness."
Concerns about the survey and/or wording of a question	2	"Interesting topic. Survey needs to be broader. Doesn't touch on psychological factors, mental toughness or competitive opportunities that can be instilled via strongman training exercise implementation."
Miscellaneous	11	"As with any endeavor, proper training, persistence, being consistent and exploring ones abilities are critical elements to making progress." "If strongman was more effective than traditional, why do "all" strongman train traditional 2-4x wk in the gym? You have to be strong to do strongman training, not use it to get strong."

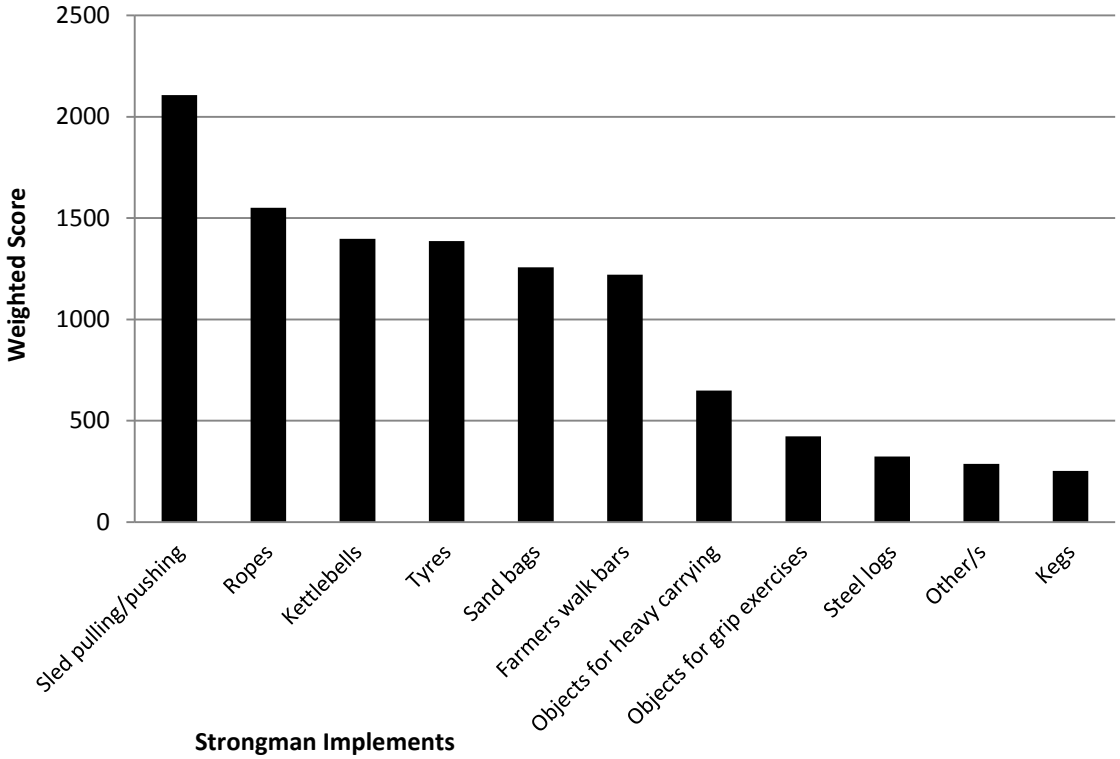

Figure 1: Top 11 strongman implements used by coaches (n = 193) in their professional practice.

N.B: The "Other/s" category, included use of heavy medicine balls (up to 200 lb), cars/utes for pushing, sledge hammers, slosh bags and balls, and power clubs.

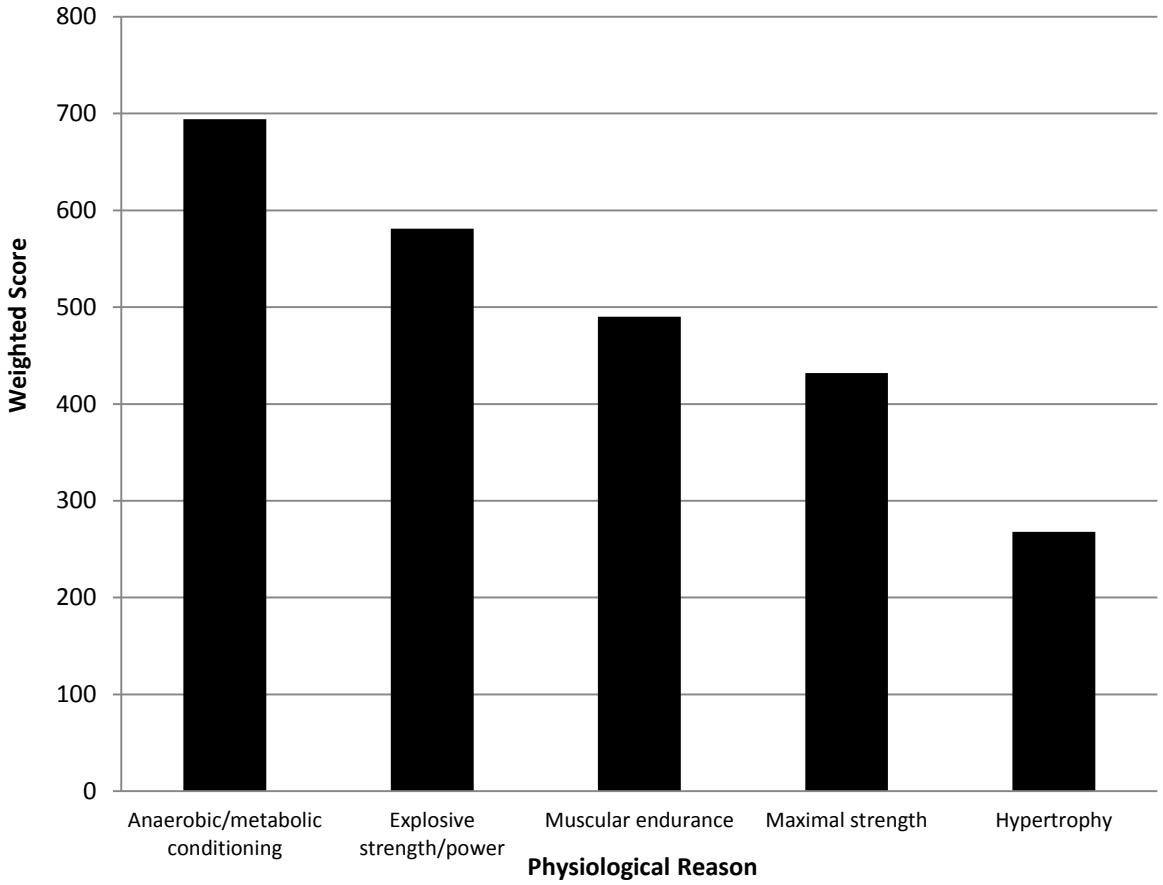

Figure 2: Main physiological reasons why coaches (n = 193) use strongman implements.

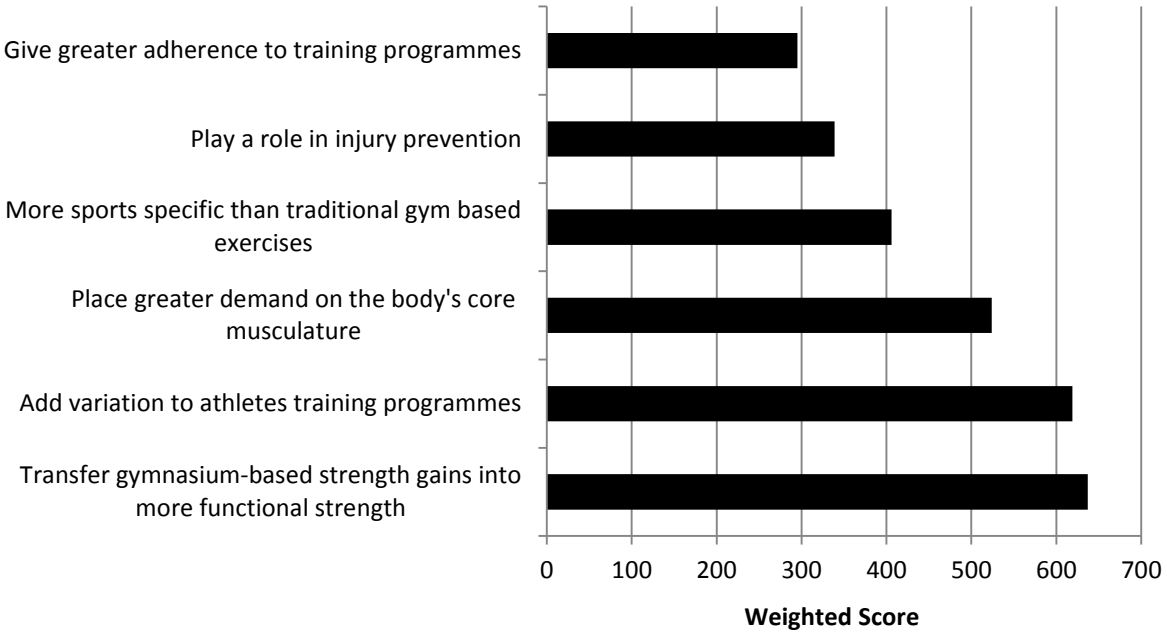

Figure 3: Ranking of why coaches use strongman implements (n = 193).

Figure 4: Ranking of where strongman implements are used (n = 193)

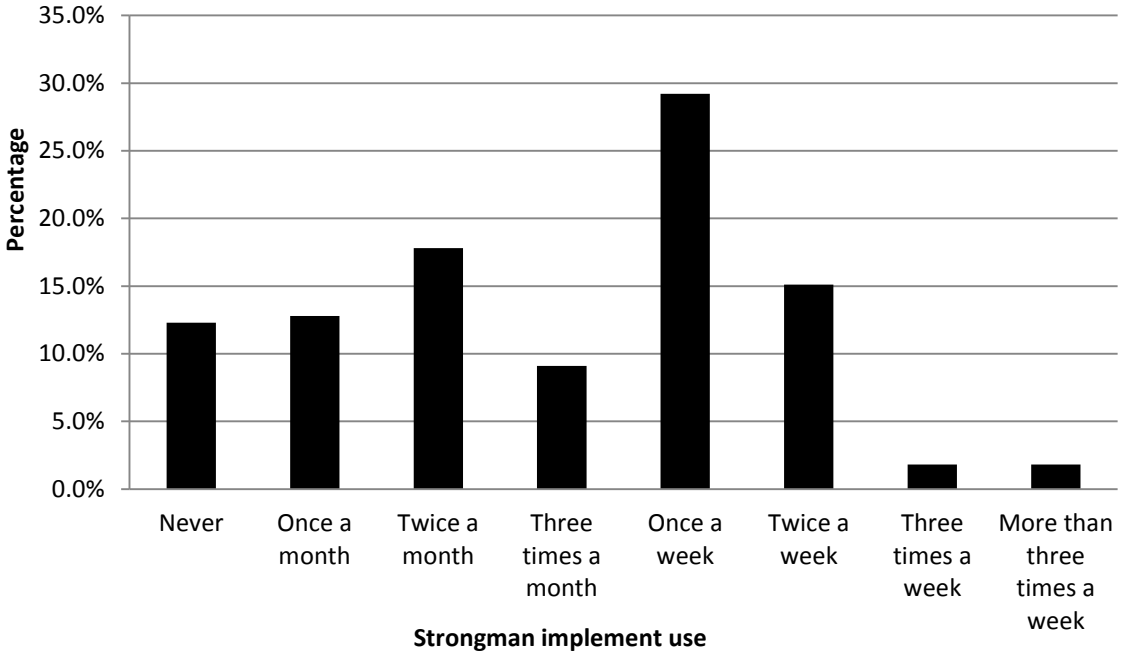

Figure 5: How often strongman implements are used by strength and conditioning coaches (n = 220)