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EDITORIAL MISSION STATEMENT

The editorial mission of the EWF – Scientific Magazine is to advance the knowledge of human movement based on the assumption that it is firstly, by any standard, the expression of muscular strength and secondly, a way of life and an ethical approach entrusted to professionals who not only are highly qualified, but also have full knowledge of the scientific facts, as well as being specifically competent. From its first issue, EWF – Scientific Magazine, has set itself the ambitious goal of bridging the gaps between the scientific laboratory and the operator on the field, enhancing both the practical experience of the coaches and the results of applied research. Consequently, the editorial rule will be a constant reference to practice and the publication of recommendations on how to apply the results of research to the practice of movement and sport.

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SUMMARY

Medically Unexplained Symptoms, known as MUS, are symptoms that do not belong to a pathological picture, but express the non-specific discomfort that precedes it from a minimum of six months to a few years.

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Weightlifters train such that all the muscles, tendons and ligaments of the lower extremities perform as a single leg spring. The unrestricted movement of all the supple weightlifter's joints, muscles, tendons and ligaments of the leg spring are interconnected, interdependent and of course, inter-conditional.

EDITORIAL

Focus

There is no training session, no competition, in which this term - focus - is not repeated, and by several individuals, either as encouragement, or as self-encouragement. Focus is often considered the fertile soil to which both cognitive and physical abilities are directed. If you are focused you perform better, we all agree on this. But, if this is true (and I don't think there can be any doubts about it), what do we inside the process called training to develop this feature? I ask myself, and I ask you, dear (and perhaps focused) readers, because this question plagued me during the Rio Olympic Games, especially when I happened to witness an athlete winning a medal, or two or more contenders losing out on the same medal. I was trying to understand this aspect, actually also wondering why we often use the term "attention" as an analogy and synonym. But are focus and attention the same thing, the same reality evoked in different ways? In actual fact they are not. Attention can be defined as the mental state in which our minds are attracted to a particular event of interest, it may be either active or passive. It is a condition that anticipates the state of focus and prepares it. Focus, therefore, by deduction is the ability to be able to concentrate on a certain point of reference, of interest; however, it is also the ability to bring our attention back to the same point, in case we are distracted by something or attracted by something else. Very simple so far: but, how does this interaction work under stress? Obviously, we cannot provide an unambiguous or straightforward answer: everything is not as simple and predictable as the above example would have us believe.
In 1958, Donald Broadbent had already reconstructed the model of the selection of stimuli at the sensory peripheral level, arguing that the human sensory periphery is very similar to information channels where the said information, arriving along and thanks to these channels, is first stored in the short-term memory and then elaborated: however, given that short-term memory is not capable of receiving all incoming information at the same time, it is therefore obliged to select, technically to activate a "filter" that alternates the opening and closing of certain perceptive channels.
J. A. Deutsch & D. Deutsch, unlike Broadbent, argued that the selection of the stimuli received in the sensory channels occurs through an elaborative analysis *a priori*.

Then in 1992, Schönpflug was able to support this hypothesis, claiming that there can be no attention if there is no prior recognition of the object or phenomenon.
According to Baddeley (1986), attention is a complex and costly process in terms of energy and, therefore, has limited ability over time. It is organised in two sub-systems called the "*phonological-articular loop*", the phonological understanding of information, and the "visuo-spatial sketchpad", which has the task of sending information to the medium and long term memory. Both elements are part of a larger container called the *Working Memory*. This model of working memory proposes a conception of memory interpreted not as a series of mnemonic warehouses, but rather as an active cognitive system through the extraordinary effort of the frontal lobe. According to Norman's theory of attention, the selection is not performed through the blockage or the filter of the sensory information, but by selectively processing the information already activated in the memory by the sensory information that is being collected. The demonstration of this automation was shown in an experiment carried out by Stroop, by which its effect is known - *the Stroop effect*. Individuals are shown words printed in different colours, and they are asked to ignore the words and to report only the colour of the words. Typically, the task was executed to perfection, except for cases in which the words represented the names of actual colours which were different from the colour of the ink. In this case, the shortcoming was due to the perception of the meaning of the word almost automatically made by the exercise, which normally facilitates reading but which, in this particular case, represented a disruptive element. *The Stroop effect* can be considered an example of the failure of selective attention.
Daniel Goleman, a psychologist and science journalist, has recently published an interesting book entitled "*Focus: The Hidden Driver of Excellence*", which deals with the topic of attentive processes from various points of view. Goleman claims that the attentive processes in question are closely related to the quality of life. The success or failure of people in all spheres of life, in his opinion, depends primarily on focus. He believes that successful people master three main types of focus:
Inner Focus: is about people and their insights, it guides values and facilitates better decisions. It implies a process of self-awareness, which is one of the most important principles of success, bringing an inner control that helps people chose what to do or not to do in life.
Other Focus: this is the link with people in an individual's life. It involves emotional empathy, cognitive empathy, which gives people the ability to understand another person's way of thinking and of seeing, although, at least apparently, there are no analogies. It encourages, allowing people to put the feelings of another person above their own.
Outer Focus: provides a view of the bigger picture. The most successful people are able to navigate on multiple systems and to have full awareness of their impact on the world.
At all levels of sport, only in a few cases, such as Formula 1 and/or shooting sports, have I been able to systematically see a programmatic and practical study both in training and in competition. I wonder then, if in other sports, the attentive processes are of such little importance that it's enough to say, "Remember to focus!" Or if, on the contrary, attention deserves all our .... attention!

Antonio Urso
EWF President

HORIZONTAL JUMP PREDICTS WEIGHTLIFTING PERFORMANCE

BY RICH J. KITE AND ADAM SPENCE


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INTRODUCTION

Talent Identification (TID) is a process through which a sport's governing body attempts to assess potential future performers. Unfortunately, many athletes will fail to reach the highest level of their chosen sport, despite displaying high levels of skill and physical fitness. Due to the transferable nature of many skills, the TID process may aim to match these athletes to an alternative or more suitable sport[29]. Physical tests are often included as part of a TID process, and may have a particular relevance to sports that do not require perceptual-cognitive capability, especially within closed-skill sports such as weightlifting[43,39]. British Weight Lifting (BWL), the UK national governing body to the sport of weightlifting, currently uses a battery of physical tests in an attempt to identify potentially talented athletes currently training and competing in other sports. The full protocol from BWL consists of flexibility, anthropometric, and physical testing, and is conducted over a number of phases. As the first phase of the BWL TID protocol is carried out at different locations, equipment transportation and assembly needs to be considered. Equally, targeted athletes for this first phase of TID may have little or no previous experience in weightlifting, meaning the selected tests should represent movements or tasks that would be familiar across a number of sports. Both of these factors favour the use of simple field tests. Initial versions of the BWL TID protocol required athletes to perform a vertical jump, a horizontal jump, a 30 m sprint, and an overhead throw with a weighted ball. A winning performance in weightlifting requires the athlete to achieve the highest possible total across two movements: the snatch, and the clean and jerk. Body mass has a strong influence on the total weight lifted, and so competitors are grouped into categories based on their size. Adjusting measures of strength to compare performances across these categories in a strength and conditioning setting is most commonly achieved through a ratio scaling method. However, as the relationship between strength and mass is not linear[10], ratio scaling provides a bias in favour of lighter lifters. Allometric scaling provides a more appropriate method of adjusting lifting performances, although some bias is still present[21]. Comparisons in a competitive environment are achieved by using a scaling exponent known as the Sinclair coefficient. The Sinclair coefficient is recalculated for every Olympic year, and is based on the record performances of the previous years. Despite their limitations, ratio and allometric scaling methods are still useful for making comparisons in a training environment. For athletes with a competitive total, the Sinclair coefficient is most relevant[10]. The competitive weightlifter will lift a loaded barbell from a stationary position on the floor to an overhead position in either one (snatch), or two (clean and jerk) movements. To achieve the required impulse for propulsion, the lifter must apply large magnitudes of force to the bar[17, 22]. In order to take advantage of the stretch reflex, and to ensure continued upward momentum as the lifter's body is reoriented during the pull phases, movements are performed quickly necessitating a high rate of force production[15]. It is for this reason that high-force and high-speed training modalities are used to improve weightlifting performance. Equally, the use of tests such as jumping, throwing, and sprinting may be relevant in a TID protocol due to the strength and power characteristics they share with weightlifting.

Vertical and horizontal jumps have been used as surrogate measures of impulse within a number of sports[41,5]. Whilst vertical jumping tests are most commonly used in TID protocols, the relevance of the standing long jump to weightlifting performance has yet to be established. Vertical jumps and weightlifting movements have been shown to have a high degree of mechanical similarity[11, 13], and so their use in testing protocols relevant to weightlifting is unsurprising. However, as surrogate measures of lower body impulse performance, jumping tests are only able to provide partial explanations of weightlifting performance. For example, countermovement vertical jumps have been able to account for between 23% and 56% of weightlifting performance[4, 16, 40]. In combination with tests measuring different characteristics across the strength-speed continuum, a more complete picture may begin to emerge. There is currently a lack of published research investigating the relevance of horizontal jump performance to weightlifting,

however the simplicity of testing might make this a suitable alternative to vertical jump assessment[25].

The 30 m sprint has been used extensively as a marker for speed, as well as an anaerobic performance measure[41]. Although there have been various studies that demonstrate the efficacy of weightlifting training to increase performance on sprinting[27,38], there is little research assessing the relationships of sprint performance to weightlifting. However, the impact of lower-limb strength qualities on sprint performance are well established[33,42]. Likewise, lower body strength is strongly related to weightlifting performance[2, 37]. Due to the inter-relationship between lower-limb strength, weightlifting performance, and sprint ability, the inclusion of a sprint test within a TID protocol for weightlifting might provide additional performance explanations. The propulsion of an external object is a central principle to weightlifting. Therefore, the use of medicine ball throwing tests may be warranted within a TID testing protocol. The relationships between weighted throws and weightlifting performance have received little research attention. However, Stone et al.[35] did note strong relationships between the snatch and throwing performance. As throwing requires a coordinated interaction between the upper- and lower-body[8,17], weighted throws may be able to explain more variance in weightlifting performance than lower-body focused tests alone.
Whilst each of the tests included in the BWL TID phase-one protocol had been selected based on available literature and biomechanical consideration, the predictive ability of this combination of tests was not originally assessed.

The purpose of this study is to assess the relevance of the tests used in the BWL TID protocol to weightlifting performance. The results were used to provide an underpinning rationale to adapt and optimise the protocol. Furthermore, these results can also provide a foundation from which additional research can identify appropriate test selection for athletes of different backgrounds.

MATERIALS AND METHODS

EXPERIMENTAL APPROACH TO THE PROBLEM

The purpose of this study was to determine the relevance of a simple field-test battery to weightlifting performance, using volunteers who are already competent weightlifters. Subjects were required to attend a testing session within the two weeks following a scheduled and formally officiated weightlifting competition. The testing session consisted of a 30 m sprint, a vertical jump, a horizontal jump, and an overhead medicine ball throw. These tests were selected based on their perceived relevance to weightlifting performance, the ease of administering these tests at different locations, and the simplicity of the tasks allowing non-weightlifting athletes to successfully perform them.

SUBJECTS

Prior to participant recruitment, ethical consent was attained by St. Mary's University ethics sub-committee who determined that the study was in accordance with the Helsinki declaration. Twelve volunteers provided written informed consent to participate in this study. This sample was comprised of seven males and five females of a mixed standard, all of whom were actively training and competing in the sport of weightlifting (Individual participant characteristics can be found in table 1). Participants were provided with both written and verbal information about the study prior to commencement.

PROCEDURES

Participants were required to attend a testing session within two weeks of a scheduled and officiated weightlifting competition. The BWL TID testing battery is comprised of four tests in the following order: a 30 m sprint, a vertical jump test, a horizontal jump test, and an overhead medicine ball throw. Participants underwent a standardised warm-up prior to testing, which consisted of five minutes of low intensity jogging, five minutes of dynamic stretching, and concluded with three 20 m accelerations. All tests were completed in an indoor sports facility on a synthetic surface.

Sprint testing

Thirty metre sprint time (30ST) was measured using single beam light gates (Brower, USA) placed at 0 and 30 m, whilst the participants' start-line was placed at -0.70 m. Participants were required to start the sprint with one hand on the start line, known as a three-point start position. Participants were instructed to sprint past the final set of light gates before decelerating. Participants were required to perform three successful attempts, with no less than two minutes of passive recovery between attempts. The fastest sprint time was used for the statistical analysis. The typical error expressed as a percentage (%TE) in 30 m sprint testing has been reported as 2%[14].

Vertical jump

Participants were required to perform vertical countermovement

jumps (VJ) with each foot placed on one of two portable force platforms (PAS010660; Pasco, USA). The participants held their hands on their hips for the duration of the jump. Participants performed the countermovement to a self-prescribed depth, and at a speed that they felt would allow them to perform their best. Force data were exported and analysed offline. Jump height was calculated using the double integration method to establish peak vertical centre of mass displacement[32]. Participants were required to perform three successful attempts, with a self-prescribed rest period between attempts. The highest jump was used for the statistical analysis. The %TE in CMJ testing has been reported as between 4 and 7%26.

Horizontal jump

The horizontal jump (HJ) required the participants to jump as far forwards as possible from a standing start. Participants were allowed to use an arm swing, and were required to perform an initial countermovement to a self-prescribed depth. The participants were instructed to jump for distance. Any movement following the landing resulted in a foul attempt. The distance between the participants' toe at the start position and the heel that was furthest back upon landing was recorded to the nearest centimetre. participants were required to perform three successful attempts, with a self-prescribed rest period between attempts. The furthest jump was used for the statistical analysis. The %TE in HJ testing has been reported as 2%[23].

Overhead medicine ball throw

Participants were instructed to face the opposite way to the direction of the throw with their feet placed comfortably apart. The participants were required to begin the overhead medicine ball throw (MBT) with the ball held at overhead with straight arms. The participants were then required to perform a countermovement, bringing the medicine ball down between their legs, before forcefully extending through a triple extension pattern to throw the ball overhead. The participants were instructed to throw for distance. The arms were required to remain straight throughout the throw. Males were required to throw a 6 kg medicine ball, whilst females were required to throw a 4 kg medicine ball, corresponding to 7 and 5% of body mass respectively. The distance was measured from the heel of the participant in their initial start position, to the point the medicine ball made first contact with the floor. Throw distance was recorded by the same investigator throughout the data collection period. Participants were required to perform three successful attempts, with a self-prescribed rest period between attempts. The furthest throw was used for the statistical analysis. The MBT has previously been considered to have good test-retest reliability, based on an intraclass correlation coefficient of 0.996[34].

Weightlifting performance

Weightlifting performance was established from a competition held within two weeks prior to completing the testing battery. All competitions attended by the participants were required to have been scheduled into a training plan for a minimum of 12 weeks, and had to be officiated by qualified BWL referees. Absolute lifts and totals, lifts and totals scaled to body mass (ratio), and lifts and totals scaled to body mass raised to the power of 0.67 (allometric) were all included in the statistical analysis. To assess the predictive capability of the testing battery, weightlifting competitive performance was considered as the Sinclair total. The Sinclair total is the product of the absolute total and the Sinclair coefficient. The Sinclair coefficient for 2013-2016 is calculated as:

$$\text{Sinclair coefficient} = 10^{AX}$$

Where:

$A\,(male) = 0.794358141$

$A\,(female) = 0.897269740$

$$X = \log_{10}\left(\frac{X}{b}\right)$$

Where:

X = body mass

$b\,(male) = 174.393$

$b\,(female) = 148.026$

STATISTICAL ANALYSIS

Statistical analysis was carried out using IBM SPSS 22 (IBM Corporation: Armonk, NY). A Shapiro-Wilk test was used in combination with visual inspection of Q-Q plots to assess normality of all variables. A Pearson's product-moment correlation (r) was used to determine the relationships between the HJ, VJ, 30 m sprint, MBT, and the measures of weightlifting performance. Correlation coefficients were defined as trivial when r <0.10,

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Table 1. Participant characteristics, including weightlifting performance

Participant Number	Mass (kg)	Snatch (kg)	Clean & Jerk (kg)	Snatch (Ratio)	Clean & Jerk (Ratio)	Snatch (Allometric)	Clean & Jerk (Allometric)	Total (kg)	Total (Ratio)	Total (Allometric)	Total (Sinclair)
1 (F)	83	35	45	0.42	0.54	1.81	2.33	80	0.96	4.14	91.2
2 (F)	104	62	72	0.60	0.69	2.77	3.21	134	1.29	5.98	140.7
3 (F)	105	62	78	0.59	0.75	2.75	3.46	140	1.34	6.21	146.6
4 (F)	52	40	60	0.77	1.15	2.83	4.25	100	1.92	7.08	153.2
5	70	50	90	0.71	1.29	2.90	5.22	140	2.00	8.13	186.6
6 (F)	58	60	75	1.03	1.29	3.95	4.94	135	2.33	8.89	190.1
7	95	93	100	0.98	1.05	4.40	4.73	193	2.03	9.13	219.2
8	123	100	145	0.81	1.18	3.98	5.77	245	1.99	9.75	255.5
9	94	100	131	1.06	1.39	4.76	6.24	231	2.46	11.01	263.5
10	82	105	126	1.28	1.54	5.48	6.58	231	2.82	12.06	281.1
11	85	110	138	1.29	1.62	5.61	7.03	248	2.92	12.64	296.4
12	79	130	153	1.65	1.94	6.96	8.19	283	3.58	15.15	351.4
Mean	86	79	101	0.93	1.20	4.02	5.16	180	2.14	9.18	214.6
s	20	31	36	0.35	0.41	1.50	1.71	66	0.75	3.16	76.5

F = female. Absolute results are measured in kg, ratio results are reported as multiples of body mass, allometric results are reported as multiples of body mass raised to the power of 0.67. Sinclair total is the product of the absolute total and the Sinclair coefficient

Table 2. Testing battery results

Participant Number	30ST (s)	VJ (cm)	HJ (cm)	MBT (cm)
1 (F)	5.53	25.4	135	590
2 (F)	5.39	32.7	183	740
3 (F)	4.83	35.5	190	940
4 (F)	4.81	46.7	216	985
5	4.44	43.4	229	726
6 (F)	4.18	47.6	231	610
7	4.24	42.3	249	1235
8	4.59	55.7	257	1430
9	4.65	48.0	243	990
10	4.46	56.3	264	750
11	4.28	52.8	259	1080
12	4.29	57.9	266	960
Mean	4.64	45.4	227	920
s	0.44	10.1	40	252

F = female.

small when r = 0.11-0.30, moderate when r = 0.31-0.50, large when r = 0.51-0.70, and very large when r >0.71[12]. 95% confidence intervals (95% CI) were also calculated for the correlation coefficients. Predictors of weightlifting competitive performance (Sinclair total) were identified using a stepwise regression analysis. Only the best single variable model was accepted due to the sample size. As the participants were drawn from an opportunity sample, a post hoc power analysis was carried out using R (package "pwr", with extension "powerSurvEpi")[6,31]. Alpha was set at 0.05, and beta at 0.20.

RESULTS

Visual inspection of Q-Q plots and the results of the Shapiro-Wilk test indicated none of the data violated assumptions of normality. The weightlifting performances are provided in table 1, and the results of the testing battery for all participants are provided in table 2. The coefficient of variation (CV) for all weightlifting performance measures were between 33 and 39%, indicating a wide range of competitive standards. The results of the correlational analysis are presented in table 3. The MBT was not significantly related to any of the weightlifting performance measures, however demonstrated a large significant relationship to absolute clean & jerk performance (r = 0.58; 95% CI [0.01, 0.87]). The VJ demonstrated very large significant relationships to all measures of weightlifting performance, but was most strongly related to Sinclair total (r = 0.89; 95% CI [0.65, 0.97]). The HJ test demonstrated very large significant relationships to all measures of weightlifting performance, and was also most strongly related to Sinclair total (r = 0.90; 95% CI [0.67, 0.97]), shown in figure 1. Results from the 30ST, VJ, and HJ tests were entered into a stepwise regression analysis, using Sinclair total as the dependent variable. The results of this analysis indicated the HJ was the strongest predictor of weightlifting performance, accounting for 79% of the variation in Sinclair total (SEE = 35; F = 42.5; p <0.001). The equation predicting weightlifting performance from the HJ is included in figure 1. The post hoc power analysis was conducted on the lowest and highest significant correlation to weightlifting performance (Sinclair total). Using this sample of 12 participants (where alpha was set a priori at 0.05, and beta at 0.20), a Pearson's product moment correlation coefficient of -0.72 and 0.90 return powers of 0.80 and 0.99, respectively.

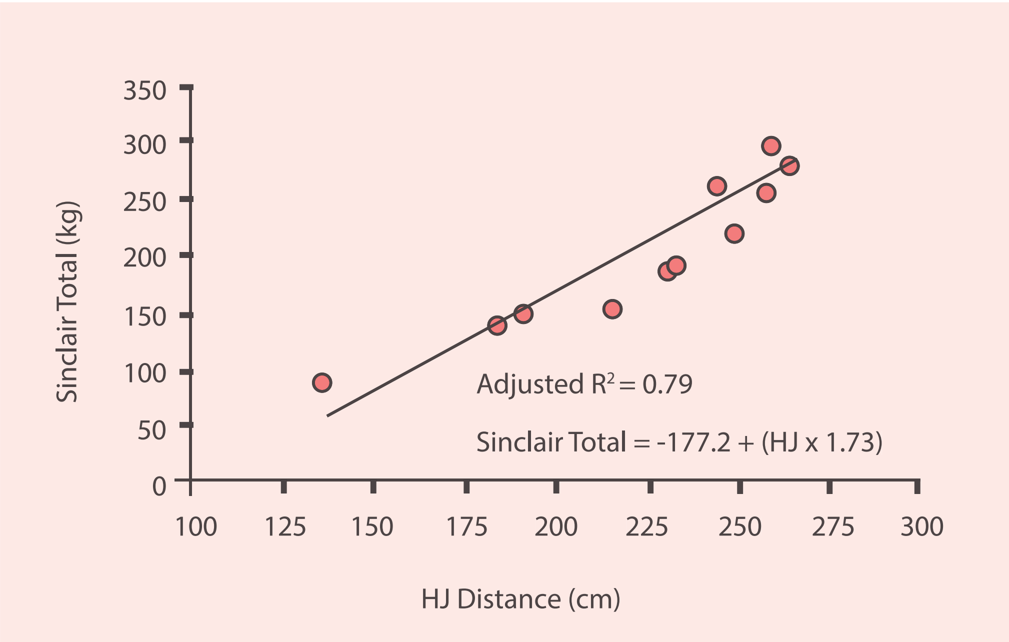

FIGURE NO. 1
RELATIONSHIP BETWEEN HJ DISTANCE AND SINCLAIR TOTAL.

Table 3. Results of the correlation analysis

	Snatch (kg)	Clean & Jerk (kg)	Snatch (Ratio)	Clean & Jerk (Ratio)	Snatch (Allometric)	Clean & Jerk (Allometric)	Total (kg)	Total (Ratio)	Total (Allometric)	Total (Sinclair)
30ST	-0.58 [-0.87, -0.01]	-0.61 [-0.88, -0.05]	-0.73 [-0.92, -0.28]	-0.78 [-0.94, -0.37]	-0.70 [-0.91, -0.22]	-0.75 [-0.93, -0.32]	-0.60 [-0.87, -0.05]	-0.77 [-0.93, -0.36]	-0.74 [-0.92, -0.29]	-0.72 [-0.91, -0.24]
VJ	0.76 [0.32, 0.93]	0.83 [0.49, 0.95]	0.83 [0.49, 0.95]	0.91 [0.69, 0.97]	0.83 [0.48, 0.95]	0.92 [0.73, 0.98]	0.81 [0.44, 0.94]	0.89 [0.63, 0.97]	0.90 [0.64, 0.97]	0.89 [0.65, 0.97]
HJ	0.81 [0.43, 0.94]	0.85 [0.54, 0.96]	0.83 [0.48, 0.95]	0.87 [0.59, 0.96]	0.84 [0.52, 0.96]	0.90 [0.68, 0.97]	0.84 [0.51, 0.95]	0.86 [0.57, 0.96]	0.89 [0.64, 0.97]	0.90 [0.67, 0.97]
MBT	0.53 [-0.07, 0.85]	0.58 [0.01, 0.87]	0.22 [-0.41, 0.70]	0.22 [-0.41, 0.70]	0.33 [-0.30, 0.76]	0.36 [-0.28, 0.77]	0.57 [-0.01, 0.86]	0.22 [-0.40, 0.71]	0.35 [-0.28, 0.77]	0.27 [-0.17, 0.81]

Values are provided as Pearson's product moment correlation coefficient (r) with 95% confidence intervals in square brackets. Confidence intervals that do not cross zero indicate significant correlations.

DISCUSSION

The purpose of this study was to provide insight into the relevance of the BWL TID testing battery. The relevance of these tests to weightlifting performance, defined as Sinclair total, was assessed using 12 weightlifters, all of whom varied greatly in respect to current performances and training history. The findings of this study demonstrate large and very large relationships between the 30ST, VJ, and HJ to weightlifting performance. While the MBT was not found to be significantly related to weightlifting performance, it was significantly correlated with absolute clean and jerk (CJ) performance. Despite the common emphasis of relationships between vertical jumping and weightlifting performance[9], the results of our analysis demonstrated HJ as the strongest single predictor of weightlifting performance, able to explain 79% of the variance in Sinclair total. The key finding of this study is the strength of the HJ in predicting weightlifting performance. The HJ has been used as an assessment tool in numerous athletic environments, and has been used to predict athletic performance across a range of running distances, long jump and triple jump, and noted as an effective assessment of lower body power[1,20]. However, the HJ has not been given much attention in regards to its position within power sports, unlike the VJ, which has been found to be strongly correlated with a number of athletic power movements, such as weightlifting, sprinting and throwing[1,30]. It should be noted however, not only did the HJ and VJ demonstrate practically comparable relationships with Sinclair total (r = 0.90, and 0.89, respectively), but HJ and VJ were found to be highly correlated with one another (r = 0.94), and so are both a demonstration of a common physical competency. Unfortunately, accurate and reliable testing of vertical jump performance requires the use of force platforms or contact mats, both of which might be prohibitively expensive for many smaller weightlifting clubs. However, horizontal jump performance measured by tape measure has been found to be a valid performance measure[25], and might provide a cheap and logistically favourable method of assessing lower limb impulse capabilities.

VJ performance is a commonly used surrogate measure of high force and high velocity lower limb extension capability, and is thought to correspond with weightlifting performance. The relevance of the VJ to weightlifting performance has been established from studies assessing the underpinning biomechanics[3,13,22], training

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studies[7,18,38], and investigations of performance correlates[4,28,40]. Large relationships between VJ and weightlifting performance (r = 0.71-0.83)[40], the snatch (r = 0.60-0.75)[4,40], and the clean and jerk (r = 0.59-0.79)[4,28 40] have previously been reported. The findings of this study demonstrate very large relationships between VJ and measures of absolute weightlifting performance, and relative weightlifting performance. In comparison, Vizcaya et al.[40] found very large relationships between Sinclair total and the deep squat jump (r = 0.83), the squat jump (r = 0.71), and CMJ (r = 0.75). Whilst qualitatively comparable, the coefficients presented by Vizcaya et al.[40] are slightly lower than the present study. This is likely explained by the fact that the sample group used by Vizcaya et al.[40] were of a higher weightlifting standard (Sinclair total = 287.7 vs. 214.6), and had more homogenous performances (CV = 20.5% vs. 35.6%), than the sample used here. This might suggest that performances can be better explained through different tests dependent on competitive standard, likely as a result of differences in underpinning physical qualities and differences in technical ability. **The HJ** is currently somewhat under-researched in terms of its use in talent identification, and specifically for weightlifting performance assessment. However, our findings demonstrate a very large relationship between the HJ with absolute weightlifting performance and relative weightlifting performance. Outside of weightlifting, the HJ has been found as a reliable tool to predict athletic performance in shotput (r = 0.72)[1], and shown to have a large correlation with sprint acceleration
(r = 0.61)[30], peak sprint velocity (r = 0.67)[30], and a very large correlation to strength
(r = 0.81)[30]. Additionally, it is noteworthy that Peterson, Alvar & Rhea[30] found a large correlation to sprint performance only in females (r = 0.61-0.66), with a weaker correlation with males (r = 0.42-0.48). This potentially highlights sex differences in underpinning biomotor qualities, which is worth considering when providing exercise selection for TID purposes. Similar to the HJ, sprint tests and weightlifting performances are currently lacking depth in research. Hori et al.[19] reviewed the correlation of the hang power clean and change of direction, sprint and jump performances. A large correlation was noted from Hori et al.[19] between one-repetition maximum hang power clean and 20 m sprint performance (r = -0.58). Similar findings are presented in this study between the clean and sprint performance. This study noted a large correlation with sprint performance and absolute weightlifting performance, and a stronger relationship with relative performance. Due to the strong relationships previously noted between measures of strength and sprint performance[33,36], it is unsurprising that we see these correlations between short distance high velocity running and weightlifting performance, which itself is highly correlated with measures of strength[37]. Whilst our study does provide evidence that there is a

strong relationship between weightlifting and sprint performances, there was not enough unique variation explained to warrant the inclusion of the 30ST into the prediction model.

The MBT has been used as an assessment for power and validated as a reliable test by Stockbrugger & Haennel[34] who also demonstrated a very large correlation between MBT and VJ power index (r = 0.91). In the present study, the MBT was able to provide a large significant a correlation with the clean & jerk, but failed to demonstrate any significant correlations with relative weightlifting performance, or absolute performance. As the MBT demonstrates the ability of the lower body, trunk, and upper body to express power as a working unit[34,24], the inclusion of this the MBT as a test to predict weightlifting performance initially seemed appropriate. Considering the sport of weightlifting is based around the sequencing and coordinated contributions of the legs, trunk, and arms[17], there would have perhaps been an expectation for a greater relationship between MBT and performance than was found in this study. A likely contributing factor to this was the arbitrary mass of the medicine ball used in our testing. In line with the BWL TID protocol, males were required to throw a 6 kg ball, whilst females were required to throw a 4 kg ball. Considering the difference in mass between the heaviest and lightest participants in our study, it stands to reason that the resulting difference in relative load experienced by each participants may have impacted in the ability of the test to differentiate performances in this test. Future work should aim to identify how this test differentiates performance in samples of similarly sized weightlifters.

The purpose of this study was to establish the relevance of the phase-one BWL TID testing battery against weightlifting performance. To do this we purposefully recruited male and female participants who were representative of different weight categories, levels of weightlifting experience, and performance standards. Of course, the strength of relationships between selected tests and measures of physical performance are sensitive to the characteristics of the sample, and to the sample size. It is also important that future research considers the relevance of this TID testing battery to athletes of a particular standard, athletes from different weight categories, using a larger sample, and assessing their relevance to male and female weightlifters separately. In addition, it should be remembered that these physical tests only provide a snapshot of current ability, not of potential. Any physical testing battery related to a TID program should carefully consider how these tests are able to demonstrate underlying physical traits and therefore future potential, rather than simply reflecting their current training state. Finally, each of the tests included in the BWL TID testing battery have previously been demonstrated to be correlated with maximal strength. As such, future research should include an independent measure of strength alongside these tests, in order to establish the extent of the shared variance. It should be noted that the results of this study have already been considered as part of an updated BWL TID protocol, and further research in optimising this approach is ongoing.

CONCLUSIONS AND PRACTICAL APPLICATIONS

The results of this study provide early evidence that the HJ can be used as an appropriate predictor of weightlifting performance for adults. Due to the relatively small sample size, generalisation and extrapolation should be applied cautiously. However, the results of the post hoc power analysis support the validity of the results presented here. The limited requirements of resources for the execution of the assessment provide a logistical advantage over other forms of assessment. However, the practitioner should carefully consider the relevance of this particular test to the athletes they are working with, with particular consideration to performance standard, previous experience, and sex. Furthermore, the relationships demonstrated between VJ, HJ, and 30ST with various measures of weightlifting performance provide additional evidence that these movements all share similar underpinning strength and power requirements. Therefore, training for enhanced high-force and high-velocity actions could be optimised by the inclusion of some, or all, of the exercises presented in this study.

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PROTECTED: ACHILLES TENDON RUPTURES AND THE NFL

"The speed at which animals can turn depends on the forces involved in cornering, and larger animals need to produce greater forces for any given turn. However, larger animals can apply relatively less force than smaller animals for turns and so cannot turn as rapidly." R.Wilson, I. et al 2015

BY ANDREW "BUD" CHARNIGA

Three essays ("Its all connected" parts I-III) dealt with various issues relating to ubiquitous misinformation inspired by the academic and medical communities, research flawed by gender bias and the possibility to employ a 'reverse engineering' concept to gain insight into injury mechanisms in sports, were elucidated.In an effort to gain objective insights into some common sports injuries to the lower extremities; the low injury rate of weightlifters principally to the ankle joint, and, especially among females were examined. Most of the examples presented were of female weightlifters, who would be expected according to the biased thinking of American academia, to suffer certain injury. The non – injury events were explained within the context of special reactive physical qualities acquired through training for Olympic style weightlifting competitions. It was reasoned these reactive physical qualities are injury prophylactic. A general conclusion formed from these essays was the all the too apparent lacking of these qualities in the preparation of many American athletes; hence the high injury rate of ankles and knees.

To continue along the same line of reasoning of reverse engineering mechanisms; this essay will focus on one injury in particular, a rupture of the Achilles tendon in professional American football.

Is there a connection between predisposition for injury and exercise techniques?

The answer to the question as to whether certain exercise techniques, specifically, strength and conditioning exercise techniques popular in the training of football players from high school to professional ranks can predispose one to injury is an unequivocal yes.

How To Go About Breaking Biological Springs

"We run and jump in a similar fashion, stretching our Achilles tendons by about 5% as we stress them with forces around seven times our weight. We also store energy in the tendons of our feet themselves." Steven Vogel, 1988. It should be emphasized such a simple assertion that strength and conditioning exercise techniques can predispose one to injury; must

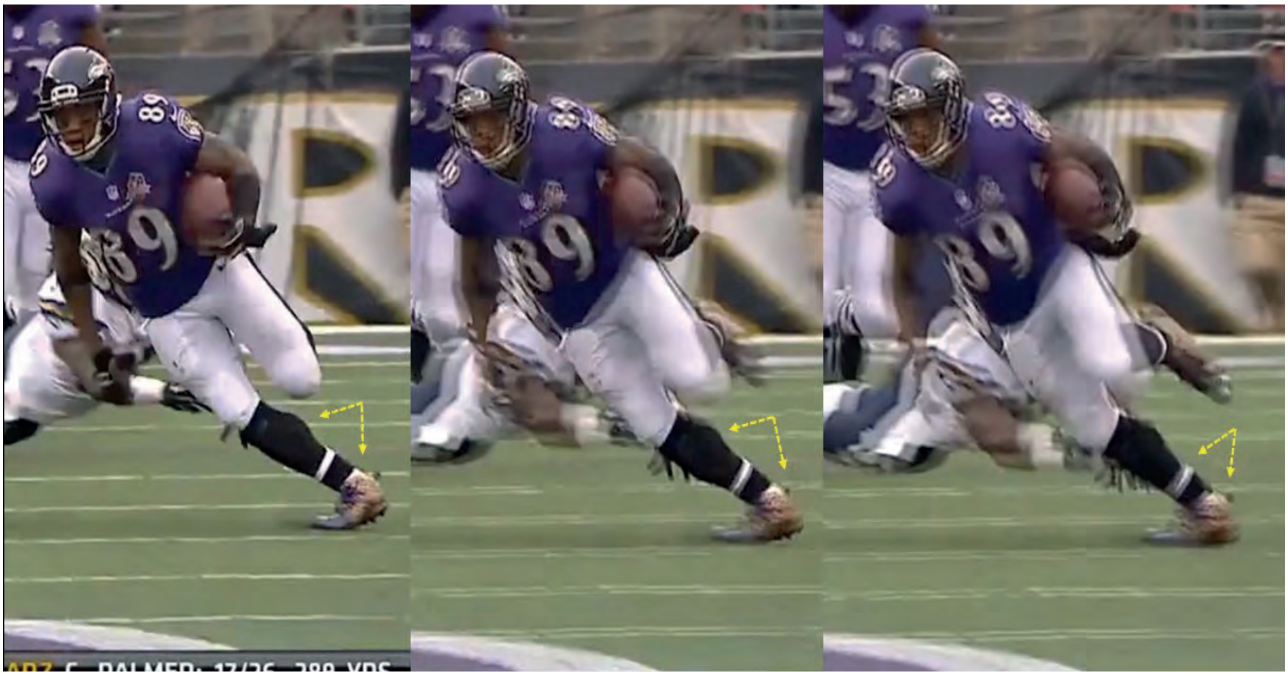


Figure No. 1

Professional football player ruptures Achilles tendon cutting to avoid tackle in open field. In general, strength and conditioning exercises and techniques employed for football players fail to take into account actual game conditions: to pursue and avoid pursuit. Sharp changes of direction necessitate lowering body center of mass and subjecting the lower extremities to increased loading to produce the centripetal acceleration for tilting the body and at the same time prevent toppling over (Biewener, 2007; Wilson, 2015). The viscoelastic properties of the tendons, especially the Achilles, come into play to enhance the body's ability to produce those forces to make sharp turns without toppling over.

be inclusive the influences of the medical community, the academic community, the athletic training and physical therapy professions exert in the training room and on the athletic field. For example, a by no means comprehensive list of sources which influence conditioning techniques and methods is presented below.

- **Bodybuilding; Powerlifting**
- **The National Strength and Conditioning Association (NSCA)**
- **Equipment manufacturers**
- **Personal training associations**
- **Strongman competitions**
- **Exercise emporiums**
- **Professional athletic trainers**
- **Physical therapists and orthopaedic surgeons**
- **Questionable research: especially gender biased**
- **University sports medicine programs and textbooks**
- **Olympic lifting**
- **Online gurus**

Indeed, the influence of the various sources are obvious from the amalgamation of strength and conditioning exercises and techniques to be found in school, university and professional football weight rooms; and, are part of the training in certification programs:

- Exercise techniques, especially strength training exercises, tend to be choreographed to conform to arbitrarily defined limitations of movement deemed 'safe';
- Exercise techniques can be based on rudimentary knowledge of biomechanics and/or kinesiology;
- The ubiquitous presence of equipment manufacturers dictates most of the types exercises and the equipment used: racks; chains; benches; machines; bands; ropes; tires; balls, etc.;
- The teaching and mastery of complex motor skills in general, are antithetical to exercises employed in weight rooms;
- Exercise to fatigue and/or prolonged straining over single repetition in weightlifting exercises are frequently emphasized in strength training workouts for athletes.

A connection between the rather high number of Achilles ruptures suffered by NFL players, 13 for instance, by the first week of the 2011 season, and a single predisposing factor is not possible. However, such a connection is possible with the amalgamation of all the above influences, acting together over time. This conclusion is based on analysis of non – contact Achilles ruptures where there is no obvious predisposing factor such as another player or players falling on the injured or otherwise subjecting the tendon to unusual strain. According to various sources in the literature (Khalid, Hsu, Shaginaw, Myer, Siebert) the frequency of Achilles tendon ruptures in the NFL appears to be on the rise; even though accurate data as to the precise number of incidents is hard to come by. The NFL is a business, not an open book; even though the overall injury rate is high; likewise the cost in human and financial terms. Various misinformation can be ascertained relative to the etiology of such a devastating injury. From the little data available, approximately one third of football players are unable to return to the game after suffering an Achilles rupture. Many more have difficulty or are unable to return to their pre – injury power capabilities. The generally acknowledged prevalence of at least 5 – 10 ruptures per year probably costs the league in the tens of millions of dollars. Surgery is usually necessary, recovery can take up to a year; replacements have to be found while the athlete is recovering or if the injury is career ending. Viewpoints vary as to how football players go about breaking the body's largest, strongest spring, but not widely so. From the standpoint of the orthopaedic surgeon, the mechanism of Achilles tendon rupture involves: "Mechanisms leading to tendon failure involve the rapid loading of an already tensed tendon. Proposed mechanisms of loading or overloading that result in an Achilles tendon failure include a dorsiflexion force to the ankle with a strong contraction of the triceps surae muscle, pushing off of the weight-bearing foot with the knee in extension, and a strong dorsiflexion force on the plantar flexed ankle". (Khalid, 2016)

This mechanism echos a viewpoint of the Achilles rupture etiology from athletic training:

"I saw a common mechanism for most of them. The athlete takes some kind of back step and as he pushes off, his knee extends at the same time. This combination

Figure No. 2

Female still in mid – air before landing back – foot – first to fix 154 kg barbell, with extremely flexed ankle. Compare this to football player at the approximate instant of rupturing Achilles tendon after planting foot while carrying a 450 gram football.

of eccentric loading of the Achilles followed by forceful plantar flexion and knee extension may overload the tendon causing rupture". Justin Shaginaw, (2015)

And, from another surgeon:

"Stepping backward onto the toes in order to push off the ground to suddenly start forward."

"Pushing forward into opposing players by standing on the toes and driving the heel to the ground."

"Stopping suddenly on the toes in an attempt to quickly change directions." Seibert, (2011)

What this technical gobbledigook means is the body's largest, strongest spring blows apart as a result of everyday, normal running, turning, jumping mechanics: extending the leg against a raised heel. How one can run about a football field, run and jump about a basketball court and so forth, without straightening the knee, hip and ankle without raising the heel, i.e., sans this biomechanics, is left to the imagination. Even more to the point, how can any explosive motion from the lower extremities be effective without all the muscles, tendons and ligaments working together in the just describe gobbledigook manner? Consider the contrasting circumstances depicted in the three photos of figure 2. A 75 kg young woman is jerking a 154 kg barbell (205% of her bodyweight). The Achilles tendon of the football player's right ankle ruptures at approximately the instant he pushes off while running with the ball. The difference between the massive strain (normal for weightlifters) on the lifter's tendons and that of the football player's Achilles, who suffered a serious injury is the woman's 'spring' stretches, elongating up to 5 – 6% of its length to store strain energy. On the contrary, the football player's tendon ruptures as it resists by comparison a modest, natural elongation. There is nothing out of the ordinary or unusual about the conditions under which the football injury occurred. Tendons are designed to store and release elastic energy, that is why they are referred to as viscoelastic. The weightlifter in the example dissipates the combined forces of the her bodyweight and the barbell on her tendons while storing strain energy. The elastic (strain) energy from the stretch is released just as a spring recoils, when the lifter pushes off to straighten her legs. More power is generated with this recoil than is possible from mere

Figure No.3
Female weightlifter lifting 154 kg, pushing off the rear foot from a extreme stretch of Achilles and other tendons and ligaments of the ankle and foot. Charniga photos

muscular contraction. There is no logical argument, no amount of technical jargon which can demonstrate the relatively low stress tendon blow out circumstances of the football player are at all comparable to those of the everyday, massive strains on the weightlifter's tendons. The young woman's Achilles tendon and indeed the ankle joint, are subjected to strain far exceeding the rather modest forces on the tendons of the football player's ankle; which resulted in serious injury. "Whenever the Achilles lengthens too much too sharply, it can rupture." (Seibert, 2011)

Were there any truth to the above statement Achilles tendon ruptures would abound; especially in weightlifting.

Another line of thinking about tendon rupture etiology is from the standpoint of conditioning coaches. Since a lot of these injuries occur in preseason or training camps it was reasoned (and this is echoed by the surgeons) the players were out of shape when they reported to camp and may have "Exercise deficit disorder"; a term used to describe young athletes: "who do not have enhanced physical prowess and necessary neuro – muscular control are at increased risk of injury, as evidenced by epidemiological reports on anterior cruciate ligament injuries…." Myer et al, 2011 Consequently, the authors concluded the rash of injuries which occurred in the immediate aftermath of the 2011 NFL lockout were due to the players reporting to training camp in the absence of sufficient time training with the strength and conditioning coaches, athletic trainers and medical staff 'to ease them into the rigors of preparing for the football season'. (Myer et al, 2011)

Prematurely aging the younger athlete

In their review Myer, et all, 2011, noted that research of NFL Achilles ruptures established an average age of 29. Whereas, Myer, et al, found that of the rash of rupture injuries in 2011 the average age was 23.9 years. As already noted the authors attributed this catastrophic injury to a lack of time with the amalgamation of conditioning coaches, trainers and physical therapists; creating a sort of "Exercise deficit disorder". A far more plausible explanation for the rejuvenation of rupture victims is the cumulative effects from an earlier onset of bodybuilding/powerlifting exercises and techniques in strength training, ankle taping, i.e., restrictive range of motion exercises and supported taping, already, in high school. Surgeons typically see this type of injury with "40 – 60 year old" male weekend warriors playing pick up basketball and such (Stone, K., 2015).

The common thread between the NFL and the middle age rupture victims, unequivocally, is a loss off muscle – tendon elasticity. The football players have been 'stiffened' with bodybuilding/powerlifting exercises and a general lack of bending the hip, knee, and, especially the ankle through a large amplitude of motion; roughly equivalent to what happens to the weekend warriors: aging and lack of conditioning. Were the assessment of Myer, et al, at all plausible there would be sufficient evidence to demonstrate Achilles ruptures were a common injury in the more than 100 year history of American football. And, with advent of the strength and conditioning coach, athletic trainers taping ankles and knees, taping shoes to ankles, knee braces, and so forth; the rate of Achilles ruptures would naturally decline because the players with "Exercise deficit disorder" would have begun to disappear, i.e., the ankles of young athletes would be better 'conditioned' and protected with tape and braces. On the contrary, sans data preceding the appearance of the weight coach and ankle taping practitioners; most observers acknowledge the rate is rising. Furthermore, since when did this disease known as "Exercise deficit disorder" make its appearance?

The high rate of injury to the lower extremities, especially Achilles ruptures, strongly suggests something is radically wrong with the training and general preparation of football players A logical explanation, with an extraordinarily high probability, is the etiology of such an unusual, devastating injury to young elite athletes can be traced to heavy reliance on bodybuilding/powerlifting exercises and methods in the strength and conditioning of football players. These practices are all the more problematical because they are coupled with the mobility altering use of taping/bracing of joints. This type of strength training over time produces 'linear robots'; capable of running linearly; which in actuality, contradicts the typical demands of the game. "At first glance, tendon looks like a poor spring. We've been talking it about it here as an inextensible spring, and a spring must stretch to be of any use. In reality, though, tendon can be stretched, just not very much; it breaks when elongated beyond about 8 percent." Steven Vogel, 1988. Based on this statement by highly acclaimed biologist Steven Vogel, tendons are biological springs, the function and purpose of which is to stretch and recoil. These biological springs allow animals and humans to generate forces to jump further and run faster than is possible from contraction of all the muscles involved in these actions. A tendon can rupture when it is stretched up to 8% of its length. That being the case, it is highly unlikely the rupture injuries common to the NFL involve stretching the body's main springs to 8%. Why? Because very, very few if any of the players ever elongate

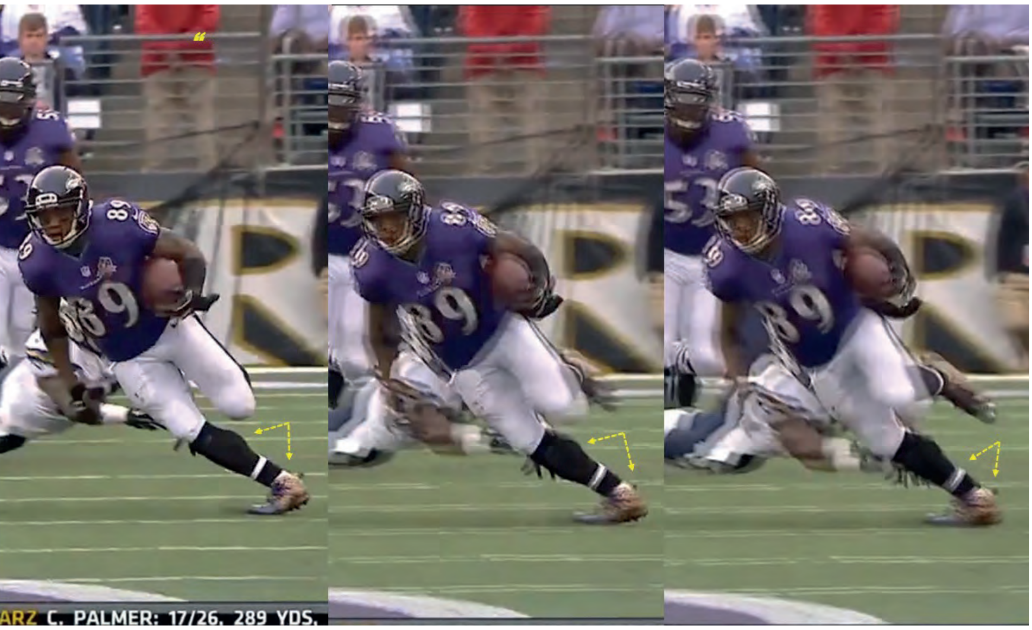


Figure No. 4
Professional football player ruptures Achilles tendon avoiding pursuit while 'pursuers' likewise must alter linear movements to tackle runner.

their Achilles in weight room exercises or on the field remotely close to that of the young female weightlifter in the illustrations. Consequently, after many years of powerlifting/bodybuilding weight room exercises, taping and spatting ankles, knees and so forth and normal playing conditions where the knee and ankles do not bend through a large amplitude of motion; the average NFL player's range of motion, and especially the muscle – tendon elasticity of the lower extremities deteriorates. In all probability the tendon ruptures because this loss of elasticity creates internal resistance to what should be normal coordination of muscles and elongation of tendons and ligaments from hip to foot.

The actions described above of football players extending lower extremities are normal movements and are precisely how humans and animals achieve power outputs unattainable by mere contraction of muscles.

False notions of what constitutes acceptable movement amplitude in strength and conditioning exercises, taping, bracing and so forth, coalesce to ultimately to increase the vulnerability of the ankle joint tendons and ligaments in sports like American football

The idea that the ability to turn the ankle (inversion) rapidly could be part of a complex reaction; an injury prophylactic; does not exist in the world of athletic training

The ankle joint is full of Biological springs – called ligaments and tendons. That being said, it is illogical to arbitrarily determine 'safe' and 'unsafe' motions for the ankle; and of course it goes without saying; to likewise go about taping or otherwise restricting motion in joints which are set up to move in harmony, interconnected and inter-conditionally to all other joints. See illustrations in figures 6-8: "A human or animal body is a complex structure whose parts move relative to each other." R. McN. Alexadner, 1988

Figure No. 5

Dialectical contradictions arise when serious non – contact football injuries to the lower extremities are contrasted with normal, non – injury inducing weightlifting exercises; this, despite significantly greater stress on the 'un – protected' lower extremities of weightlifters. Contrasting circumstances are depicted above of injury with normal high stress on lower extremities. From left to right: A serious knee injury occurs from non – contact running; a female executes a normal maximum bending in ankle joint while fixing 220% of bodyweight overhead in the clean and jerk; an Achilles tendon rupture from non – contact movement in football..

Figure No. 6

Note: Perceived extremely narrow 'safe' range of movement of the ankle joint illustrated in the picture on the left and the obvious solution to 'protect' the ankle by 'spatting' the foot and ankle joint to the shoe.

Figure No. 7
Three photos depict female and male weightlifters twisting ankles. In each case the athlete twisted the ankle holding a heavy barbell overhead, without consequence.

Football-injurya

Bodybuilding/powerlifting movements constitute the majority of exercises and techniques to be found in the high school, college and professional weight rooms. In general these exercises are not performed with full range of motion in joints; are performed slowly with heavy weights and/or become slow in one set with multiple repetitions. These exercises are low skill movements, relatively simple in motor structure; or, in the case of weight machines, movement constitutes antithetical skill.Furthermore, with heavy weights or prolonged contractions through multiple repetitions this type of training is almost indistinguishable from isometrics. Strength training in this manner over a long period of time has been shown to reduce muscle – tendon elasticity. Hence, Russian sport scientists who studied the negative effect of bodybuilding/powerlifting exercises for strength training athletes in dynamic sports note:

“All of this has a negative effect on muscle elasticity, on their ability to stretch and relax, and an unfavorable effect on those sport exercises which require speed strength and precise movement coordination.”A.I. Falameyev, 1985

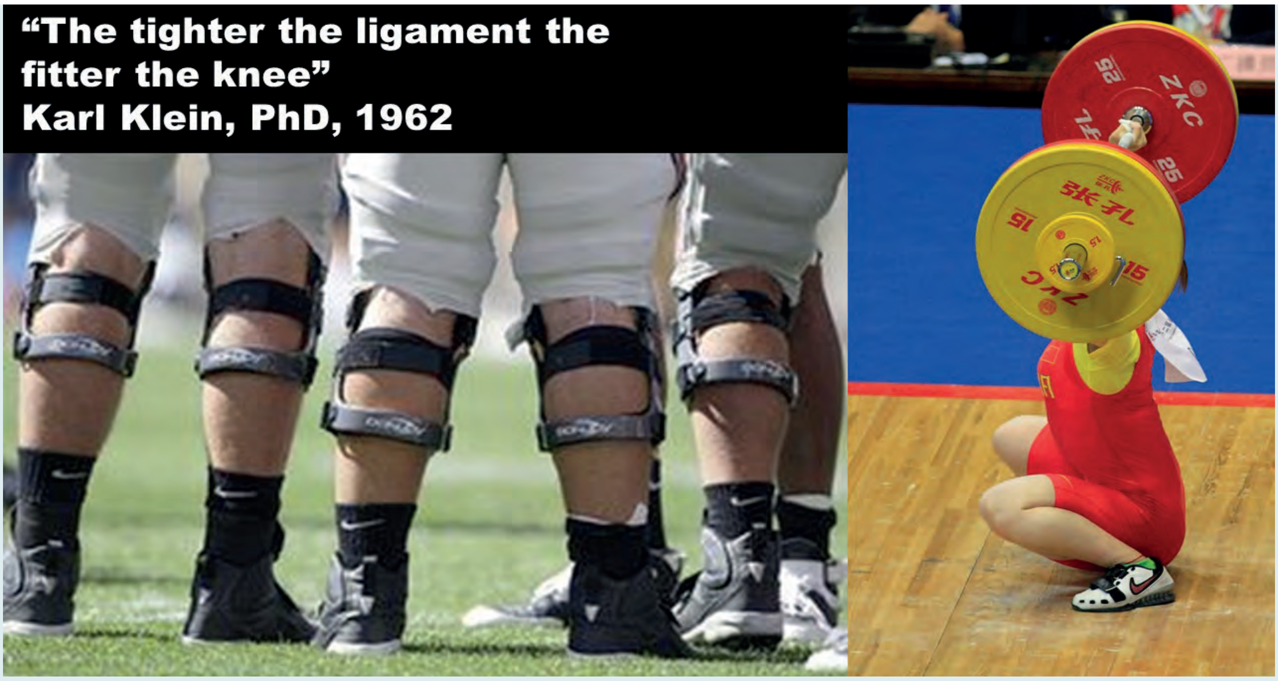


Figure No. 8
The single worst idea ever conceived in the realm of athletic training: ‘tighter ligaments’ , and the disastrous aftermath it has spawned. Football linemen wearing knee braces with high top shoes and no doubt, ankles taped for additional support to prevent injury. A stark contrast between football linemen required to “tighten” joints with braces with female weightlifter subjecting the lower extremities to extreme loading snatching 103 kg; sans any support other than bone, muscles, tendons and ligaments.

Figure No. 9
Elite collegiate football player suffers season ending knee injury attempting to decelerate; his right leg is injured with heel strike first, in pursuit of opposing runner who is cutting to avoid tackle. More than sufficient evidence of the myriad influences affecting the training of football players from the list provided can be found in numerous weight room videos posted by universities and professional teams.

For instance:

- **www.youtube.com/watch?v=e-jopcihzmm**

In this video the athlete is 'coached' to perform slow grinding half squats chained to a resistance machine;

- **www.youtube.com/watch?v=3zzVLRARNMo**

In this video athletes perform powerlifting type squats with heavy weights, inside rack with depth of bending controlled, employ machines etc.;

- **www.youtube.com/watch?v=vtxsW8yydac**

The coach in this video instructs athletes to squat, pointing out that he has good ankle flexibility. A classic example of the blind leading the blind, he sits back in half squat with shins vertical.

- **www.youtube.com/watch?v=xWBSf4BfKRk**

ACL injury prevention video demonstrates techniques to prevent knee injury. The concepts presented to bend a certain way with feet aligned with shin and so forth contradict the un-choerographed demands on the athletes lower extremities on the field.

- **www.youtube.com/watch?v=x7Bl7rMGQxc**

This video is a vivid example of the utter lack of any conceptual understanding of flexibility, suppleness, muscle tendon elasticity and so forth. How else can this be described other than a 'carnival barker' leading players 'stretching' boards at a lumber yard.

Compounding the "stiffening" effect of bodybuilding/powerlifting training in the football weight room; add the athletic trainer taping ankles, knees, shoes to ankles and so forth and over time, 'linear robots' emerge. Consequently, it is precisely when the players report to training camp that these muscle – tendon – joint stiffening influences coalesce. When players' whose muscles have been 'stiffened' by bodybuilding/powerlifting movements and machine exercises, take the field and are expected to perform dynamic, explosive movements with taping and bracing they are confronted with what the Russian sport scientists call 'internal resistance'. The agonists/antagonists involved in a motor action have to 'cooperate' in order to minimize internal resistance to movement and maximize power output. Furthermore, this 'cooperation' allows athletes to react to unanticipated conditions and avoid injury. Consider the quote below referring to this concept of lessening internal resistance by training with movements of large amplitude.

"It is easy to stretch the muscle antagonists and thereby lessen the resistance to the power of the muscle agonists, the contraction of which perform the movement, if one possesses large movement amplitude." A.N. Vorobeyev, 1988

It is rare if any football player exercises the knee, hip and ankle through a large range of movement. This, out of fear of bending the knee and ankle so far as to stretch ligaments and tendons, i.e., the influence of strength and conditioning coaches, trainers, academics, medical staff, etc. Consequent-

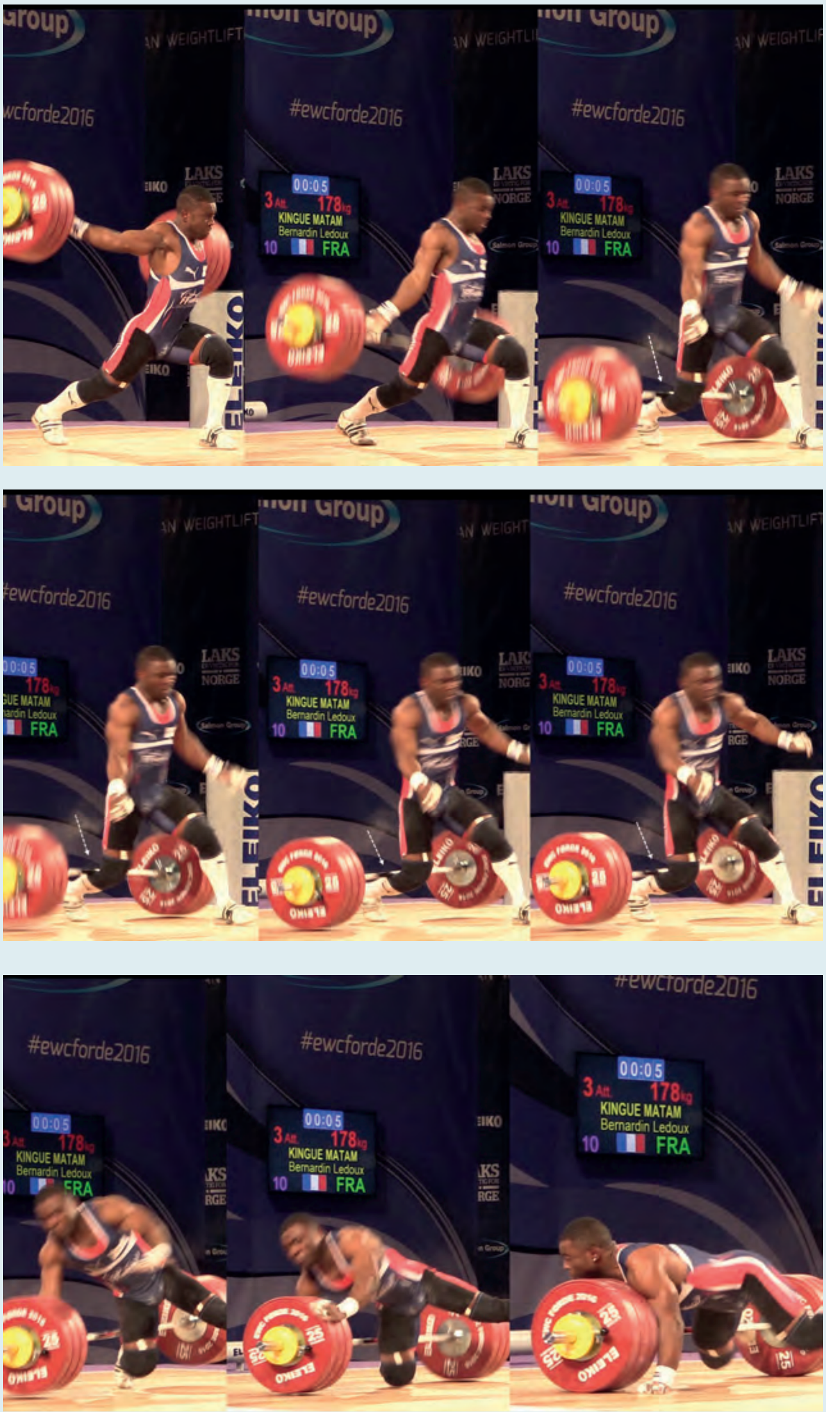


FIGURE NO. 10 - 10.B - 10.C

A CONTACT 'NON – INJURY' IN WEIGHTLIFTING. WEIGHTLIFTER DROPS 178 KG ON HIS SHANK WITHOUT SUFFERING INJURY DESPITE ABSORBING THE FULL WEIGHT OF THE BARBELL. THE ELASTICITY OF THE LIFTER'S MUSCLES AND ESPECIALLY THE ACHILLES TENDON DISSIPATE THE ENERGY OF THE FALLING MASS WHICH UNDER ANALOGOUS CONDITIONS ONE WOULD EXPECT SOMETHING LIKE THIS TO LAY WASTE TO A WHOLE FOOTBALL TEAM.

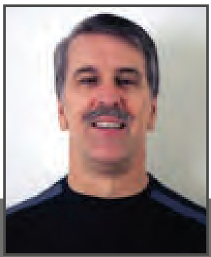
ly, the axiom from Biology 'use it or lose it', applies to the prospect of losing range of motion in joints and especially muscle tendon elasticity; after years joint stiffening exercises, taping and bracing of joints.

CONCLUSIONS

Weightlifters subject the lower extremities, especially the ankle joint and Achilles tendon, to forces far exceeding those of football players at any level; yet experience exceptionally low rates of injury to ankle and almost non – existent to Achilles tendon. Weightlifters train such that all the muscles, tendons and ligaments of the lower extremities perform as a single leg spring. The unrestricted movement of all the supple weightlifter's joints, muscles, tendons and ligaments of the leg spring are interconnected, interdependent and of course, inter-conditional. The same cannot be said of the football players' lower extremities; the elasticity of their muscles, tendons and ligaments can be compromised over time by bodybuilding/powerlifting, ie., slow exercises lacking full range of motion. Furthermore, the elastic mobility of the leg spring can be the compromised by artificially compartmentalizing the interconnected links, i.e., restricting movement of joints; with tape and supports.

There is sufficient anecdotal evidence that the strength training regimens of football players is made up of a preponderance of bodybuilding/powerlifting exercises and techniques. Over the long term of more than eight years, from high school to professional ranks, this has to adversely affect muscle tendon elasticity. This in turn, makes these athletes more susceptible to what should be an extremely rare affliction like an Achilles rupture; relatively common by the time a chosen few are able to play in the NFL.

Ankle injuries in weightlifting are extremely rare; but, rarer still are Achilles rupture. Conversely, not only are ankle injuries the most prevalent problem in football (especially non – contact injuries); but even no – contact ruptures of the Achilles tendon which should be extremely rare; are relatively common. The principle difference between the training of weightlifter and that of the football player is the weightlifting exercises demand and contribute to suppleness. The weightlifter's lower extremities are subjected to a large amplitude of un -choreographed movement, without taping or braces to support and otherwise restrict motion. And, there in all likelihood lies the solution.



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THE USE OF COMPLE-MENTARY EXERCISES

TAKEN FROM OLYMPIC WEIGHTLIFTING AS A MEANS OF RECOVERING FROM MUS - MEDICALLY UNEXPLAINED SYMPTOMS

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INTRODUCTION

Medically Unexplained Symptoms, known as MUS, are symptoms that do not belong to a pathological picture, but express the non-specific discomfort that precedes it from a minimum of six months to a few years. People with MUS present have specific features such as:

FATIGUE

difficulty when waking up, loss of strength, fatigue not proportional to the effort exerted.

EMOTIONAL DISORDERS

anxiety, apathy, melancholy, fear, compulsive behaviour, sadness, discomfort in relationship with others, difficulties in relationships, etc.

THERMOREGULATION

hands and feet permanently cold, shivers, the need to wrap up warm in order to feel well, constant suffering from the cold.

INSOMNIA

difficulty falling asleep, difficulty sleeping, waking at night, waking early in the morning, light sleep, extended but non-restorative sleep.

APPETITE

changes in appetite, compulsive hunger, lack of appetite, hunger disproportionate to requirement, initial hunger but inability to finish meal or hunger in between meals.

STOMACH

stomach acid, stomach aches, belching, acid belching, bloating after meals, nausea.

COLON

constipation, diarrhoea, bowel movement changes, colon pain, meteorism, urgent need to evacuate, painful evacuation of bowels.

PERSPIRATION

sweating not proportional to movement, sweating alterations, difficulty in sweating during movement, excessive sweating even in the absence of movement.

DESCRIPTION

The greater the symptoms, the greater the imbalance in metabolism, body composition and the Neuro-Vegetative System (HRV). Their absence, on the other hand, reflects a state of health and psycho-physical performance.

Who can suffer from MUS?

Individuals with stress and chronic low-grade inflammation: from the professional athlete to sedentary types, from children to the elderly, we are basically all potentially at risk. The literature on physical activity and health is now extensive and consolidated. Numerous scientific works have proven that the conservation and quality of Skeletal Muscle Mass is an excellent index of health, prevention, longevity and anti-aging. Loss of muscle mass is often associated with several issues such as: chronic fatigue, loss of strength, myalgia, slow recovery from disease, sarcopenia, cachexia, delay in wound healing, low basal metabolic rate (BMR), physical disability, poor quality of life and high health costs. All are related to Medically Unexplained Symptoms (MUS). Physical activity that is capable of recovering the quantity, but above all, the quality of Skeletal Muscle Mass becomes fundamental. Today there is extensive literature linking Skeletal Muscle Mass and heavy strength training as a tool for functional and physiological recovery. In this study, we shall evaluate the functional difference in body composition between individuals suffering from MUS and those without MUS, compared to COMPETITIVE WEIGHTLIFTERS without MUS, and we shall assess how, and if, additional exercises from Olympic Weightlifting, which have been scientifically recognised, can be a part of the recovery method from MUS, and the recovery of the functional and constitutional Skeletal Muscle Mass.

MATERIALS AND METHODS

To subdivide the case studies (population with presence of MUS, males and females, population with no MUS, males and females, WEIGHTLIFTERS without MUS, male and female), the following questionnaire was submitted all subjects, regardless of age, sex, physical and working activity:

MUS SELF-ASSESSMENT FORM		
Please mark your answers with an X	**yes**	**no**
Have you been suffering from excessive tiredness or persistent fatigue?		
Have you been suffering from mood swings?		
Have you been suffering from persistent insomnia or night-time waking?		
Have you been feeling sleepy during the day?		
Have you been feeling anxious?		
Have you been feeling listless?		
Do you suffer from panic attacks?		
Have you noticed changes in your heart rate (irregular beats, increase in beats) when at rest?		
Have you noticed any changes in your appetite (excessive hunger or lack of appetite)?		
Do you have night-time hunger pangs?		
Have you been suffering from stomach acidity and aches, a feeling of fullness, bloating after meals, nausea?		
Have you been suffering from irritable bowel syndrome?		
Do you suffer from periods of persistent constipation or changes in bowel movement?		
Are your hands and feet often cold?		
Do you experience changes in perspiration while asleep?		
Do you often wake up in a bad mood?		
Do you frequently feel a sense of unjustified guilt?		
Do you have difficulty finding pleasure or relief as a consequence of positive facts?		
Have you lost a significant amount of weight in recent months?		

TOTAL subjects: 680, 80% women and 20% men, average age 35 years Both subjects with MUS and subjects without MUS had not been engaged in physical activity for at least 6 months.

Subjects with MUS (Male and Female):
320, of which 80% women and 20% men. The average age was 35.2 years. The average number of MUS experienced was 10, including:

tiredness or persistent fatigue
persistent insomnia or night-time waking drowsiness during the day
apathy changes in appetite acidity, stomach aches, feeling of fullness after meals and/or bloating cold hands and/or feet night sweats waking up often in bad mood

Subjects without MUS (Male and Female):
290, of which 80% women and 20% men. The average age was 34.9 years. The number of MUS was 0.

Competitive Weightlifters (Male and Female):
80 subjects made up of 80% women and 20% men. The average age was 32 years. They trained on average 3 times a week for a total of 6 hours a week. Training took place between 2 pm and 7/8 pm. The participants did not specify the presence or absence of diseases and the intake or otherwise of medication. All subjects voluntarily attended gyms or fitness/personal training centres with the purpose of "getting in shape" or improving their performance; the subjects were either sedentary individuals, amateur sports men and women, or athletes. BioTekna BIA-ACC (Bioelectric Analysis Spectrometry) tools were used for the Functional Evaluation of body composition, and the following parameters were considered:

HPA axis index (PA°): the PA° phase angle parameter in bioelectrical impedance diagnostics, that represents the integrity of cell membranes and a correlation with the circadian rhythm of cortisol (HPA axis). A particularly low value is associated with low integrity of cellular membranes with low-quality of muscle activity.Value less than 2.5: absence of circadian rhythm of cortisol with elevation in the evening
From 2.5 to 3.5: absence of circadian rhythm of cortisol;
Greater than 3.5: physiological circadian rhythm of cortisol;

HSMI: the instrumental value indicating muscle density. Normal value: min. 5.5 Kg/m2 in females and 7.2 Kg/m2 in males.
S-score: or sarcopenia score, the instrumental value that indicates the standard deviation of the muscle from a healthy statistical reference sample between 25 and 30 years. Normal values: S-score from -1 at positive values.
Pre-sarcopenia: S-score between -1 and -2
Sarcopenia: S-score less than -2
Sarcopenia with loss of muscle strength: S-score less than -2 and alterations in muscle quality

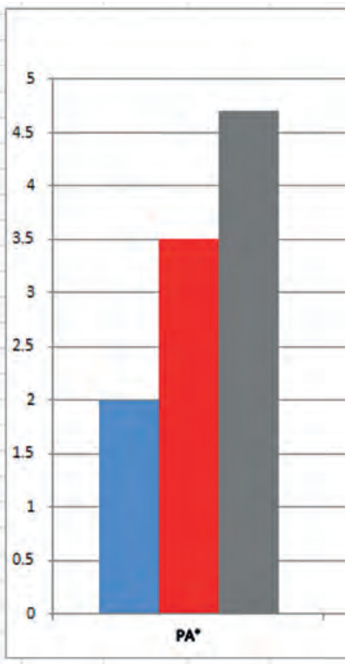
T-score: instrumental value of BIA-ACC indicating the stability of bone density. It is the standard deviation compared to a healthy statistical sample between 25 and 30 years.
Reference T- scores are:
values less than -2.5: probable osteoporosis. Between -1 and -2.5: probable osteopenia. Above -1: standard values
FM%: Fat Mass; represents the total amount of lipids present in the human body, minus the essential fatty acids (EFA).
Range of normality: minimum 12%, maximum 30% per females; minimum 7%, maximum 25% for males.

IMAT%: percentage of intramuscular fat. normal values: max 2% of BW, ideal <1.5% BW.
FFM% (Fat Free Mass): represents all the parts of the body minus the body parts less the fat mass.
Skeletal Muscle % :
The minimum skeletal muscle mass to ensure longevity and maintain a good state of health is:30% of FFM for females, 35% of FFM for males

After the initial evaluation, subjects with MUS were asked to work out at the gym doing standard exercises from OLYMPIC WEIGHTLIFTING + 1 POWER LIFT EXERCISE (Flat bench).

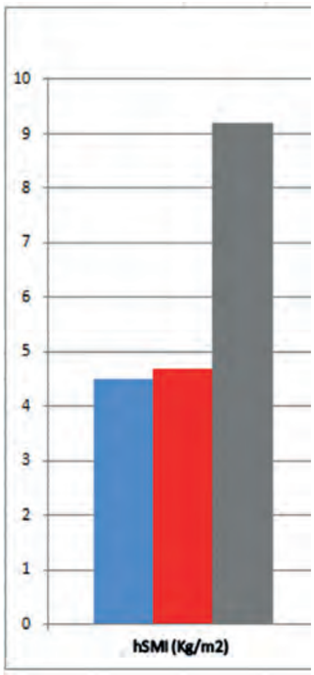
DATA ANALYSIS

WITH MUS NO MUS LIFTERS



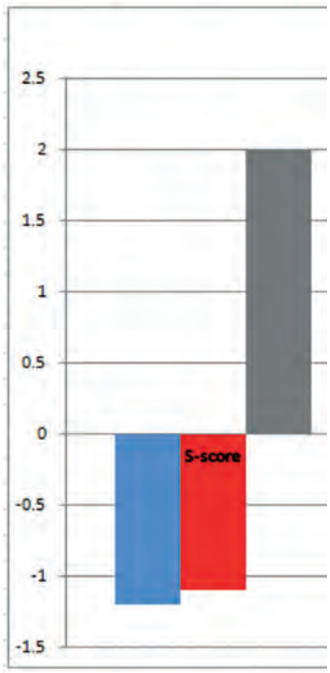
HPA AXIS INDEX (PA°)

GREATER THAN 3.5: PHYSIOLOGICAL CIRCADIAN RHYTHM OF CORTISOL;
FROM 2.5 TO 3.5: ABSENCE OF CIRCADIAN RHYTHM OF CORTISOL;
VALUE LESS THAN 2.5: ABSENCE OF CIRCADIAN RHYTHM OF CORTISOL WITH ELEVATION IN THE EVENING



MUSCLE DENSITY

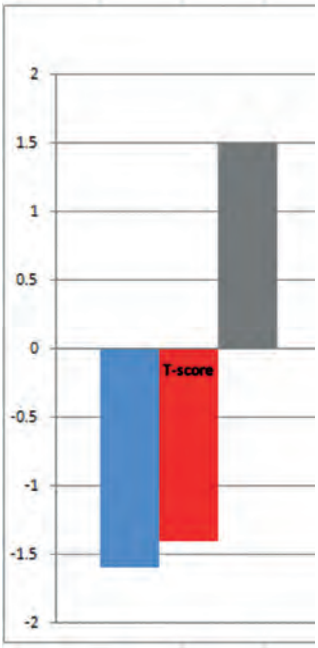
NORMAL VALUE: MIN. 5.5 KG/M2 FEMALES AND 7.2 KG/M2 MALES



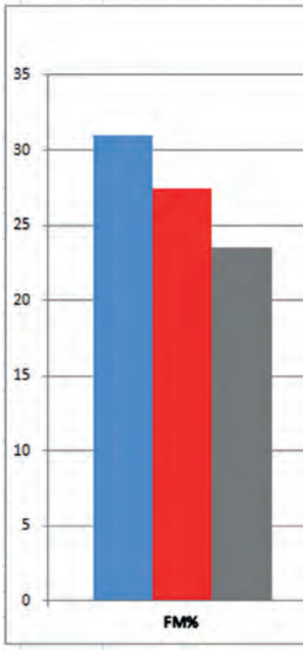
S-SCORE

NORMAL VALUES:S-SCORE FROM -1 AT POSITIVE VALUES
PRE-SARCOPENIA: S-SCORE BETWEEN -1 AND -2
SARCOPENIA: S-SCORE LESS THAN -2

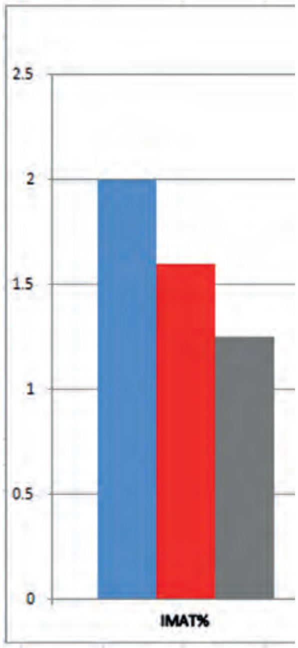
WITH MUS NO MUS LIFTERS



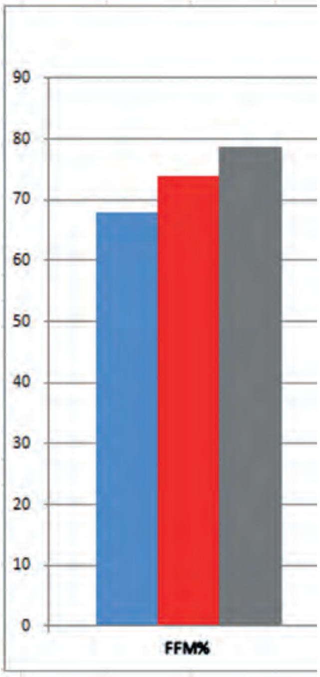
T-SCORE
VALUES LESS THAN -2.5: PROBABLE OSTEOPOROSIS /BETWEEN -1 AND -2.5: PROBABLE OSTEOPENIA/ ABOVE -1 STANDARD VALUES



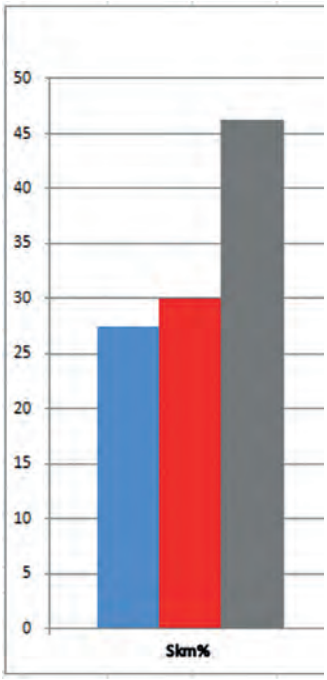
FM%
MINIMUM 12%, MAXIMUM 30% FOR FEMALES.
MINIMUM 7%, MAXIMUM 25% FOR MALES.



IMAT%
MAX 2% BW, IDEAL <1.5% BW.



FFM%
MINIMUM 75% BW



SKELETAL MUSCLE %
MINIMUM 30% FFM
MINIMUM 35% FFM

The choice of the exercises was carried out in accordance with the following criteria:

OBJECTIVITY/SUBJECTIVITY: Exercises that produce tangible results both objectively and subjectively (e.g. Squat, Deadlift, Flat bench etc.).
RELIABILITY: there must be a standard execution for everyone, making only minor modifications based on posture and subject mobility.
REPEATABILITY OVER TIME: the exercises must produce continuous results over time and not just partial/temporary results.
VALIDATION: the exercises must be scientifically recognised.

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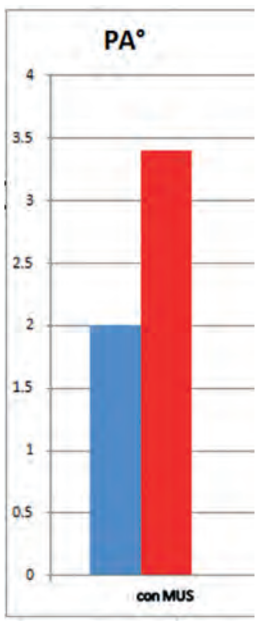
The individuals trained for 3 months, on average 3 times a week, performing the following exercises:

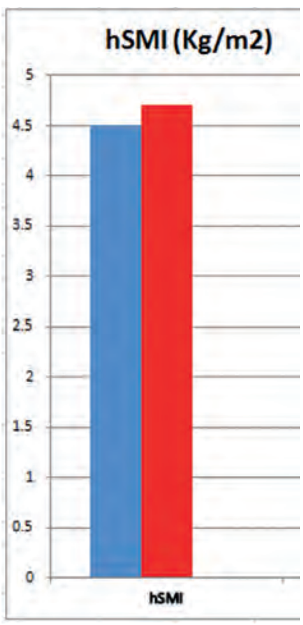
- **DEADLIFT**
- **CLEAN PULL**
- **SQUAT WITH BARBELL/STICK OVER HEAD, WIDE GRIP, ARMS STRETCHED**
- **FLAT BENCH**
- **SQUAT WITH BARBELL** (depending on the individual's characteristics, the exercise could be performed as a FRONT squat, or as a squat with the barbell behind the head).

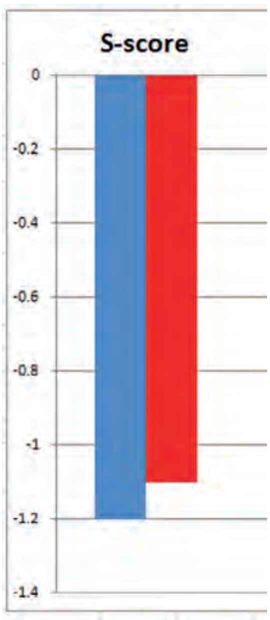
3 sets of 4-6 reps from 75% to 85% of 1RM, 1 sec concentric phase, 2-3 seconds eccentric phase, 3-5 minutes recovery between both sets and exercises. The training sessions took place between 7am - 3pm. From a nutritional point of view, no strict diet was imposed, the participants were simply been asked to have a generous breakfast, a mid-morning snack, a lunch with complex carbohydrates and vegetables, fruit for snack, and a dinner of proteins and vegetables, without introducing carbohydrates of any kind.

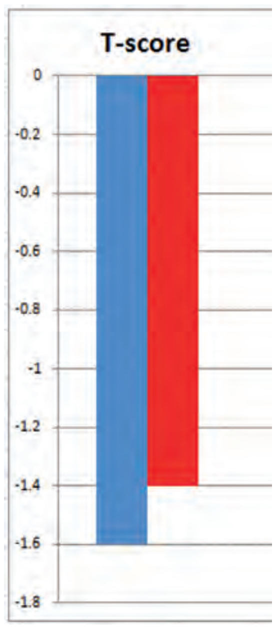
RESULTS

BEFORE AFTER









+70%

MINIMUM 75% BW FROM 2.5 TO 3.5: ABSENCE OF CIRCADIAN RHYTHM OF CORTISOL; GREATER THAN 3.5: CIRCADIAN RHYTHM OF PHYSIOLOGICAL CORTISOL; LESS THAN 2.5: ABSENCE OF CIRCADIAN RHYTHM OF CORTISOL WITH ELEVATION IN THE EVENING.

+6,6%

NORMAL VALUE: MIN. 5.5 KG/M2 FEMALES AND 7.2 KG/M2 MALES

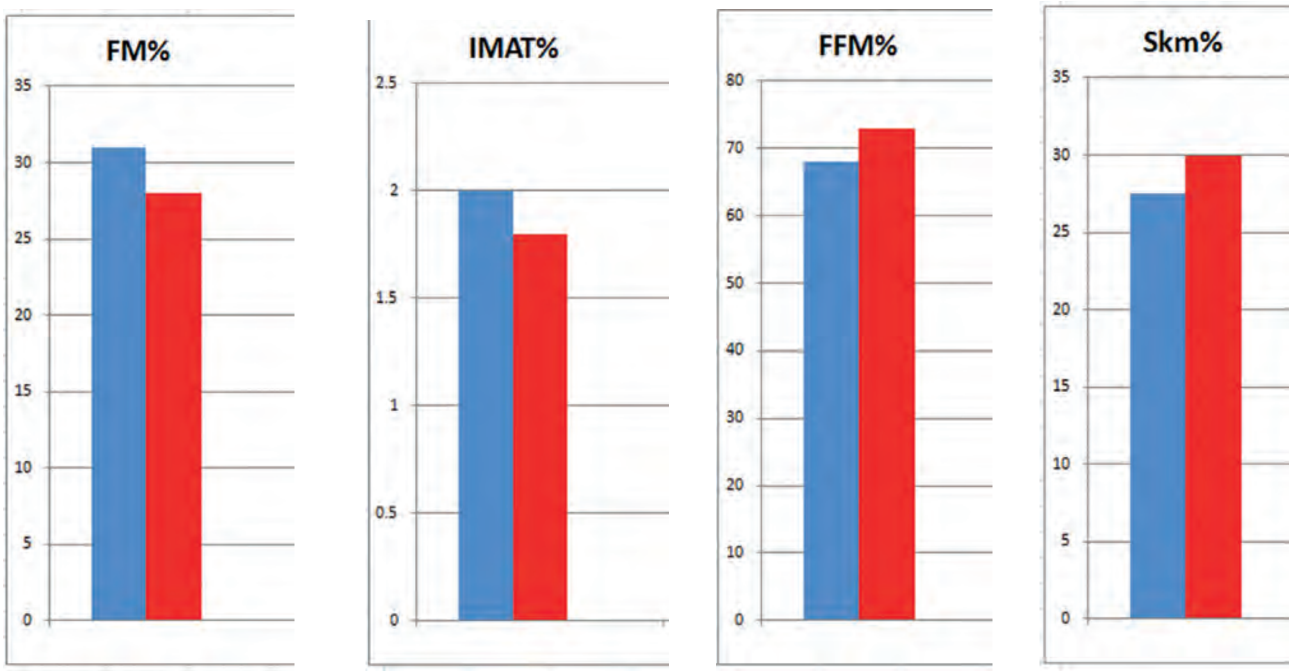
+9%

PRE-SARCOPENIA: S-SCORE BETWEEN -1 AND -2
SARCOPENIA: S-SCORE LESS THAN -2

+12,5%

VALUES LESS THAN -2.5: PROBABLE OSTEOPOROSIS (IF CHRONIC INFLAMMATION) RISK OF OSTEOPOROSIS
BETWEEN -1 AND -2.5: PROBABLE OSTEOPENIA
GREATER THAN -1: VALUES WITHIN STANDARD RANGE

BEFORE AFTER



-13%

-15%

MAX 2% BW,
IDEAL <1.5% BW.

+9%

MINIMUM 75%

+11%

MINIMUM 30% FFM
MINIMUM 35% FFM

MUS SELF-ASSESSMENT FORM	yes	no
Have you been suffering from excessive tiredness or persistent fatigue?	X	
Have you been suffering from mood swings?		
Have you been suffering from persistent insomnia or night-time waking?	X	X
Have you been feeling sleepy during the day?	X	X
Have you been feeling anxious?	X	X
Have you been feeling listless?	X	
Do you suffer from panic attacks?		
Have you noticed changes in your heart rate (irregular beats, increase in beats) when at rest?		
Have you noticed any changes in your appetite (excessive hunger or lack of appetite)?	X	
Do you have night-time hunger pangs?		
Have you been suffering from stomach acidity and aches, a feeling of fullness, bloating after meals, nausea?	X	
Have you been suffering from irritable bowel syndrome?		
Do you suffer from periods of persistent constipation or changes in bowel movement?		
Are your hands and feet often cold?	X	
Do you experience changes in perspiration while asleep?	X	
Do you often wake up in a bad mood?	X	
Do you frequently feel a sense of unjustified guilt?		
Do you have difficulty finding pleasure or relief as a consequence of positive facts?		
Have you lost a significant amount of weight in recent months?		
70% less MUS		

CONCLUSIONS

The absence of MUS in individuals practicing physical activity using the methodology of exercises taken from Olympic Weightlifting is related to body composition, especially to the variables of body composition that determine the quality of Skeletal Muscle Mass. In individuals suffering from MUS (after practising complementary exercises from Olympic Weightlifting), a change in body composition variables, and a 70% decrease in MUS perception was observed. The remaining MUS may be associated with an INCOMPLETE recovery of circadian rhythms, as well as the HPA (Hypothalamus- Pituitary-Adrenal) axis, in so far as the short training period (3 months) did not allow for a full recovery. This short period is, however, sufficient to improve the perception of well-being, and consequently the style and quality of life. It can be concluded that the complementary exercises taken from Olympic Weightlifting and powerlifting are a very useful tool for the recovery of MUS and of body composition, in both qualitative and quantitative terms.

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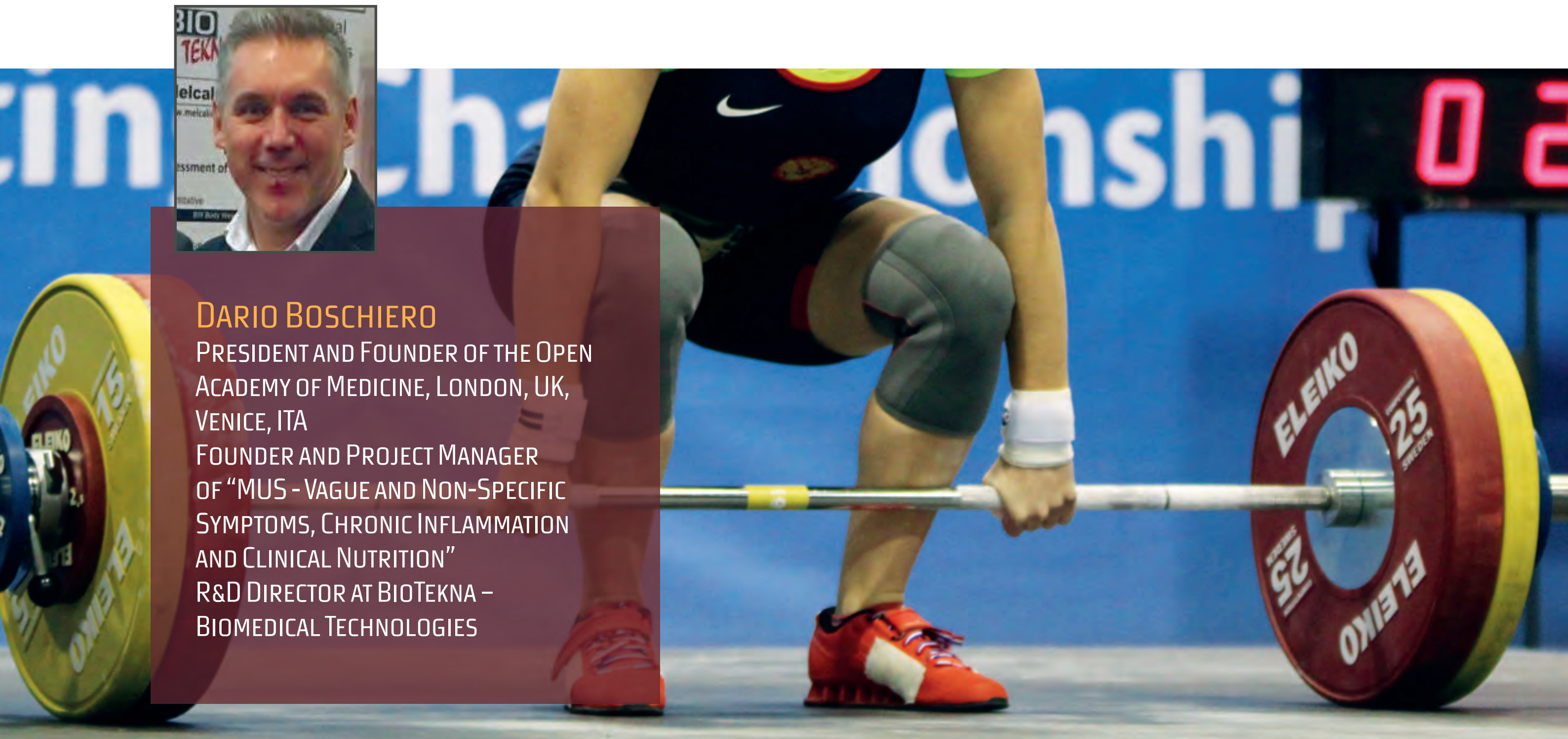

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THE POWER CLEAN AND POWER SNATCH FROM THE KNEE

BY TIMOTHY J. SUCHOMEL, BRAD H. DEWEESE, E AMBROSE J. SERRANO


FOR CHAMP
PZPC
ELEIKO

INTRODUCTION

Exercises that involve high rates of force development (RFD), such as the clean and snatch, are beneficial for improving an athlete's physical preparedness (9,11,12,14–17,22,26,36).

Additionally, previous research has demonstrated that weightlifters produce greater peak force, higher velocities, and peak power in comparison to powerlifters (22). Acknowledging these findings, weightlifting movements and their derivatives are popular resistance training exercises that are prescribed by many strength and conditioning practitioners. The transferability of the full clean and snatch hinges on proper movement execution. Incidence of injury may increase if the technique is not refined or revisited during the training year (8). To decrease the complexity of the movement and reinforce proper technique, weightlifting derivatives used to teach the full weightlifting movement can also be used in training (3–6,31–33).

TYPE OF EXERCISE

The power clean from the knee (CK) and power snatch from the knee (SK) weightlifting derivatives are complex multijoint exercises that can be used to train lower-body muscular power and strength at key positions during the transition into the peak power position and the subsequent triple extension of the hip, knee, and ankle joints. Concurrently, these exercises also provide the athlete with an opportunity to enhance their ability to complete the catch phase using movements that are less complex than the full clean and snatch. The CK and SK may be performed from a static position off of technique blocks or with the bar lowered to a hang position at the knee.

MUSCLES INVOLVED

The CK and SK involve muscles that have been previously described during similar weightlifting movements (3–7,32,33).

1. Static stability in the starting position
   - Gruppo Erector spinae group (iliocostalis, longissimus, and spinalis), rectus abdominis, transverse abdominis, external obliques, internal obliques, quadratus lumborum, triceps brachii (long head), deltoid, subscapularis, latissimus dorsi, brachioradialis, trapezius, splenius capitis, splenius cervicis, infraspinatus, serratus posterior inferior, rhomboid major, rhomboid minor, and the supraspinatus.
2. Transition, second pull, and catch phases of the CK and SK
   - **Upper extremities:** trapezius, splenius capitis, splenius cervicis, levator scapulae, rhomboid minor, rhomboid major, serratus posterior superior, posterior deltoid, teresminor, teres major, erector spinae group (iliocostalis, longissimus, and spinalis), rectus abdominis, transverse abdominis, external obliques, and internal obliques.
   - **Lower extremities:** quadriceps group (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius), gluteus maximus, hamstrings group (biceps femoris, semimembranosus, and semitendinosus), gastrocnemius, soleus, tibialis posterior, flexor digitorum, peroneus longus, and the peroneus brevis.

BENEFITS OF THE EXERCISE

The CK and SK weightlifting derivatives are skill-transfer exercises that strength coaches can prescribe to improve their athlete's development of weightlifting movements. Initially, the CK and SK aid in the strengthening of the musculature used during the execution of the full weightlifting movements. In addition, these movements allow the athlete to focus on a proper transition into the peak power position and the triple extension of the hips,

knees, and ankles, while also providing the additional stimulus of culminating the lift with the catch phase. Furthermore, these derivatives can serve as transitional exercises in learning the full weightlifting movements by integrating previously described partial movement derivatives (3–6,10,32,33). As such, the CK and SK accompany the short-to-long principle, or partial to full range of motion, approach to training the full weightlifting movements. In the practical setting, the CK and SK involve both eccentric and concentric muscle actions that allow the athlete to efficiently transition into the proper peak power position and accelerate the bar using a full-body triple extension movement while eliminating the added stress of properly pulling the

weight from the floor. For this reason, the CK and SK can be used as teaching tools to progress the technique of an athlete into the full lifts. In addition, these exercises can also be used to enhance the RFD and resultant competitive preparedness through mechanical specificity. Specifically, commonalities exist between an athlete's position in this lift and common sporting movements (e.g., shot put, jump shot, tennis serve, max velocity sprinting, and bobsled start) (29). In theory, the static start of these movements may allow for a large transfer of training effect in athletes who are required to produce high RFD and power from a static starting position (e.g., sprinters in track and field and American football linemen). Finally, the CK and SK could theoretically be used as potentiating modalities because of the creation of high

RFD during the movements. Previous research has incorporated weightlifting derivatives into strength-power potentiating complexes (1,23–25). Because of the decreased range of motion and ability to overload the triple extension movement, the CK and SK may be used as part of a strengthpower potentiating complex.

Figure No. 1

Starting positions for the power clean from the knee (left) and the power snatch from the knee (right). Note that the starting position of the athlete may vary slightly based on the athlete's anthropometrics.

STARTING POSITION

- In preparation to perform either the CK or SK, technique boxes or the safety bars of a squat rack should be placed so that the bar is at the appropriate height relative to the athlete's anthropometrics. Specifically, the bar should be positioned directly in front of, but not touching, the patella just above the proximal attachment of the patellar tendon.
- After the bar has been positioned properly, the athlete should address the bar with his or her feet approximately hip width apart. The bar should be positioned above the midfoot, and the athlete's toes should be pointing slightly outward to maintain consistent foot positioning with other weightlifting derivatives (3–6,32,33).
- Following foot placement, the athlete should properly position his or her hands on the bar. The appropriate hand placement will be based on whether the athlete is performing the clean or snatch variation (10). The "hook grip" (fingers over thumb) should be used for both the CK and SKexercises to prevent grip being a limiting factor of performance. Because loads in excess of a maximum clean or snatch may be used during the CK and SK, respectively, athletes may consider the use of lifting straps.
- Following the acquisition of proper hand and grip placement, the athlete should flex forward at the hip while creating a normal lordotic curve in the lumbar spine by isometrically contracting the erector spinae musculature to "raise" the chest. Concurrently, the athlete should flex the knee until a slight stretch in the hamstring is felt. The athlete's shins should be vertical and perpendicular to the floor while his or her shoulders should be positioned ahead of the bar *(Figure 1)*.
- The athlete should then be cuedThe athlete should then be cued to internally rotate his or her shoulders and "turn his or her elbows out" to ensure that a stable arm position exists for the active pulling portion of the CK and SK. This will assist in preventing the elbow joint from prematurely bending (flexing) during the pulling phase of the exercises.
- The athlete should be instructed to "sit on his or her heels" in the starting position to maximize his or her ability to

produce the greatest possible forces through the platform during the initiation and continuation of the lift. This cue will also allow the athlete to maintain the correct foot pressure during the transition to the peak power position and also allow greater control and improved bar speed.

TRANSITION TO THE PEAK POWER POSITION

- Before initiating the CK or SK from the static starting position, the athlete should create a "tight" torso by developing tension in the muscles of the midsection by inhaling deeply. The athlete should also maintain the lordotic curvature of his or her lumbar spine to maintain the appropriate hip angle to maximize the force produced into the platform.
- After achieving the set starting position, the athlete should initiate the CK and SK by engaging his or her hamstrings, glutes, and erector spinae muscles to begin to move the bar vertically.
- During the transition phase of the CK and SK, the athlete must transition the bar to the peak power position (4,13,21) to maximize the force and power produced during the later second pull phase of the movement. The transition of the bar from the starting position to the peak power position is accomplished by the athlete by extending his or her backwhile simultaneously moving the hips and knees forward at the same instant and tempo. At this point, the athlete should be moving into a dorsiflexed position at the ankle joint.
- During the transition phase to the peak power position, the path of the bar should always be moving vertically "up and into" the body.
- The bar should remain as close as possible to the body without touching the thighs until reaching the peak power position *(Figure 2)*. This will allow the athlete to continue to accelerate the bar without additional frictional influences.

THE SECOND PULL

- The second pull phase of the CK and SK begins when the athlete reaches the power position. As the athlete transitions to the power position, he or she should use the momentum the first pull to build up the intensity into an explosive pull.

FIGURE NO. 2
POWER POSITIONS FOR THE POWER CLEAN FROM THE KNEE (LEFT) AND THE POWER SNATCH FROM THE KNEE (RIGHT). NOTE THAT THE POSITION OF THE BARBELL MAY VARY SLIGHTLY BASED ON THE ATHLETE'S ANTHROPOMETRICS.

FIGURE NO. 3
THE SECOND PULL OF THE POWER CLEAN FROM THE KNEE (LEFT) AND THE POWER SNATCH FROM THE KNEE (RIGHT).

- Upon reaching the power position, the bar should make a "brushing" contact with the thighs before the triple extension movement occurs. The athlete should continue to engage his or her erector spinae musculature and keep his or her elbows extended and externally rotated to prevent early bending (flexing) of the elbows during the pull.
- At this point, the athlete should perform the triple extension movement by explosively extending his or herhips, knees, and ankles. Simultaneously, the athlete should shrug their shoulders to maximize barbell velocity *(Figure 3)*.
- In addition to the shrug, the athlete should be taught to slightly flex the wrists to keep the barbell close to his or her body.
- Following the pull, the athlete should control the bar's descent to the midthigh position. The athlete can then either lower the bar onto the technique boxes or power rack or lower the bar to the hang position at the knee in preparation for the next repetition.

THE CATCH FOR THE POWER CLEAN FROM THE KNEE

- Once the full triple extension and shrug have been executed, the elbows should "break" (bend/flex). The athlete should be cued to "lead with the elbows" to further elevate the bar as a continuation of the second pull.
- The athlete should then be instructed to aggressively drive the elbows forward and up "through the bar." The athlete should rotate his or her elbows around the bar from a vertical position (above the bar) into a horizontal position (in front of the bar).
- During the rotation of the elbows, the coach should direct the athlete to "relax" his or her grip, which will allow greater flexibility of the wrists when receiving the weight on his or her shoulders.
- Simultaneously, the athlete should flex the knees or "drop" into a quarter squat position to receive the weight as it lands on his or her shoulders (Figure 4). During the descent, the athlete's feet may leave the ground and move slightly outward to create a more comfortable and stable position to receive the bar.
- The shoulders of the athlete should make contact with the bar at the same moment the bar changes from ascension to descension to avoid the bar "crashing" on his or her shoulders. The proper timing of this chain of events is to prevent the accumulation of unnecessary stress on the body.
- When receiving the bar, or "catching the bar," the athlete should maintain a contracted and braced midsection to provide optimal control of the weight and prevent an injury that could occur through a deviated trunk angle.
- While in the catch position, the athlete should continue to flex the knees while activating his or her quadriceps, hamstrings, and gluteal muscles to apply vertical forces to bring the descension of the bar to a halt. The athlete should then return to an upright position completing the lift.
- To properly return the barbell to the technique boxes or rack, the athlete should drop the elbows and maintain an isometric contraction of the midsection and posterior musculature to avoid any unnecessary anterior pelvic tilt as the bar descends to the midthigh position. The athlete can then either lower the bar onto the technique boxes or power rack or lower the bar to the hang position at the knee in preparation for the next repetition.
- Before initiating the next repetition, the athlete should fully return to the starting position as displayed in Figure 1.

THE CATCH FOR THE POWER SNATCH FROM THE KNEE

- After the completion of the triple extension movement and once the shrug has been executed, the elbows should "break" (bend/flex). The athlete should be cued to "lead with the elbows" to further elevate the bar as a continuation of the second pull.
- The athlete should then be instructed to rotate the hands and elbows "around the bar." The elbows should appear to rotate from a vertical position above the bar into a position that is below the bar.
- Simultaneously, the athlete should flex the knees or "drop"

into a quarter squat position (*Figure 4*).

- The athlete's feet may leave the ground during the "drop" and move slightly outward to a more comfortable and stable position.
- At this point, the athlete should maintain contact with the platform through the whole foot. This will allow for improved control in the reception and recovery during this transitory phase.
- The athlete should press up until the elbows are locked in full extension. The athlete can be cued to "push through the bar" or "pull the bar apart" to maintain this extended position.
- Just as described in the catch for the CK, the athlete should attempt to attain the receiving position just as the bar changes direction from ascension to descension to avoid the bar "crashing" onto them.
- When receiving the bar, or "catching the bar," the athlete should maintain a contracted and braced midsection to provide optimal control of the weight and prevent an injury that could occur through a deviated trunk angle.
- While maintaining this position with the weight overhead, the athlete should have continued knee flexion while applying vertical forces until the descent of the bar has stopped. Once in control, the athlete should then ascend into an upright position completing the lift.
- To return the barbell to the technique boxes or power rack, the athlete should allow the weight to descend in a controlled motion from overhead to the midthigh position. During this process, the athlete should continue to maintain an isometric contraction of the midsection and posterior musculature to avoid any unnecessary anterior pelvic tilt as the bar descends to the midthigh position. The athlete can then either lower the bar onto the technique boxes or power rack or lower the bar to the hang position at the knee in preparation for the next repetition.
- Before initiating the next repetition, the athlete should fully return to the starting position as seen in Figure 1.

Figure No. 4
Power positions for the power clean from the knee (left) and the power snatch from the knee (right). Note that the position of the barbell may vary slightly based on the athlete's anthropometrics.

COMMON MISTAKES OF THE POWER CLEAN AND POWER SNATCH FROM THE KNEE

The transfer of the training stimulus produced by the CK and SK hinges on proper movement execution. Moreover, if technique is not reinforced during the training year, the incidence of injuries may increase (8).

- The athlete may begin the movement without his or her shoulders retracted and a rounded back, which may result in an improper transition to the peak power position and may place excess stress on the athlete's lower back.
- The athlete may not shift to a fully upright position with the shoulders, hips, and midfoot in line before beginning the second pull, causing the chest and shoulders to remain ahead of the bar.
- The athlete may not allow the hips and knees to shift forward once the barbell passes the knees (transition phase) as a result of the athlete pulling forward rather than vertically.
- The athlete may begin the second pull phase too early. Specifically, the athlete will begin the second pull by performing the triple extension motion when the bar is visually too low on the athlete's thigh. This would result in the athlete not

properly reaching the necessary power position for maximum force production.

- The athlete may "dip" (i.e., drop under the bar) before completing the triple extension movement.
- The athlete may push his or her hips too far forward during the transition and second pull instead of continuing to drive vertically through the midfoot, likely resulting in a looping of the bar away from the athlete's body.
- The athlete may transition his or her body weight to his or her forefoot too early, likely resulting in the improper vertical transference of force through the midfoot before the triple extension movement during the second pull.
- Premature elbow flexion may prevent maximum transference of generated force to the bar before the second pull.
- The athlete may not complete the full triple extension movement of the hips, knees, and ankles, ultimately preventing maximum vertical force production.
- The athlete may complete the shrugging motion before the full triple extension movement.
- The athlete may not aggressively shrug at the top of the second pull, which may prevent maximum bar velocity. Although failing to aggressively shrug at the top of the second pull may not impact lower-body power development, it may impact the transfer of the pulling technique of the CK and SK.
- During the CK, the athlete may not elevate the elbows and upper arms high enough during the catch, resulting in the weight resting on the wrists and elbows instead of the shoulders.
- During the CK, the athlete may lean forward during the catch, causing rounding of the thoracic spine, which would lead to greater weight distribution on the toes and unwanted pressure on the wrists and elbows.
- During the SK, the athlete may not keep his or her elbows "locked" during the catch, which may result in having to perform a partial press to regain complete extension.
- During the SK, the athlete may fail to "push the head forward," which would result in the weight being slightly ahead of the torso. This would prevent the athlete from being able to maintain the barbell in an overhead position.
- During the SK, the athlete may allow the barbell to travel too far behind his or her head, which may prevent him or her from stabilizing the load in the correct position.

PRACTICAL APPLICATION

The CK and SK weightlifting variations are resistance training exercises that can be used in most blocks of training. Like other weightlifting derivatives, the CK and SK are primarily used to enhance RFD, power development, and explosive speed

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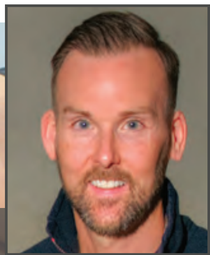

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during the triple extension movement. The CK and SK to a lesser extent may be used to overload the triple extension movement; however, other weightlifting derivatives may be more effective as an overload stimulus (31). Practitioners should be aware that the method of performing the CK and SK may change the training stimulus experienced by the athlete. Specifically, if the CK or SK were performed from training blocks or a power rack, the completion of the exercise may require greater RFD because the athlete would have to overcome the inertia of the training load from a dead-stop position.

This variation of the CK and SK may present more benefits to athletes who perform an explosive movement with RFD from a static starting position (e.g., sprinters in track and field and American football linemen). In contrast, a CK or SK performed from the knee without the assistance of training blocks or a power rack could theoretically require greater positional strength in the initial starting position.

This variation of the CK or SK may be appropriate for athletes with sufficient levels of strength. Practitioners may consider implementing the CK and SK into maximal strength and strength-power training blocks, where the primary goals are to enhance maximal force output and RFD. These types of training blocks typically use reduced volumes (3 3 5 to 3 3 3) and heavier training loads (2,27,28). Previous research suggests that the training loads for the CK and SK will likely be lower than that of the power clean and power snatch from the floor (19). However, athletes may be able to use loads comparable to those used with the hang power clean (18,20,30,35), considering the similar displacement of the load. It should be noted that the CK and SK do not include a countermovement that is characteristic of the hang power clean or hang power snatch, and thus, there may not be as much preactivation of the hamstrings. During a maximal strength or strength-power training block, the CK and SK can also be used to reinforce technique before transitioning to future training blocks in which the full weightlifting movements may be prescribed. The CK and SK exercises may also be used during speed-strength or explosive speed training blocks. The primary goal in speed-strength or explosive speed training blocks is to enhance peak power output. Because the CK and SK require the bar to be "turned over," they are speed-dependent movements that require a higher level of technical proficiency compared with other partial movements (31,34). The primary sets and repetitions that would be used with these exercises would be, for example, 3 sets of 5 repetitions during a speedstrength block and even lower for explosive speed blocks (3 3 3, 3 3 2, and 2 3 2) (2,27,28). A paucity of research on the optimal load for peak power production during the CK and SK exists. Thus, practitioners must consider the loading recommendations based on previous studies that have examined similar weightlifting derivatives to make evidence-based decisions on loading for the CK and SK. As previously mentioned, it is likely that the loads used during the CK and SK may be comparable to those of the hang power clean and hang power snatch.

Previous research has suggested that the optimal load of the lifter plus bar system during the hang power clean occurs at approximately 70–80% 1 repetition maximum (RM) (18,20), whereas other studies indicated that greatest peak power of the lifter plus bar system occurred at 65% 1RM (30,35). Because of the similarities of the CK and SK to the hang power clean and hang power snatch, it is likely that similar loads may be prescribed with modifications for athlete proficiency and strength as needed. Weaker or less technically proficient athletes should focus on improving peak power through lighter loads, whereas heavier loads may be prescribed for a stronger, more technically proficient athlete.

The technique and application discussed in this article should serve as baseline information for those interested in performing and implementing the CK and SK exercises. The CK and SK may be used in the teaching progression of the clean and snatch exercises because they emphasize positional strength during the transition phase, use the double knee bend technique, and train the triple extension of the hip, knee, and ankle joints. Only general recommendations may be made on how best to implement the CK and SK exercises because of the limited amount of current research. Future research should consider examining the loading effects on performance variables during the CK and SK so that more specific recommendations can be made.

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MUSCLE ACTIVATION PATTERNS DURING DIFFERENT SQUAT TECHNIQUES

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INTRODUCTION

Bilateral squats are a staple exercise in most sport performance and knee rehabilitation programs. Despite its popularity in gyms and sports medicine clinics, there is little research on muscle activation patterns during an unloaded bodyweight bilateral squat other than its use to strengthen the quadriceps. Previous researchers (4,18,24) have noted high quadriceps activation and little hamstring activation during the descending, holding, and ascending phases of the squat, supporting the use of the bilateral squat for quadriceps strengthening in rehabilitation and performance programs. Although the squat is a widely accepted exercise to strengthen the thigh musculature, sports medicine and performance professionals teach a variety of techniques, most commonly changing the stance width and depth of the squat. Foot abduction driven by hip rotation and stance width generally vary among practitioners and practice, however no significant difference in quadriceps muscle activation patterns have been noted when comparing narrow and wide stance and varying foot positions (12,32).

However, increased adductor longus and gluteus maximus activity during a wide stance squat have been reported (32). This suggests that different stance widths do not change the use of the squat as a quadriceps strengthening exercise, however they may help target adjacent muscles. Another squat technique variation, the deep squat where maximal knee flexion is encouraged, may result in increased gluteus maximus activation during the ascending phase of the squat (4), however increased squat depth using relative loads may not increase gluteal activation (6). Although the full squat may not increase hip involvement, poorly performed squats have been associated with altered gluteal activation (7), indicating that changes in squat performance may alter muscle involvement. A poorly performed squat may result in altered lower extremity alignment such as increased knee valgus which may expose the lower extremity joints to excessive torques that may require adaptive muscle activation strategies to stabilize the lower extremity joints.

Although many sports medicine and performance professionals are comfortable instructing patients to execute proper squats, there is little information regarding differences in muscle activation patterns in the lower extremity muscles during squats with varying alignments. Furthermore, strength and conditioning coaches often design client programs based on performance on functional screenings and assessments, including the bilateral and single-leg squat (2,7,20). Understanding if different lower extremity alignments during a squat change muscle activation patterns in the lower extremity will provide an evidence-based approach to coaching patients on appropriate squat alignment and designing effective strengthening programs. Consideration for lower extremity alignment during the bilateral squat is also important because of the potential for increased patellofemoral contact forces during knee flexion (3,33,39,41). Some models have predicted peak force during the squat to be around 90–1008 of knee flexion (14,15), which is common during squat exercises. Because the knee deviates from neutral alignment near peak knee flexion, different patterns of muscle activation may be necessary to attenuate the increased patellofemoral forces and stabilize the knee joint. For example, decreased vastus lateralis and increased gastrocnemius muscle activation have been reported during squats with medial knee displacement compared with a neutrally aligned squat (29,36). However, little is known about the muscle activation patterns in the rectus femoris and knee flexors during knee joint deviations while squatting. Increased knee flexor activation during bilateral squats may increase ligamentous strain to stabilize the knee joint (37).

Therefore, bilateral squat positions that increase muscle activation in the hamstrings may increase knee injury risk. This is particularly important given the growing popularity of the ballet plie´ squat where clients purposefully lift their heels off the ground and squat with weight at their toes despite a lack of information about the way the lower extremity musculature stabilizes the knee joint during the increased anterior displacement. Therefore, the purpose of this study was to compare lower extremity electromyographic muscle activation during a neutrally aligned squat compared with antero-posterior (AP) malaligned and medio-lateral (ML) malaligned bilateral squats. We hypothesized that malaligned squats would result in increased quadriceps, hamstring, and gastrocnemii activity compared with control squats.

METHODS

Experimental Approach to the Problem

A descriptive, repeated measures laboratory study was used to compare muscle activation patterns during the control, AP malaligned, and ML malaligned bilateral squats. The experimental approach provided unique information about the muscle activation patterns during each squat technique to assist sports medicine and performance professionals with information about differences in lower extremity muscle activation patterns and strategies during commonly performed malaligned squats. The independent variable in this study was the squat technique (control, AP and ML aligned squats). The dependent variables were lower extremity muscle activation pattern during the squat cycle measured with surface electromyography.

Subjects

Twenty-eight healthy, recreationally active participants (19 women, 9 men) without self-reported history of lower extremity injury volunteered (21.5 6 3 years, 170 6 8.4 cm, 65.7 6 11.8 kg). All participants were familiar with the squat exercise. Exclusion criteria included history of lower extremity injury within previous 6 months, history of low back pain or lower extremity joint surgery, pregnancy, known muscular abnormalities, and known degenerative joint disease. All participants signed informed consent approved by the university's institutional review board.

Instrumentation

A wireless surface electromyography (EMG) system (Trigno Sensor System, Delsys Inc., Natick, MA, USA: interelectrode distance = 10 mm, 80 dB common mode rejection rate) was used to record lower extremity muscle activity. Electromyography data were sampled at 2,000 Hz. Maximal voluntary isometric contractions were exported using EMGworks Analysis software (version 4.1.1.0; Delsys Inc.). An electromagnetic motion-analysis system (Ascension Technology Corporation, Burlington, VT, USA) was used during collection. Kinematic data were sampled at 144 Hz. Threedimensional joint angles and EMG data were synchronized, reduced, and exported using MotionMonitor software (Innovative Sports Training, Chicago, IL, USA).

Electromyography Electrode Placement

The electrodes for the quadriceps muscles were placed on the distal third of the participant's vastus lateralis and vastus medialis and the proximal third of the participant's rectus femoris. The lateral and medial gastrocnemius electrodes were placed at 20% of the distance of the shank from the knee joint line to the lateral malleolus (36). The electrode on the biceps femoris was placed halfway between the ischial tuberosity and the lateral epicondyle of the tibia (19).

Procedures

Participants reported to the laboratory for a single session wearing athletic shoes and athletic clothing. Electromyography electrodes were placed over the muscles of interest on the participant's dominant leg, defined as the preferred kicking leg, after the skin was shaved, lightly abraded, and cleaned with alcohol. After electromagnetic sensors were attached, participants placed the dominant leg within the boundaries of a single force plate embedded in the floor and the contralateral leg on the floor, outside of the force plate (13) *(Figure 1)*. The participant practiced bilateral squats to parallel to become accustomed to the wires from the electromagnetic motion capture system. The participant was asked to stand with feet shoulder width apart, toes pointing forward and was instructed to perform 5 squats to 908 of flexion with knees collapsing inward (ML malaligned), 5 squats to 908 of flexion while lifting heels off the floor (AP malaligned), and 5 squats to 908 of flexion while keeping heels on the floor and knees in line with feet (control) (Figure 1). Feedback was only given during the control squat and was standardized to include the following statements: Sit back at your heels like you're sitting in a chair; push your knees out in the bottom of the squat; keep your toes pointing forward.

Normalization Procedures

Maximal voluntary isometric contractions (MVICs) were collected before the participant completed any squats. Maximal voluntary isometric contractions for the vastus lateralis, vastus medialis, rectus femoris, and biceps femoris were collected in short sitting with the knees flexed to 908 using a gait belt around the distal third of the shank during both isometric knee extension and knee flexion. Ninety degrees was used to normalize quadriceps and hamstring activa-

Figure No. 1
Participants performed 5 medio-lateral malaligned squats (A, D followed by 5 antero-posterior malaligned squats (B, E) followed by 5 control squats (C, F). Participants rested for 1 minute between each squat repetition. No feedback was provided during any of the squat techniques other than the control squat.

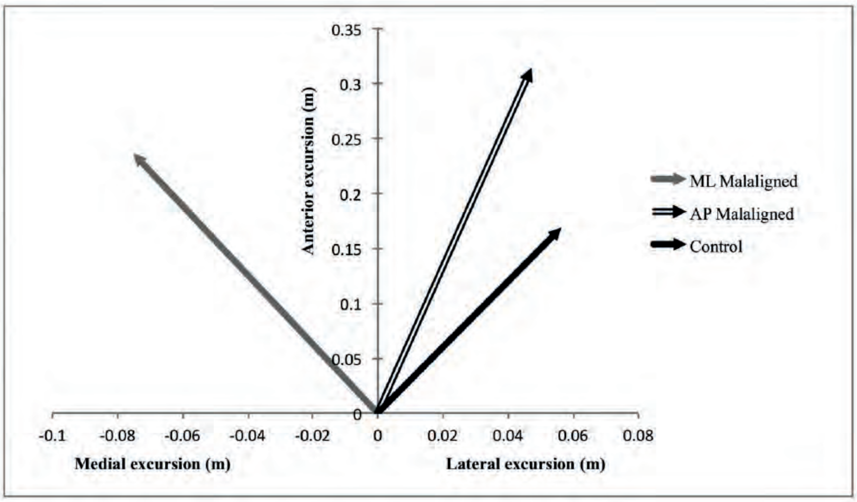

Figure No.2
Peak knee joint excursion from full knee extension at the beginning of the squat.

tion to maximal activity during peak knee flexion. Maximal voluntary isometric contractions for the lateral and medial gastrocnemius were collected with the subject lying prone and 108 of plantarflexion. Knee flexion and ankle plantarflexion were measured using a goniometer. Three 5 second MVIC trials were collected in each position, averaging the middle 3 seconds of each trial for the individual muscles. All muscle activity was normalized and expressed as a percentage of MVIC.

Statistical Analyses

The raw EMG data were filtered and exported using the MotionMonitor software, utilizing a bandpass filter (10–450 Hz) with a 60 Hz notch filter and a 50 milliseconds window, moving average, root mean square algorithm. The EMG and kinematic data were synchronized and reduced to 100 points to represent 100% of the squat cycle, where 50% represents peak knee flexion and 0 and 99% represent full knee extension (27). Initial and final descent were defined as 0–24 and 25–49%, respectively. Initial and final ascent were defined as 50–74 and 75–99%, respectively. After being reduced to 100 points, data were smoothed using a 3-point moving average window and 90% confidence intervals were calculated about the mean of each percentage point. Means and 90% confidence intervals were calculated for each muscle during each squat technique. Areas in which the confidence intervals did not overlap for more than 3 consecutive percentage points were considered statistically significant (9,21). Mean differences and associated pooled standard deviations were calculated for each muscle during periods of the squat cycle when squat techniques were significantly different. Cohen's d effect sizes using mean differences and pooled standard deviations were calculated for each muscle. Effect sizes were interpreted as weak (,0.2), small (0.21–0.39), moderate (0.4– 0.7), large (0.71–0.99), and very large (.1.0).

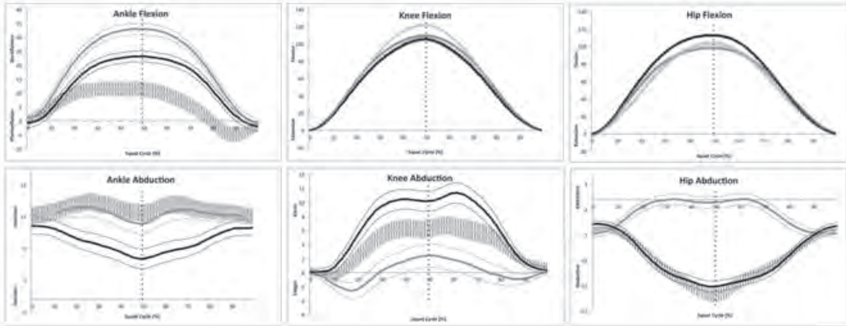

FIGURE NO.3

DIFFERENCES IN KINEMATICS DURING THE MEDIO-LATERAL MALALIGNED SQUAT (GREY LINE), ANTERO-POSTERIOR MALALIGNED SQUAT (VERTICAL LINES), AND CONTROL SQUAT (BLACK LINE) ACROSS THE SQUAT CYCLE WITH 90% CONFIDENCE INTERVALS. AREAS IN WHICH CONFIDENCE INTERVALS DID NOT OVERLAP FOR 3 OR MORE CONSECUTIVE POINTS WERE CONSIDERED STATISTICALLY SIGNIFICANT.

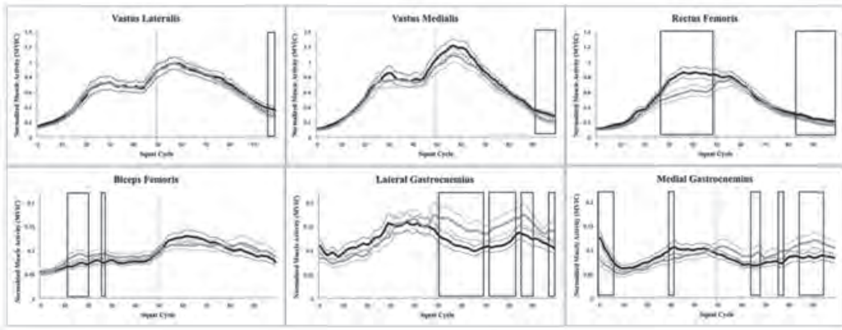

FIGURE NO.4

DIFFERENCES IN MUSCLE ACTIVATION PATTERNS DURING THE MEDIO-LATERAL MALALIGNED (GREY LINE) AND CONTROL (BLACK LINE) SQUAT ACROSS THE SQUAT CYCLE WITH 90% CONFIDENCE INTERVALS. AREAS IN WHICH CONFIDENCE INTERVALS DID NOT OVERLAP FOR 3 OR MORE CONSECUTIVE PERCENTAGE POINTS WERE CONSIDERED STATISTICALLY SIGNIFICANT.

RESULTS

Medio-Lateral Malaligned Squat

Participants demonstrated increased anterior and medial knee displacement compared with the control squat (Figure 2). The ML malaligned squat resulted in significantly increased dorsiflexion, ankle inversion, knee flexion, knee abduction, and hip adduction during approximately 10–85% of the squat cycle compared with the control squat.Participants also demonstrated significantly decreased hip flexion during 14–71% of the squat cycle compared with the control squat (Figure 3).

Vastus Lateralis. The vastus lateralis had decreased activation during final ascent (96–99%) of the squat cycle in the ML malaligned squat compared with the control squat (Figure 4). Effect size was very large (26.21) for the significant difference during the squat cycle for ML malalignment (Figure 5).

Vastus Medialis. Vastus medialis activation decreased during the final phase of ascent (92–98%) of the squat cycle in the ML maligned squat compared with the control squat (Figure 4). Effect size was very large (23.78) for the difference in activation (Figure 5).

Rectus Femoris. Rectus femoris activation decreased during the initial (15–18%) and final phase of decent (28–48%) of the squat cycle in the ML malaligned squat compared withthe control squat. The rectus femoris also displayed decreased activation in the ML malaligned squat during the final phase of ascent (85–99%) of the squat cycle (Figure 4). Effect sizes were very large (Range = 24.90, 21.72) for all differences during the squat cycle (Figure 5).

Biceps Femoris. The biceps femoris activation increased during the initial phase of descent (11–21%) and beginning of the final phase of descent (25–28%) during the ML malaligned squat compared with the control squat (Figure 4). Effect sizes were very large (Range = 4.71, 13.14) for all differences in the ML malaligned squat (Figure 5).

Lateral Gastrocnemius. The lateral head of the gastrocnemius was more active during the ML maligned squat compared with the control squat in the initial (51–69%) and final phase of ascent (71–82%,

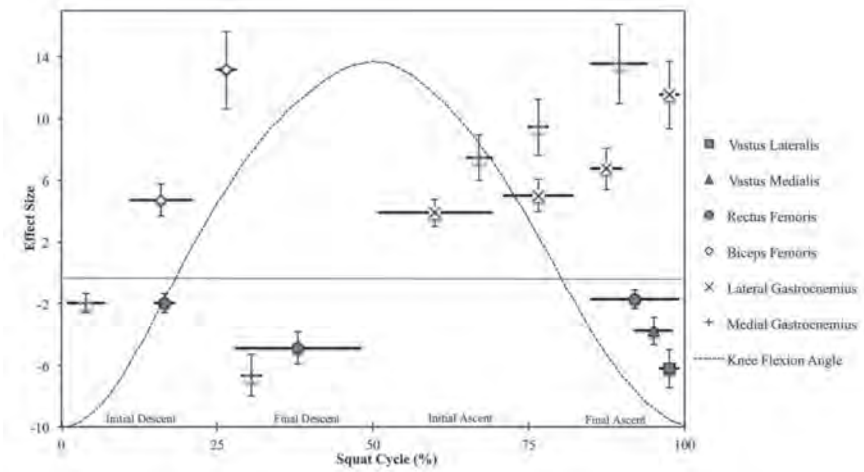

Figure No.5

Effect sizes for significant differences between medio-lateral malaligned and control squat. Vertical error bars represent 95% confidence intervals for the effect size point estimate. The horizontal line represents the duration across the squat cycle where confidence intervals did not overlap.

85–90%, 96–99%) during the squat cycle (Figure 4). Effect sizes were very large (Range = 3.90, 11.53) for all differences between the ML malaligned and control squat during the squat cycle (Figure 5).

Medial Gastrocnemius. The medial head of the gastrocnemius was less active during the initial (1–7%) and final phases of descent (29–32%) of the ML malaligned squat compared with the control squat (Figure 4). During the ascending phases of the squat cycle, the medial gastrocnemius was more active in the ML malaligned squat (65–69%, 75–78%, 85–94%) compared with the control squat (Figure 4). Effect sizes were very large (Range = 21.97, 13.53) for all differences between the ML malaligned and control squat during the squat cycle (Figure 5).

Antero-Posterior Malaligned Squat

Antero-posterior malaligned squats increased anterior knee displacement and decreased lateral knee displacement compared with the control squat (Figure 2). Participants demonstrated significantly less dorsiflexion during the AP malaligned squat during 21–95% of the squat cycle compared with the control squat. The AP malaligned squat increased knee flexion from 22 to 80% of the squat cycle and decreased hip flexion from 5 to 77% of the squat cycle compared with the control squat. Ankle inversion increased from 10 to 92% of the AP malaligned squat compared with the control squat. Participants demonstrated decreased knee adduction during 15–75% of the AP malaligned squat compared with the control squat (Figure 3).

Vastus Lateralis. The vastus lateralis had decreased activation in the AP malaligned squat compared

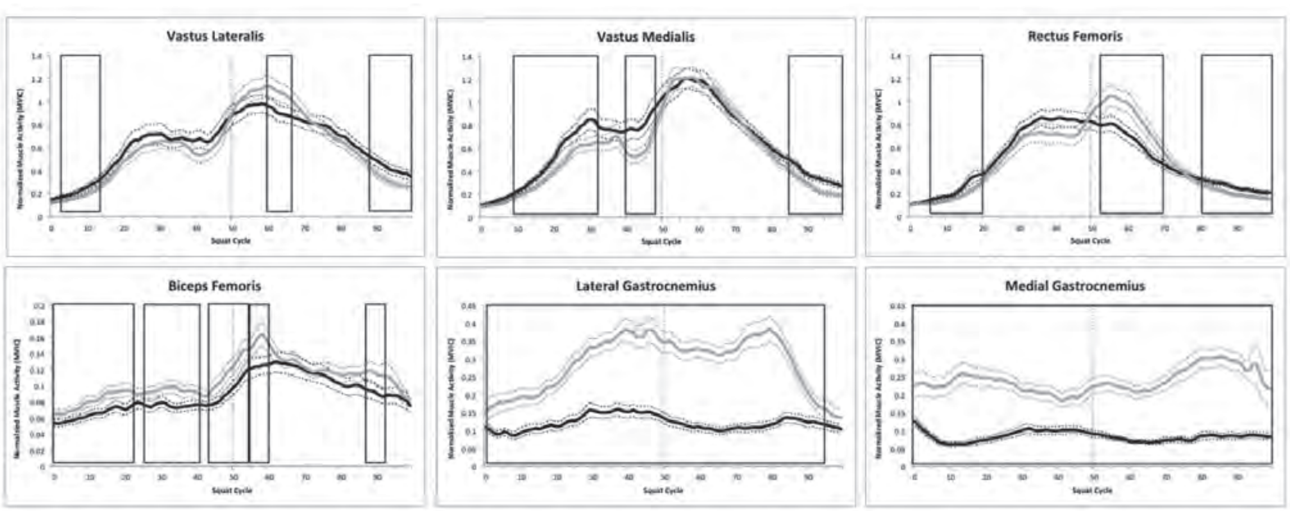

Figure No.6

Differences in muscle activation patterns during the antero-posterior malaligned (grey line) and control (black line) squat across the squat cycle with90% confidence intervals. Areas in which confidence intervals did not overlap for 3 or more consecutive percentage points were considered statistically significant.

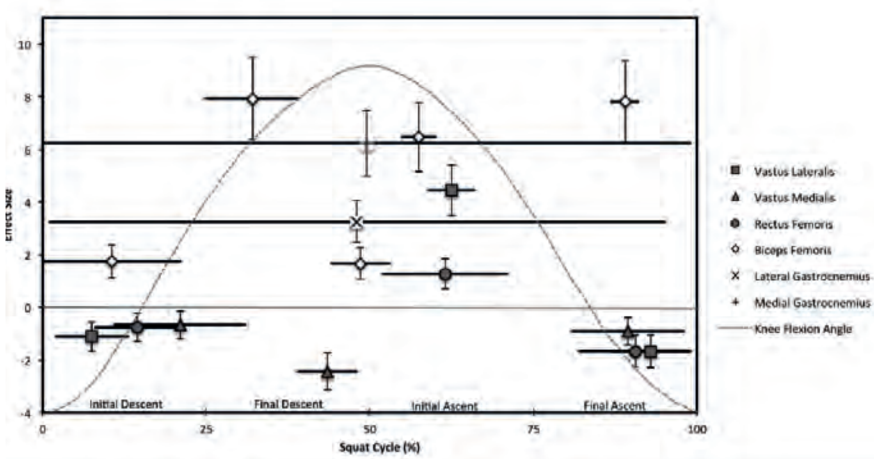

FIGURE NO.7
EFFECT SIZES FOR SIGNIFICANT DIFFERENCES BETWEEN ANTERO-POSTERIOR MALALIGNED AND CONTROL SQUAT. VERTICAL ERROR BARS REPRESENT 95% CONFIDENCE INTERVALS FOR THE EFFECT SIZE POINT ESTIMATE. THE HORIZONTAL LINE REPRESENTS THE DURATION ACROSS THE SQUAT CYCLE WHERE CONFIDENCE INTERVALS DID NOT OVERLAP.

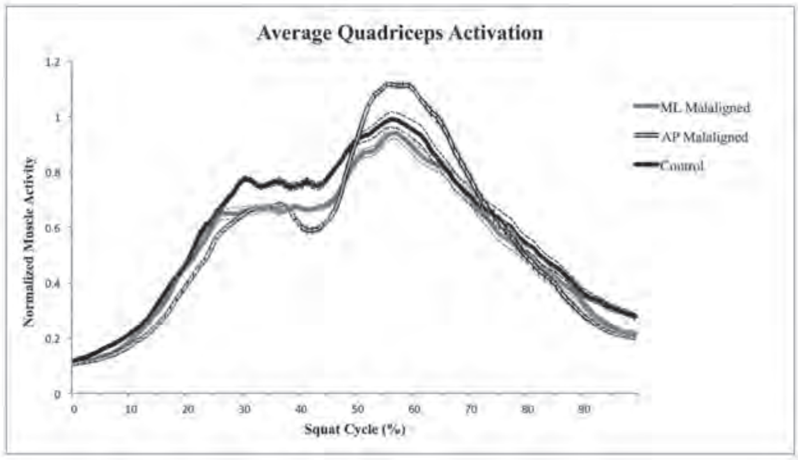

FIGURE NO.8
DIFFERENCES IN AVERAGE QUADRICEPS (VASTUS LATERALIS, VASTUS MEDIALIS, AND RECTUS FEMORIS) ACTIVATION PATTERN WITH 90% CONFIDENCE INTERVALS BETWEEN SQUAT TECHNIQUES.

with the control squat during initial descent (2–13%) and final ascent (87–99%) of the squat cycle. Vastus lateralis had increased activation during the AP malaligned squat during initial ascent from peak knee flexion, 59–66% of the squat cycle (Figure 6). Effect sizes were very large (Range = 22.29, 3.47) for all significant differences during the squat cycle for AP malalignment (Figure 7).

Vastus Medialis. The vastus medialis had decreased activation during the initial (11–31%) and final descent (39–48%) of the AP malalignment squat compared with the control squat (Figure 6).

Vastus medialis activation also decreased during the final ascent of the squat cycle (81–98%) of the AP malaligned squat compared with the control squat (Figure 6). Effect sizes were moderate to very large (Range = 20.69, 22.44) for all differences during the AP malaligned squat during the squat cycle (Figure 7).

Rectus Femoris. Activation of the rectus femoris decreased during the initial phase of descent (8–21%) and final phase of ascent (82–99%) in the AP malaligned squat compared with the control squat. The rectus femoris activation increased in the AP malaligned squat during the initial phase of ascent (52–71%) (Figure 6). Effect sizes were large to very large (Range = 21.68, 1.26) for all differences during the AP malaligned squat (Figure 7).

Biceps Femoris. The biceps femoris had increased activation in all 4 phases of the AP malaligned squat compared with the control squat (Figure 6). Effect sizes were very large (Range = 1.66, 7.94) for all differences during the AP malaligned
squat (Figure 7).

Lateral Gastrocnemius. The lateral gastrocnemius activation also increased during the AP malaligned squat during all phases of descent and ascent (1–95%) compared with the control squat (Figure 6). Effect size was very large (3.24) for the difference in activation during the AP malaligned squat (Figure 7).

Medial Gastrocnemius. The medial gastrocnemius was more active during the AP malaligned squat during all phases of descent and ascent (0–99%) compared with the control squat (Figure 6).

Effect size was very large (6.24) for the difference in activation during the AP malaligned squat (Figure 7).

DISCUSSION

The main purpose for the inclusion of the body weight squat in training and rehabilitation programs is to increase strength at the thigh, hip, and back musculature (10). The activation patterns of the vastus lateralis, vastus medialis, and rectus femoris during the control squat in this study are similar to those previously reported (8,11,24,28), supporting that the squat exercise focuses on quadriceps activation. The results in this study support the notion that the quadriceps are most active during the concentric phase of the exercise (35,40). The results in this study also support that malaligned squats, both in the sagittal and frontal planes, significantly alters quadriceps activation. The decreased quadriceps activation associated with ML malalignment indicates that frontal plane deviations during a squat alter muscle activation strategy to stabilize the lower extremity during a bilateral squat (Figure 8). Our study agrees with prior findings that the rectus femoris is less active than the vastus medialis and lateralis during a control squat (12); however, frontal plane malalignment further decreased rectus femoris activation during descent into peak knee flexion and increased activation in the knee flexors. The decreased rectus femoris activity during frontal plane malalignment may suggest that increased medial knee displacement during squats changes the nature of the exercise, decreasing quadriceps activation and increasing hamstring and gastrocnemii activity. Further research should continue to investigate the influence of medial knee displacement on rectus femoris activation during closed-chain knee exercises.

In the current study, both AP and ML malaligned squats increased gastrocnemius activation compared with the control squat. The medial and lateral gastrocnemii activation during the descending and ascending phase of the squat was similar to that previously reported during squatting (36). The increased gastrocnemii activation during ML malaligned squats was also similar to increased gastrocnemii activation in individuals with passive medial knee displacement during squatting (36). Participants in this study were instructed to purposefully squat into a malaligned position, which may not represent muscle activation patterns during passive malalignment.

The similarities in gastrocnemii activation during passive medial knee displacement indicate that both the medial and lateral gastrocnemii are more active during frontal plane malalignment even with the slight medial knee excursion seen in this study. Increased coactivation of the gastrocnemii during closed kinetic chain exercises stabilizes the ankle during flexed knee stance and decreases the strain at the anterior cruciate ligament by pulling the femur backwards (22,26,34). The increased coactivation of the gastrocnemii during both malaligned squats may indicate an unstable knee joint position with increased anterior and medial knee displacement. These findings support the importance of sagittal plane alignment squat form when patients and clients display even minimal knee abduction especially when the goal of the squat is to strengthen the quadriceps muscle group.

The increased eccentric activation of the knee flexors during malaligned squats may be in an effort to stabilize the knee joint when quadriceps activation decreases and when contact forces are highest. Previous researchers (3,14,15,33,39,41,43) have noted that patellofemoral contact forces are high around 908 of knee flexion, whereas tibiofemoral contact forces are largest when the knee is close to full extension. During both malaligned squats, cocontraction of the biceps femoris and gastrocnemii during parts of the squat cycle when contact forces are highest may be a strategy to stabilize the hip and knee joint (1,8). Hamstring cocontraction during knee flexion also decreases anterior translation and internal rotation, whereas cocontraction of the gastrocnemius decreases strain at the anterior cruciate ligament (16,30), supporting that increased activation of the hamstring and gastrocnemius muscles during malaligned bilateral squats may be a stabilizing technique. Furthermore, the increased activation in the hamstring and gastrocnemii during malaligned squats changes the nature of the exercise, targeting muscles that are considerably less active during a squat with neutral alignment. Further research comparing neutral and malaligned squats should also include gluteus maximus, semitendinosus, and semimembranosus activation. Although gluteus maximus activation reportedly increases with squat depth (4), this may not represent gluteal activation during an unloaded squat to 908 of knee flexion (5) with neutral and malaligned techniques. In contrast to the decreased quadriceps activation during the ML malaligned squat, the AP malaligned squat increased vastus lateralis and rectus femoris activation during initial ascent. Furthermore, the decreased vastus medialis activation during the AP malaligned squat may be in effort to decrease tibial internal rotation and patellofemoral contact pressure (42). Previous researchers (33) have noted increased patellofemoral contact forces during flexion with increased quadriceps activation, which may lead to the increased eccentric activation of the knee flexors during the AP malaligned squat. Although restricting anterior knee displacement can result in increased thoracic motion and forces at the hip and back during squats (17,27), too much anterior knee displacement may lead to increased patellofemoral contact forces (33,38,39). The knee joint displaced approximately 0.17 m anteriorly compared with neutral-position during control squats in our study; however, the biceps femoris and gastrocnemius had little activity throughout the squat cycle. Both the ML and AP malaligned squats increased anterior knee displacement by approximately 0.07 and 0.15 m, respectively (Figure 2), which may explain the increase in biceps femoris activation we observed during initial descent and increase gastrocnemius activation during initial and final ascent of the squat cycle (Figures 4 and 6).

There is no established "safe zone" for anterior excursion at the knee during squats that can be recommended from the data in the current study. However, we have identified altered muscle activation patterns when alignment is altered during a squat. Further research should explore optimal anterior knee displacement during bilateral squatting to ensure that the spine, hip, and knee are not exposed to risk during the exercise.

There were some limitations to this study including the lack of standardization of knee flexion angle, squat velocity, and reliability of EMG findings. Although knee flexion angle was not standardized, all participants received the same verbal instructions and these instructions were interpreted in a similar manner given the tight confidence intervals. Squat velocity was not standardized; however, both the descending and ascending phases of the squat were reduced to 50 points in order to standardize each squat based on kinematic events. Future research using this technique should standardize squat velocity to further minimize changes in muscle activity. Although we did not assess reliability of EMG in the current study, reliability of surface EMG using a repeated measures design has been well documented during functional tasks in both healthy and pathological populations (23,25,31). Lastly, the order of squat performance was not counterbalanced, with the control condition performed last. This was an active decision to limit any feedback during squat performance until malaligned squats were completed. Participants were also given adequate rest between squats, limiting the influence of the previous squat. Future researchers using this design should consider counterbalancing the order of the malaligned squat technique to further limit the influence of one squat variation on another.

The results of this study support that malaligned squats in the frontal and sagittal plane significantly alter muscle activation patterns in the lower extremity, increasing activation in hamstring and gastrocnemius muscles compared with a control squat. Frontal and sagittal plane knee excursion also significantly alter quadriceps activation patterns during squatting, changing the demands of the task on the knee musculature. Despite the altered activation strategies during malaligned squats, activation in the hamstring and gastrocnemius decreased during the control squats using basic instructions and feedback. The simple cues used in this study may help guide clients and patients to activation in the quadriceps and decrease activation in the hamstring and gastrocnemius during bilateral bodyweight squats.

PRACTICAL APPLICATIONS

The bilateral squat exercise is a commonly used exercise for strengthening the quadriceps. Oftentimes, the exercise is not executed properly without initial instruction from a practitioner. Two common malalignments during a bodyweight bilateral squat are medial and anterior knee displacement; however, there is little information about the changes in muscle activation patterns resulting from these malalignments.

The results in this study support

that medio-lateral and antero-posterior malalignments alter muscle activation patterns in the lower extremity, specifically increasing activation of the hamstrings and gastrocnemii, which have relatively low activity in a neutrally aligned squat. Increased cocontraction of the knee flexors and gastrocnemii during malaligned squats may be in an effort to stabilize the ankle, knee, and hip during flexed knee stance, indicating that malaligned knee positions may be potentially injurious. The increased quadriceps activation with increased anterior knee excursion around peak knee flexion should also be a consideration in strength and conditioning programs and inclusion of squats similar to the ballet plie´ squat should be cautioned. Furthermore, the results of this study support the use of the bilateral squat as an assessment tool for clients and patients who complain about tightness and pain in the hamstring or gastrocnemii.

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β-ALANINE SUPPLEMENTATION FOR THE COMPETITIVE ATHLETE

BY JAY R. HOFFMAN


25
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β-alanine has become one of the more popular supplements being used by competitive strength/power athletes today. β-alanine is a non-proteogenic amino acid (e.g., does not stimulate protein synthesis), and is one of the two constituents of carnosine (the amino acid histidine is the second constituent), and appears to be the rate limiting step in carnosine synthesis (Harris et al., 2006). Carnosine is found in skeletal muscle of all vertebrates (Harris et al., 1990), but the carnosine content of skeletal muscle in mammals that rely on anaerobic metabolism to fuel their activity is quite high. The relationship between carnosine content and muscle buffering capacity is strongly positive across all species (Harris et al., 1990; Abe, 2000), with a significantly greater concentration of carnosine found in type II compared to type I muscle fibers (Harris et al., 1998). Carnosine's primary physiological role in muscle is to serve as a pH buffer (Harris et al., 2006). High carnosine concentration within muscle could serve to delay fatigue and prolong highly intense exercise lasting 1-5 minutes. Thus, the purpose of **β-alanine** supplementation is to maximize carnosine content in skeletal muscle for improving anaerobic activity.

Diet does appear to have an effect on muscle carnosine concentrations. Muscle carnosine concentrations in carnivores are significantly higher than that seen in vegetarians (Evaraert et al., 2011). In vegetarians muscle carnosine content could only be elevated by hepatic β-alanine synthesis through uracil degradation. This is a very inefficient process and dietary intake of meat, chicken and turkey are required to elevate muscle carnosine concentrations (Harris et al., 2007). Ingestion of - 200 g of chicken breast meat, or 150 g of turkey breast meat, would result in the plasma bioavailability of an 800 mg β-alanine supplement (Harris et al, 2006). Considering that the daily dose of β-alanine ranges from 1.6 to 6.4 g, that would require one to consume between - 400 g – 1600 g of chicken breast or - 300 g – 1200 g of turkey breast per day. Thus, the use of β-alanine as a supplement appears to be more effective than dietary intake only in elevating muscle carnosine concentrations.

Dose – Response for β-Alanine Ingestion and Muscle Carnosine Synthesis.

It has been suggested that a daily dosing regimen of 1.6 - 6.4 $g \cdot day^{-1}$ can cause significant increases in muscle carnosine concentrations (Stellingwerff et al., 2012a). Doses higher than 6.4 $g \cdot day^{-1}$ have generally not been examined due to the greater risk of symptoms of paresthesia occurring. However, vast majority of those studies were conducted prior to the use of sustained release formulations of β-alanine, which may minimize the appearance of paresthesia (Harris and Stellingwerff, 2013). The increase in carnosine content within muscle, subsequent to β-alanine supplementation, appears to be dependent upon several factors that include training history, dose and duration of use. Stellingwerff and colleagues (2012b) appear to be the only study to directly com-

pared multiple dosing strategies and demonstrated that a higher dose (total ingestion of 134.4 g) of β-alanine resulted in a greater increase in carnosine content in both fast-twitch (gastrocnemius) and slow-twitch (tibialis anterior) muscle fibers than a lower dose (total ingestion of 89.6 g) in an 8-week supplementation study. Stellingwerff and colleagues (2012b) also reported that muscle carnosine levels are significantly increased with as little as 1.6 g·day^{-1} following only 2 weeks of supplementation. Other studies have generally not compared different dosing schemes. Baguet and colleagues (2009) provided 4.8 g·day^{-1} for 5 – 6 weeks and reported a 23% increase in carnosine content of the gastrocnemius of recreationally trained men. In a following up study, the same research team investigating elite athletes ingesting a higher dose (5.0 g·day^{-1}) for a slightly longer duration (7-weeks) reported an increase in muscle carnosine content of 28% in the gastrocnemius (Baguet et al., 2010). This study though used rowers, who primarily rely on their upper body during training and competition. Derave and colleageus (2007) examining track and field athletes reported a 37% increase in carnosine content in the gastrocnemius following 4.8 g·day^{-1} for 4 – 5 weeks. Interestingly, Hoffman and colleagues (2015a) examining elite combat soldiers ingesting 6.4 g·day^{-1} of sustained release tablets for 4-weeks reported a 28% increase in the carnosine content of the gastrocnemius muscle. Thus, doses ranging in amounts of 4.8 – 6.0 g·day^{-1} for 4 – 7 weeks will result in an increase in carnosine content in the gastrocnemius ranging from 23-28% in recreationally trained individuals, but possibly higher levels in competitive athletes, suggesting a potential a synergistic effect from training. The combination of training and β-alanine ingestion appears to have a greater effect than β-alanine ingestion alone on increasing muscle carnosine content. The increased sensitivity in trained muscle was recently supported by Bex et al., (2013). In that study, the investigators compared non-athletes to competitive athletes and showed muscle carnosine increases greater in the exercised muscles in athletes compared to non-exercised muscle in non-athletes. Specifically, 23-days of β-alanine supplementation at 6.4 g·day^{-1} was reported to increase carnosine content in the deltoid muscle 82% in swimmers but only 63% in the non-athletes. Others have examined the effects of 4-weeks of β-alanine ingestion (6.4 g·day^{-1}) on trained and untrained vastus lateralis muscle (Kendrick et al., 2009). Subjects served as their own controls (i.e. one leg was exercised, while the other remained sedentary). Increases in muscle carnosine concentrations of 52.2% were reported in the trained leg, and only a 28.3% increase was observed in the untrained leg. These measures were obtained through a muscle biopsy, whereas the previous measures have used magnetic resonance spectroscopy (MRS) to determine muscle carnosine content. Improvements reported in muscle carnosine content assessed using muscle biopsy procedures appear to be larger in magnitude the changes reported from MRS assessments (Stellingwerff et al., 2012a).

Most supplement studies examining β-alanine ingestion have generally used an absolute dose for an ingestion protocol. Hill and colleagues (2007) examining 25 physically active male subjects used a dosing protocol beginning with 4.0 g·day^{-1} for the first week and increasing it 800 mg per week until week 4, and then maintained a 6.4 g·day^{-1} for an additional 6-weeks. This was reported to be an equivalent to a relative does of approximately 50 – 80 mg·kg^{-1}·day^{-1} reported a 58.8% increase in muscle carnosine concentration following 4-weeks of ingestion and an additional 21% increase seen by week 10 (Hill et al., 2007). Similarly, Kendrick and colleagues (2008) reported increases in muscle carnosine concentrations (53.5%) in physically active physical education students following 10-weeks of supplementation using a 6.4 g·day^{-1} for the entire supplementation period. The relative dosing was similar to the Hill et al. (2007) study. Thus, increases in carnosine content appear to be rapid during the initial stages of ingestion, but the rate of carnosine elevation begins to slow as ingestion is maintained. Large variability of carnosine content exists between Type II and Type I fibers, Harris and colleagues (1998) indicated that these differences may be up to two-fold, and likely impact the potential of these muscle to increase carnosine content. Derave and colleagues (2007) provided 4.8 g·day^{-1} for 4-5 weeks in track and field athletes and reported a 47% increase in carnosine content in the soleus muscle, a predominantly slow twitch fiber, but only a 37% increase in the gastrocnemius, a predominantly fast twitch muscle. Baguet and colleagues (2010) reported nearly a two-fold difference in the magnitude of carnosine content elevation between the soleus and gastrocnemius in elite female rowers ingesting 5.0 g·day^{-1} for 7 weeks. Even when the absolute increase in carnosine content is similar, the relative increase may be different due to baseline carnosine levels (Stellingwerff et al., 2012b). Based upon a linear regression model developed by Stellingwerff and colleagues (2012a) a —50% increase in muscle carnosine, a total of —230 g of β-alanine must be consumed (assuming a 1.6 – 6.4 g·day^{-1} ingestion dose). This model demonstrated a linear dependency ($R^2 = 0.921$) on the total amount of β-alanine consumed and the increase in muscle carnosine content. This was shown to be independent of muscle type. In a meta-analysis published by Hobson et al., 2012), data analysis indicated that supplementation with a total ingestion of 179 g of β-alanine (the median dose across all studies) resulted in a median performance improvement of 2.85% compared with a placebo.

CARNOSINE WASHOUT

Cessation of β-alanine ingestion will result in a gradual return of muscle carnosine concentrations to baseline levels. In one study 20 young physically active males were divided into two groups that received either 4.8 g·day^{-1} of β-alanine or placebo for 6 weeks. Three weeks after supplement cessation the mean carnosine concentrations in three muscles was reported to have decreased by 31.8% (Baguet et al., 2009). Following nine weeks of β-alanine ingestion muscle carnosine concentrations returned to baseline levels. The degree of muscle carnosine decrease may be dose dependent. Participants who were reported to be high responders (saw a greater accumulation of muscle carnosine content) required a greater washout time to return to baseline levels (—15 weeks) than participants that were reported to be low responders (—6 weeks). Stellingwerff et al. (2012b) demonstrated that a 1.6 or 3.2 g·day^{-1} for 8 weeks in healthy but untrained males increased absolute muscle carnosine content by average 2.01 mmol·kg$^{-1}_{ww}$. This absolute change was equivalent to a relative —30 – 45% increase (depending upon fiber type) in muscle carnosine content. Cessation of β-alanine ingestion resulted in a slow washout time (—15-20 weeks) with a rate of decay approximately 2% per week. This decay period was slower than that reported by Baguet et al., (2009), and may have been related to the higher baseline levels reported in latter study.

ERGOGENIC PROPERTIES OF Β-ALANINE SUPPLEMENTATION

The ergogenic role of β-alanine is not seen by the direct actions of the amino acid, but in its ability to combine with histidine within muscle tissue to form carnosine. However, the evidence supporting the ergogenic benefit of elevating muscle carnosine concentrations is strong. In a meta-analysis study, Hobson et al. (2012) found that the greatest ergogenic potential for elevated carnosine concentrations occurs during high intensity exercise lasting 60- 240 seconds in duration. Overall, significant ($p<0.001$) differences in performance were found between the β-alanine and the placebo groups. The analysis included 360 subjects (174 with β-alanine supplementation and 186 with placebo) from 15 published manuscripts. No significant benefit in β-alanine ingestion was noted in performance durations lasting <60 seconds compared to placebo ingestion. In placebo-controlled studies, β-alanine supplementation has been consistent in demonstrating significant performance benefits in both recreational and competitive athletic populations performing high intensity activity

(Hill et al., 2007; Hoffman et al., 2006; 2008a; 2008b; Kendrick et al., 2008; Stout et al., 2006; 2007). In a double-blind, placebo controlled study, ingestion of 6.4 g·day^{-1} and 3.2 g·day^{-1} of β-alanine (days 1-6 and days 7-28, respectively) in 12 untrained young men for 4-weeks (high dose was titrated to the low dose following the first week of ingestion) was shown to improve physical working capacity at fatigue threshold (PWC_{FT}) by 14.5% ($p < 0.05$) in the β-alanine group (Stout et al., 2006). This difference was significantly ($p<0.004$) greater than the placebo group that showed no change in physical working capacity. Stout and colleagues (2007) conducted a follow-up study, recruiting 22 untrained college-aged women in another placebo controlled, double-blind protocol. The active group were supplied with 3.2 g·day^{-1} and 6.4 g·day^{-1} of β-alanine (days 1-7 and days 8-28, respectively) for 4-weeks. The investigators reported a 12.6% ($p<0.001$) improvement in PWC_{FT} and a 2.5% ($p<0.05$) increase in time to exhaustion during a graded exercise cycle ergometry test than the placebo supplemented group. Studies in trained, competitive athletes supplemented with β-alanine for similar durations have reported similar results. Derave and colleagues (2007) in a double-blind, placebo controlled study, reported that 4-weeks of β-alanine supplementation (4.8 g·day^{-1}) in 15 male 400-m sprinters was significantly ($p<0.05$) able to delay fatigue in repeated bouts of isokinetic exercise (5 sets of 30 maximal voluntary knee extensions). Another double-blind, placebo controlled study provided 4.8 g·day^{-1} of β-alanine or placebo for 4-weeks to experienced, resistance trained strength/power athletes (Hoffman et al., 2008b). The difference in training volume (total number of repetitions performed in the squat exercise per workout) reported as the difference between workouts performed at week 0 and week 4 of the study was significantly ($p<0.05$) greater in the athletes using β-alanine (9.0 ± 4.1 repetitions) compared to the placebo (0.3 ± 7.8 repetitions). In addition, the average mean power output per repetition for each set was significantly ($p<0.05$) higher in the athletes supplementing with β-alanine than those ingesting the placebo. Hoffman and colleagues (2008a) provided 4.5 g·day^{-1} of β-alanine for four weeks to college football players. Initial performance testing which occurred following two weeks of supplementation revealed no significant differences in sprint times or fatigue rates during repeated (total of three) shuttle runs (30 – 35 second per run with a 2-min rest between each sprint). However, a strong trend ($p = 0.07$) was noted in fatigue rate during a 60-second Wingate anaerobic power test. As supplementation continued, examination of the player's resistance training logbooks showed further trends ($p = 0.09$) towards a higher (9.2 %) volume of training (load x repetitions) in those athletes supplementing with β-alanine compared to placebo. Although the inability to see any effect on repeated sprints of approximately 30 – 35 seconds appears to be consistent with the results of Hobson and colleagues (2012), it is also likely that the two week supplementation period (only 63 g of β-alanine ingested) in trained athletes may not have been sufficient to significantly increase muscle carnosine content. The trend towards an improved fatigue rate in a 60-second maximal intensity bout of exercise is consistent with the physiological role that β-alanine supplementation has a possible effect on improved buffering capacity during prolonged (>60 seconds) high intensity exercise

(Hobson et al., 2012). Studies examining longer supplementation periods of β-alanine during performance events lasting more than 60-seconds in duration have also reported significant benefits. Baguet and colleagues (2010) provided 5 g·day^{-1} of β-alanine in elite, competitive rowers. Following 7-weeks of supplementation, athletes ingesting β-alanine were 2.8 ± 4.8 seconds faster during a 2,000 m rowing time trial performance than their pre-supplement times. The placebo group was 1.8 ± 6.8 seconds slower than their pre-supplement times. Although these differences were not statistically significant ($p = 0.07$), these results do suggest a strong trend in an elite group of athletes that may have practical significance. Furthermore, intramuscular carnosine content in the experimental group was significantly ($p < 0.05$) higher by 45% and 28% in the soleus and gastrocnemius, respectively, and the change in muscle carnosine content was significantly correlated ($r = 0.498$, $p = 0.042$) to performance improvement in the rowing time trial. High intensity exercise performed immediately following a prolonged bout of endurance exercise may also benefit from β-alanine supplementation. In a double- blind, placebo controlled study, Van Thienen and colleagues (2009) provided 17 trained cyclists β-alanine in graduated doses from 2 – 4 g·day^{-1} for 8-weeks. Performance testing included a varied intensity [50% - 90% of maximal lactate steady state (MLSS)] 110-minute cycle ergometer time trial followed by a 10-minute time trial at 100% of their MLSS, which was followed by a 30-second sprint. The 9 athletes consuming β-alanine show a significant 11.4% ($p<0.0001$) and 5.0% ($p<0.005$) improvement in both peak and mean power, respectively during the 30-second sprint performance, which was higher than the group

that consumed the placebo (n = 8). The authors concluded that β-alanine supplementation can significantly enhance sprint performance at the end of an exhaustive endurance exercise bout. There have only been a limited number of studies examining the effects of β-alanine ingestion and endurance performance. Jordan and colleagues (2010) reported that following 4-weeks of β-alanine ingestion (6.0 $g \cdot day^{-1}$) a delay in blood lactate accumulation was seen in participants who were not trained aerobically during the supplement period; a decrease in aerobic capacity was also noted. This is not surprising considering the physiological role of carnosine in muscle does not provide a strong mechanism for enhancing endurance performance. Nevertheless, Smith et al. (2009) reported significant ($p<0.05$) improvements in VO_2peak, time to fatigue and total work performed during endurance performance in recreationally active males following 6-weeks of high intensity interval training (5 - 7 sets of 2-minute intervals at 90% max power output, with 1-minute rest between each interval) and β-alanine ingestion (6.0 $g \cdot day^{-1}$ for 21 days followed by 3.0 $g \cdot day^{-1}$ for another 21 days). Although improvements were noted in both the supplement and placebo groups in these measures following 3 weeks of training, only the β-alanine group had significant ($p<0.05$) aerobic improvements after the 6-weeks of training. These results were confirmed by a subsequent study by Walter and colleagues (2010) examining recreationally active women. Even though there is no direct physiological benefit of β-alanine supplementation for endurance and aerobic performance, the combination of anaerobic high intensity intervals training and β-alanine likely improved the quality of the high intensity sprints, indirectly affecting aerobic capacity and cardiovascular fitness.

SAFETY

The only side effect reported with β-alanine supplementation is paresthesia (Harris et al., 2006). Paresthesia is a sensation of numbing or tingling in the skin. It has been commonly experienced when consuming non-sustained release doses (>800 $mg \cdot kg^{-1}$) of β-alanine (Harris et al., 2006). Reports of paresthesia have not been reported in studies that use sustained-release formulations. Symptoms of paresthesia generally disappear within 60 – 90 min following supplementation (Stellingwerff et al., 2012b). Investigations reporting potential side effects from prolonged (greater than 15 weeks) supplementation protocols have not been seen. However considering that β-alanine is a naturally occurring amino acid with an important physiological role in the body, it is likely a very safe supplement to use. Nevertheless, the long term effect of **β-alanine** supplementation and the combinations with other supplements are unknown.

SUMMARY

When β-alanine is ingested, whether through food or as a dietary supplement, it combines with histidine to form carnosine. Physiologically, elevations in muscle carnosine will increase intra-cellular buffering capacity. The efficacy of β-alanine supplementation has been supported through several studies examining sustained, high intensity exercise in competitive and recreational athletes. Based on current research, **β-alanine** supplementation appears to be efficacious during high intensity activity lasting 60-300 seconds. Research examining **β-alanine** ingestion and competitive athletes provides strong evidence that supplementing with **β-alanine** will increase muscle carnosine levels, which are associated with significant performance improvements during sustained, high intensity activity.

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Editorial guidelines

EDITORIAL GUIDELINES FOR AUTHORS OF ORIGINAL RESEARCH WORK TO BE PUBLISHED STRENGTH & CONDITIONING. THE SCIENCE OF HUMAN MOVEMENT (S&C).

EWF Scientific Magazine (hereafter *SM*) is a scientific journal published by the European Weightlifting Federation (EWF). *SM* publishes surveys and research reports, systematic reviews, reviews, collections of studies, research notes and technical and methodological reports - both original and those drawn from the most Authorized international scientific literature available (with particular but not exclusive reference to the three magazines of the Strength and Conditioning Association of the United States of America: *the Journal of Strength and Conditioning Research*, *Strength and Conditioning Journal* and *NSCA's performance training journal*), which contribute to promoting knowledge on physical training as a whole and on strength training in sport and physical activity in particular. All original typescripts, accepted for publication, must present either concrete and practical applications for the professional who works in the strength training sector, or provide the basis for further applied research in the specific field. The original typescripts are subjected to "double blind" *peer-reviews* by at least two reviewers who are experts in that particular field. Editorial decisions are taken based on the quality of the work presented, the clarity, the style and the importance of the presentation regarding the aims and objectives of *SM*. Suggestions for the drafting of a paper to be published on *SM* can be found at *http://www.nsca-li- ft.org/publications/JSCRtips.shtml*. Authors are invited to carefully read this interesting document, which is very useful for the preparation of any manuscript to be published.

EDITORIAL MISSION STATEMENT

The editorial mission of *EWF Scientific Magazine* (*SM*) is to work to advance knowledge of the movement and training of mankind, on the assumption that the first is always, and in any case, the expression of muscle strength and that the second constitutes a lifestyle and ethics entrusted to skilfully and thoroughly trained professionals with vast knowledge of the facts, as well as specific competence. Since its first appearance, *SM* has had the ambitious goal of bridging the gaps and misunderstandings between the scientific laboratory and those working in the field, enhancing both the practical experience of the coaches and the results of research, especially applied research. For this reason, it makes - as an editorial rule - constant reference to the practice and the inclusion of recommendations for the implementation of research results in the practice of movement and sport.

The process of improving the overall psychophysical condition through the implementation of appropriate exercise programmes covers a wide range of people: from children to senior citizens, through all ages, from novices to professional athletes, at all possible levels. For the professional it is important to have an in-depth knowledge of the process of training and to realise how it can be supported by other practices and other areas of knowledge, such as nutrition, rehabilitation and re-education, psychology, technology, special exercise techniques and biomechanics.

Original research

SM publishes studies and research covering both the effects of exercise programmes on performance and on the human body as well as the underlying biological basis. It includes research stemming from the many disciplines whose aim is to increase knowledge about movement in general and sport in particular, their demands, their profiles, workout and exercise, such as biomechanics, exercise physiology, motor learning, nutrition, psychology, rehabilitation and re-education.

One of the primary goals of *SM* is to provide a scientific basis for qualified and updated programmes of physical training and sports training.

Type of articles and their total length

Due to space limitations, *SM* normally publishes articles no longer than ± pages, including bibliography, figures and images (approximately 4 pages of text with line spacing 1 is equivalent to 14,000 characters, including spaces, + 1 page of bibliography + one page of images and figures and graphs). Works of greater length can naturally be accepted for publication, but may be divided into parts or, with particular reference to the bibliography may be suitably posted on the website www.calzetti-mariucci.it .

SM publishes studies and collections of studies and research, systematic reviews, reviews, methodological reports, technical reports and research notes that are associated with and related to the mission of the magazine. A collection of studies is a group of articles by different Authors that address an issue from various perspectives. The reviews should provide a brief critical review of the literature and integrate the results of previous research to inform the reader about the basic aspects and applications of the subject. As noted above, *SM* is mainly concerned with the practical aspects of the literature reviewed and published.

Furthermore, the Author or Authors of the texts submitted for publication must have experience and knowledge in the given area enabling them to declare themselves experts in the field and to ensure credibility to their findings and their recommendations. *SM* strongly recommends the presentation of material that illustrate methodologies to advance the studies on muscle strength and overall training of the same.

GUIDELINES FOR THE PRESENTATION OF ORIGINAL RESEARCH WORK TO BE PUBLISHED

1. A portion of the texts published by *SM*, as a specific editorial choice, are versions in Italian of highly accredited work already published elsewhere, carefully selected among the many papers available in literature. It is also an editorial policy to include research from young up and coming Authors or those in training. Articles may be submitted by e-mail, in the form of files in Microsoft Word format (.doc), to *dir@calzetti-mariucci.it*, following the instructions below. Authors are required to attach the declaration of assignment of copyright for paper and digital publication, which may be downloaded from www.calzetti-mariucci.it.

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3. Articles will be evaluated for publication, provided they have been submitted exclusively to *SM* and, therefore, have not already been published and will not be published elsewhere in whole or in part. Manuscripts containing data that have already been published on the Internet, available for public inspection, cannot - as a rule - be considered for publication.

4. As required by law, articles will be printed in compliance with the original version and with the name of the Author. Any matters not expressly provided for in these editorial notes and by the act of transfer of copyright attached to the article, shall be subject to the laws and customs regulations in force. All disputes arising between the parties regarding the interpretation and application of these editorial notes and/or the act of transfer of copyright, shall be resolved exclusively by the competent Court of Perugia.

5. The material submitted for publication must be accompanied by a brief resume of the Author or Authors.

6. *SM* adopts standards for the protection of living beings, with regard to testing on animals and humans. In this regard, the Authors of the work submitted for publication must have received appropriate approval from their institutional control bodies or if necessary, must demonstrate to have obtained the appropriate consent under the applicable laws. All submissions must include a statement to that effect, in the Methods section of the document presented. Failure to do so will result in the paper not being considered for publication.

7. All texts should be double-spaced, and an extra space between paragraphs. The paper must include margins of at least 2.5 cm and include the page numbers in the upper right corner beside the current title. Authors should use terminology that is based on the International System of Units (SI).

8. The Authors of the texts are invited to use non-sexist language and to show that they are sensitive to the appropriate semantic description of people with chronic illness and disability (as pointed out - for example - in an editorial of Medicine & Science in Sports & Exercise®, 23 (11), 1991). As a general rule, only abbreviations and codified symbols should be used. If unusual abbreviations are used, they must be explained from their first appearance in the text. The names of trademarks must be written with a capital letter and their spelling is to be carefully checked. The names of chemical compounds and generic names must precede the trade name or abbreviation of a drug the first time that it is used in the text.

PREPARATION OF MANUSCRIPTS

1. Title page

The title page should include the title of the paper, the current title in short, the laboratory or laboratories where the research was conducted, the full name of the Author or Authors, the department, the institution, full postal address of the corresponding Author, phone number, fax number and email address; furthermore, a declaration of any funding received for the work carried out must be included.

Title page without the name of the Authors

A second page should be enclosed containing only the title of the paper. This page will be used to send the paper to the Reviewers for the double-blind review process.

3. Summary and Keywords

A separate sheet must contain a summary of the paper in not more than 250 words, followed by a minimum of 3 to a maximum of ± keywords, not used in the title. The summary must be structured in sentences (not titles) related to the purpose of the study, methods, results, conclusions and practical applications arising from the work presented.

4. Text

The text must be composed, as a rule, of the following sections with titles in uppercase and in the following order:

A. Introduction. This section is a careful development of the hypotheses of the study that led to the implementation of the survey. It is advisable not to use subtitles in this section and try to limit it to 4-6 paragraphs, written in a concise manner.

B. Methods. The following subtitles are required in the Methods sections in the following order: "Experimental approach to the problem," where the Author or Authors of the study show that the approach can prove the hypotheses developed in the introduction, and can offer some basic principles for the choices made regarding the independent and dependent variables used in the study; "Subjects", where the Authors insert the approval of their project by the control bodies, if any, and the appropriate informed consent obtained. All the characteristics of the subjects that are not dependent variables of the study are to be included in this section and not in the "Results"; "Procedures" includes the methods used, bearing in mind the concept of the possibility of a "replication of the study"; "Statistical Analysis", is the section that clearly states the statistical approach to the analysis of the series or of the data series. It is important to include the α level of significance (e.g., $P \leq 0.05$). Authors are requested to include in the paper the statistical power for the size and reliability of the measures used with intra-class correlation coefficient (ICC). Additional subtitles may be used, but their number must be as limited as possible.

C. Results. The results of the study are presented in this section. The most important findings must be presented in the form of tables and figures and the less important should be included in the text itself. Do not insert data that are not part of the experimental project or have been already published.

D. Discussion. In this section, the results of the study are elaborated. They must be related to the literature that currently exists; all hypotheses therefore must be covered.

It is recommended that statements such as "further research will be necessary, etc. etc... " be avoided.

Practical applications. In this section, it is essential to indicate to the coach or the sports professional how to apply and use the data contained in the article. It is a distinctive feature of *SM*, also in compliance with the editorial mission (see above), to try to bridge the gaps between the professional laboratory and the professional field.

5. Bibliography

All references must be listed in alphabetical order by last name of the first Author and numbered. References in the text must be made with numbers [e.g. (4, 9)]. All bibliographic entries listed should be cited in the paper and indicated by numbers. Please carefully check the accuracy of the bibliography, mainly to avoid - during the preparation of proofs - changes in bibliographic entries, especially regarding the numerical order in which the citations appear.

6. Acknowledgements

In this section, information may be included regarding identification of funding sources, updated contact information of the Author and acknowledgements to others involved in the execution of the experiment, if it was an experiment. In this part of the document, information must be included relating to conflicts of interest. In particular, the Authors should: 1) declare the professional relationship with other companies or producers who benefit from the findings of the study and 2) cite the specific grant funding in support of the study. Failure to disclose such information could result in the rejection of the article submitted for publication.

7. Figures

The legends of the figures should be submitted on separate pages, and each figure should appear on a separate page. Each work should be accompanied by a set of figures. Electronic photographs copied and pasted in Word and PowerPoint will not be accepted. The images must be scanned at a minimum of 300 *pixels per inch* (ppi). The Line art should be scanned at 1200 ppi. Please specify the file format of the graphs. TIFF or EPS formats will be accepted for both Macintosh and PC platforms. We also accept image files in the following native application file formats:

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If a digital camera is used to take pictures for printing, maximum resolution with less compression must be set. As digital camera manufacturers use terms and different file formats for capturing high-resolution images, please refer to the manual of the actual camera used for more information.

Layout. Ensure that all figures and tables have been mentioned in the text. Indications must be given as to their position between paragraphs, for example: Figure 1 is to be inserted at this point, or the Table 1 in the latter; etc.

8. Tables

Tables should be typed double-spaced on separate pages and include a short title. Ensure that there is adequate space within the tables and use the least possible number of layout rules of the rows. When tables are necessary, the information must not be a duplicate of data already in the text. All figures and tables must include standard deviations or standard errors.

Costs for Authors

SM does not charge the Authors with any fees for presentation or per page. It is precisely for this reason that it is assumed that once the manuscript has been accepted for publication and sent to the printers, it is in its final form.

Terminology and measurement units

Under the terms of the Scientific Committee of *SM* and in order to promote uniformity and clarity in all scientific journals, the Authors are invited to use the standard generally accepted terms in the field of sports sciences and sports. The Scientific Committee of *SM* accepts the use of the following terms and units. The units used will be those of the International System of Units (SI). Exceptions allowed: heart rate: beats per minute; blood pressure: mm Hg; gas pressure: mm Hg. The Authors may refer to the British Medical Journal (1: 1334-1336, 1978) and the Annals of Internal Medicine (106: 114-129, 1987) to properly express other units or abbreviations. When using units of measurement, please place the multiplication symbol in the middle of the line to avoid confusion with a full stop; e.g. **ml • min-1 • kg-1.**

Among the simple units and those derived most commonly used in research reports of this magazine are:

Mass: gram (g) or kilograms (kg); force: Newton (N); distance: metres (m), kilometre (km); temperature: degree Celsius (° C); energy, heat, work: joule (J) or kilojoules (kJ); power: watt (W); time: Newton per meter (N • m); Frequency: hertz (Hz); pressure: Pascal (Pa); time: second (s), minutes (min), hours (h); volume: litre (l), millilitre (ml); and the quantity of a particular substance: moles (mol), millimoles (mmol).

Conversion factors selected:

• 1 N = 0.102 kg (force);

• 1J = 1 N • m = 0.000239 kcal = 0.102 kg • m;

• 1 kj = 1000 N • m = 0.239 kcal = 102 kg • m;

• 1 W = 1 J • s-1 = 6.118 kg • m • min.

When using the nomenclature for the types of muscle fibres, please use the following terms. The types of muscle fibres can be identified using the methods of histochemical classification or by gel electrophoresis. The histochemical staining of the ATPase is used to separate the fibres in the forms of type I (slow-twitch), type IIa (fast-twitch) and type IIb (fast-twitch). The work of Smerdu et al. (AJP 267: C1723, 1994) indicates that the fibres contain the type IIb myosin heavy chain type IIx (typing fibres by gel electrophoresis). To meet the need for continuity and to reduce confusion on this point, it is recommended that the Authors use IIx to indicate what were called IIb fibres (Smerdu V, Karsch-Mizrachi I, Champion M, Leinwand L, and S. Schiaffino , Type IIx myosin heavy chain transcripts are expressed in type IIb fibers of human skeletal muscle. Am J Physiol 267 (6 Pt 1): C1723-1728, 1994).

Spanish resumenes

EL SALTO HORIZONTAL COMO FORMA DE PREDECIR EL RENDIMIENTO DEL LEVANTAMIENTO DE PESAS. UN ESTUDIO PILOTO: EL SALTO HORIZONTAL PREDICE EL RENDIMIENTO DEL LEVANTAMIENTO DE PESAS

Rich J. Kite, Adam Spence

SM (ing), n.º 8, año III, septiembre-diciembre de 2017, págs. 4-17

El proceso de identificación de talentos a menudo comprende una serie de pruebas físicas cuyos resultados permitirán asignar de forma estratégica deportistas y recursos. Una parte del conjunto de pruebas del British Weight Lifting (entidad británica de halterofilia; BWL por su sigla en inglés) para identificar talentos comprendía un esprint de 30 m (30ST), un salto vertical (VJ), un salto horizontal (HJ) y el lanzamiento de un balón medicinal por encima de la cabeza (MBT). La finalidad del presente estudio es evaluar las relaciones existentes entre el protocolo de pruebas de la BWL para identificar talentos y el rendimiento del levantamiento de pesas. Participaron de forma voluntaria 12 levantadores de pesas (media ± s; masa: 86 ± 20 kg; total ajustado con el coeficiente de Sinclair: 214,6 ± 76,5). Los participantes asistieron a una simulación de las pruebas de identificación de talentos dos semanas antes de una competición. Los datos se analizaron mediante una correlación del momento-producto de Pearson. Para determinar la prueba que mejor predice el rendimiento del levantamiento de pesas, se utilizó un análisis escalonado de regresión múltiple. Se encontraron relaciones significativas entre el rendimiento del levantamiento de pesas (total ajustado con el coeficiente de Sinclair) y el 30ST (r = -0,72; intervalo de confianza 95 % [-0,91; -0,24]), el VJ (r = 0,89; IC 95 % [0,65; 0,97]) y el HJ (r = 0,90; IC 95 % [0,67; 0,97]). La distancia en el MBT no mostró ninguna correlación significativa con el rendimiento (r = 0,27; IC 95 % [-0,17; 0,81]). Gracias a un análisis escalonado de regresión, se descubrió que el HJ es el factor predictivo más fuerte para el rendimiento del levantamiento de pesas (R2 ajustado = 0,79; EE de la estimación = 35; F = 42,5; p < 0,001). A pesar de la fuerte relación existente entre el 30ST, el VJ, el HJ y el rendimiento del levantamiento de pesas, los resultados de este estudio señalan que el HJ puede utilizarse como un buen factor predictivo del rendimiento del levantamiento de pesas para los adultos.

ROTURA DEL TENDÓN DE AQUILES Y LA LIGA DE FÚTBOL DE ESTADOS UNIDOS

Charniga Andrew "Bud"

SM (ing), n.º 8, año III, septiembre-diciembre de 2017, págs. 18-29

El autor expone el problema relativo a la frecuencia de las lesiones en las extremidades inferiores que son comunes en algunos deportes, pero no en el levantamiento de pesas, en especial en las mujeres, donde cabría esperar un alto índice de accidentes. El autor, que se refiere sobre todo a los jugadores de la liga de fútbol americano y a la rotura del tendón de Aquiles, pone de relieve la falta de cualidades reactivas en la preparación de estos deportistas, mientras que dichas cualidades están totalmente presentes en el entrenamiento de la halterofilia y, por ende, en los gestos típicos del levantamiento de pesas. Asimismo, aporta una serie de datos y testimonios a fin de comprobar la hipótesis de que un entrenamiento deficiente entraña un riesgo elevado de lesión.

UTILIZACIÓN DE EJERCICIOS COMPLEMENTARIOS DERIVADOS DE LA HALTEROFILIA OLÍMPICA COMO MÉTODO DE RECUPERACIÓN DE SÍNTOMAS INEXPLICABLES MÉDICAMENTE

Boschiero Dario, Vaudagna Danilo, Pederzolli Sergio, Marro Michele, Fantina Mattia, Bonacina Matteo, Monaco Carmine, Apelgantes Elena, Urso Antonio

SM (ita), n.º 8, año III, septiembre-diciembre de 2017, págs. 30-41

La finalidad de este estudio es determinar si puede ser útil realizar ejercicios complementarios, derivados de la halterofilia olímpica y el levantamiento de potencia, para eliminar o disminuir la percepción y el número de síntomas inexplicables médicamente. Estos síntomas son en gran parte inexplicables, es decir, no se relacionan con ninguna causa, patología o trastorno concretos. Las personas con síntomas inexplicables médicamente presentan características bien específicas, como fatiga crónica, trastornos del sueño o del apetito, colon irritable, estreñimiento, trastornos del estado de ánimo o síndromes de dolor inespecífico. A largo plazo estos síntomas crean desequilibrios en la composición corporal y el sistema neurovegetativo. Cualquier persona puede desarrollar síntomas inexplicables médicamente: desde deportistas profesionales hasta personas sedentarias y desde niños hasta ancianos, y tales síntomas no dependen del sexo. Las publicaciones especializadas han demostrado con certeza que la actividad física y la conservación de la masa de músculo esquelético son buenos indicios de salud general, longevidad y antienvejecimiento. La pérdida de masa muscular a menudo se asocia con problemas diversos, como la fatiga crónica, la pérdida de fuerza, mialgias, recuperación lenta de enfermedades, sarcopenia, caquexia, retraso en la curación de heridas, bajo metabolismo basal, discapacidad física o escasa calidad de vida, además de elevados costos sanitarios. Todo ello guarda relación con los síntomas inexplicables médicamente. Por consiguiente, la actividad física dirigida a recuperar la cantidad, pero sobre todo, la calidad de la masa de músculo esquelético es fundamental. De este estudio se desprende que los ejercicios complementarios derivados de la halterofilia olímpica y el levantamiento de potencia son un instrumento óptimo para recuperar la calidad y la cantidad de masa muscular y para reducir la percepción de los síntomas inexplicables médicamente.

LA CARGADA DE POTENCIA (POWER CLEAN) Y LA ARRANCADA DE POTENCIA (POWER SNATCH) DESDE LA RODILLA

Timothy J Suchomel, Brad H Deweese

SM (ing), n.º 8, año III, septiembre-diciembre de 2017, págs. 42-51

LA CARGADA DE POTENCIA Y LA ARRANCADA DE POTENCIA DESDE LA RODILLA PUEDEN UTILIZARSE EN LA PROGRESIÓN DE APRENDIZAJE DE LOS EJERCICIOS DE CARGADA Y ARRANCADA PORQUE ENFATIZAN LA FUERZA POSICIONAL DURANTE LA FASE DE TRANSICIÓN, UTILIZAN LA TÉCNICA DE LA FLEXIÓN DOBLE DE LAS RODILLAS Y EJERCITAN LA TRIPLE EXTENSIÓN DE LAS ARTICULACIONES DE LAS CADERAS, LAS RODILLAS Y LOS TOBILLOS.

SISTEMAS DE ACTIVACIÓN MUSCULAR DURANTE DIFERENTES TÉCNICAS DE SENTADILLA

Slater V Lindsay & Hart Joseph M

SM (ing), n.º 8, año III, septiembre-diciembre de 2017, págs. 52-63

Las sentadillas bilaterales son ejercicios que se utilizan con frecuencia en programas de rendimiento deportivo. La activación de los músculos de las extremidades inferiores puede cambiar en función de la alineación de las rodillas durante la ejecución del ejercicio. La finalidad de este estudio es comparar los patrones de activación de los músculos de las extremidades inferiores durante diferentes técnicas de sentadilla. Participaron de forma voluntaria 28 personas sanas sin lesiones (19 mujeres y 9 hombres, de 21,5 ± 3 años, 170 ± 8,4 cm, 65,7 ± 11,8 kg). Se les colocaron electrodos para realizar una electromiografía en los músculos vasto lateral, vasto medial, recto femoral, bíceps crural y gastrocnemio de la pierna dominante. Los participantes realizaron cinco sentadillas a la vez que desplazaban de forma intencional la rodilla anteriormente (desalineación anteroposterior), cinco sentadillas mientras desplazaban de forma intencional la rodilla medialmente (desalineación medial) y cinco sentadillas con control de la alineación (control). Los datos normalizados (contracción isométrica voluntaria máxima) del electromiograma se redujeron a 100 puntos y se representaron como un porcentaje del ciclo de sentadilla en el que el 50 % correspondía a la máxima flexión de la rodilla y el 0 % y el 99 %, a la extensión total. La actividad de los músculos vasto lateral, medial y recto femoral disminuyó en la sentadilla con la desalineación mediolateral en comparación con la sentadilla de control. En la sentadilla con la desalineación anteroposterior, la actividad de los músculos vasto lateral, medial y recto femoral disminuyó durante las fases de descenso inicial y ascenso final; sin embargo, la activación del vasto lateral y el recto femoral aumentó durante la fase de ascenso inicial en comparación con la sentadilla de control. Los músculos bíceps crural y gastrocnemio mostraron un aumento de la activación durante ambas sentadillas con desalineación en comparación con la sentadilla de control. En conclusión, los participantes habían alterado los patrones de activación muscular durante las sentadillas con una desalineación deliberada en los planos frontal o sagital, tal como demuestran los cambios producidos en la activación del cuádriceps, el bíceps crural y el gastrocnemio durante el ciclo de la sentadilla.

APORTE COMPLEMENTARIO DE B-ALANINA PARA EL DEPORTISTA DE COMPETICIÓN

Jay R. Hoffman, Ph.D., FNSCA, FACSM

SM (ing), n.º 8, año III, septiembre-diciembre de 2017, págs. 66-75

Cuando se ingiere β-alanina, bien a través de la comida, bien en forma de complemento alimenticio, esta se une a la histidina para formar carnosina. En el plano fisiológico, el aumento de la carnosina en el músculo incrementará la capacidad de amortiguación intracelular. La eficacia del aporte complementario de β-alanina se ha podido constatar mediante varios estudios en los que se analizó el ejercicio prolongado de alta intensidad en deportistas de competición y aficionados. Sobre la base de los estudios actuales, el aporte complementario de β-alanina parece ser eficaz durante la actividad de alta intensidad con una duración de 60-300 segundos. Los estudios que analizan la ingestión de β-alanina y los deportistas de competición arrojan resultados sólidos que apuntan que la β-alanina aumenta la concentración de carnosina en los músculos, lo que está relacionado con mejoras significativas del rendimiento durante la actividad prolongada de alta intensidad.

Russian

ПРЫЖОК В ДЛИНУ КАК ПРЕДСКАЗАТЕЛЬ РЕЗУЛЬТАТОВ В ТЯЖЁЛОЙ АТЛЕТИКЕ: ЭКСПЕРИМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ

Rich J. Kite, Adam Spence

SM (ing), n.º 8, anno III, settembre-dicembre 2017, pp . 4-17

Процесс поиска спортивного таланта (TID) часто вкючает в себя серию физических тестов, рузультаты которых позволяют определить правильную стратегию тренировки спортсенов и разпределения ресурсов. Часть британского комплекта тестов (TID) British Weight Lifting (BWL) включает: 30-и метровый спринт (30ST), вертикальный прыжок (VJ), прыжок в длину (HJ), бросок медбола (MBT). Цель исследования заключалась в определении взаимосвязи между протоколом тестирования BWL TID и результатами в тяжёлой атлетике. Двенадцать тяжёлоатлетов (среднее значение ± s; масса 86 ± 20 кг; скорректированный общий показатель Sinclair, Sinclair adjusted total: 214 ± 76,5) дали добровольное согласие участвовать в эксперименте. Была организована сессия тестов TID симулированная в течении двух недель от соревнований. Полученные данные были проанализированы используя тест корреляции смешанного момента Пирсона (Pearson's product moment correlation). Для оценки наилучшего одиночного предсказателя результата тяжёлоатлетического выступления в комлексе тестов использовался пошаговый множественный регрессионный анализ. Была обнаружена значительная корреляция между показателами выступления в тяжёлой атлетике (Sinclair adjusted total) и результатами в 30-и метровом спринте, 30ST (r = -0.72; 95% доверительный интервал [-0.91, -0.24]), в вертикальном прыжке, VJ (r = 0.89; 95% CI [0.65, 0.97]), и в прыжке в длину, HJ (r = 0.90; 95% CI [0.67, 0.97]). Результаты в броске отягощённого мяча не показали существенную корреляцию с эффективностью выполнения тяжёлоатлетических упражнений (r = 0.27; 95% CI [-0.17, 0.81]). Согласно пошаговому регрессивному анализу, прыжок а длину (HJ) является самым убедительным прескадателем эффективности выполнения упражнений тяжёлой атлетики (скорректированный R2 = 0.79; SEE = 35; F = 42.5; p <0.001). Несмотря на то что была установлена высокая связь между результатами в тестах 30ST, VJ, HJ с результатами выполнения тяжёлоатлетических упражнений, показатели в тесте HJ (прыжок в длину) могут использоваться в качестве наиболее надёжного предсказателя выступления взрослых тяжёлоатлетов.

РАЗРЫВ АХИЛЛОВА СУХОЖИЛИЯ И ЛИГА NFL (НАЦИОНАЛЬНАЯ ФУТБОЛЬНАЯ ЛИГА, НФЛ)

Charniga Andrew "Bud"

SM (ing), n.º 8, anno III, settembre-dicembre 2017, pp . 18-29

Автор затрагивает проблему связанную с частотой травм нижних конечностей рспростанённых в некоторых видах спорта, но не в тяжёлой атлетике (особенно среди женщин), где казалось бы должен встречаться более высокий процент этих поражений. Автор, имеяя в виду в основном игроков Лиги американского футбола и анализируя разрыв ахиллова сухожилия, подчёркивает что в тренировке этих спортсменов отсутствут некоторые элементы подготовки которые имеют место в подготовке тяжёлоатлетов, речь идёт о выполнении жестов типичных для тяжёлой атлетики. Автор приводит серию данных и свидетельств, которые подтверждают тот факт что недостатки в тренировке повышают риск травм.

ИСПОЛЬЗОВАНИЕ ДОПОЛЬНИТЕЛЬНЫХ УПРАЖНЕНИЙ ОЛИМПИЙСКОЙ ТЯЖЁЛОЙ АТЛЕТИКИ КАК МЕТОДОЛОГИИ ВОССТАНОВЛЕНИЯ ПОСЛЕ МУС (MEDICALLY UNEXPLAINED SYMPTOM, MUS), КОТОРЫЙ ХАРАКТЕРИЗУЕТСЯ НЕОПРЕДЕЛЁННЫМИ И НЕСПРЕЦИФИЧЕСКИМИ СИМПТОМАМИ

Boschiero Dario, Vaudagna Danilo, Pederzolli Sergio, Marro Michele, Fantina Mattia, Bonacina Matteo, Monaco Carmine, Apelgantes Elena, Urso Antonio

SM (ita), n.º 8, anno III, settembre-dicembre 2017, pp . 30-41

Цель этого исследования заключалась в оценке того как дополнительные упражнения, используемые в олимпийской тяжёлой атлетике и в мощностных подъёмах, могут быть полезными для устранения или уменьшения восприятия и количества симтомов МУС (Medically Unexplained Symptom, MUS) или же неопределённых и неспецифических симтомов. Большинство этих симтомов остаётся необъяснимым, то есть не имеет точной объяснимой причины: болезни или расстройства. Люди у которых наблюдаются симтомы МУС отмечают весьма специфические признаки: хроническая усталость, нарушения сна и аппетита, раздражительность толстой кишки, запоры, расстройства настроения, неспецифические болевые синдромы и т. д. Со временем эти симтомы провоцируют дисбаланс состава тела и нервной вегетативной системы. Симтомы МУС могут развиться у любых людей, у спортсменов и у малоподвижных субъектов, у детей и у пожилых людей, вне зависимости от пола. Данные научной литературы убедительно демонстрируют что физическая деятельность и хорошее сохранение мышечной массы являются оптимальными показателями общего состояния здоровья, долголетия и нестарения. Потеря мышечной массы часто связана с разными проблемами, как например хроническая усталость, потеря силы, мышечные боли, медленное восстановление после болезни, саркопения, кахексия, задержка заживления ран, низкий уровень базового метаболизма (RMR или BMR), физическая инвалидность, низкое качество жизни и т. д. и высокие затраты на здравоохранение. Всё это связано с неопределёнными и неспецифическими симптомами (МУС). Следовательно физическая деятельность направленная на восстановление количества и прежде всего качества мышечной скелетной массы является фундаментальной. Представленное исследование показывает, что дополнительные упражнения из олимпийской тяжёлой атлетики и из мощностных подъёмов являются отличным инструментом для восстановления качества и количества мышечной массы и снижения восприятия симтомов МУС.

СИЛОВОЙ РЫВОК ИЗ ПОЛУПРИСЕДА (POWER SNATCH) НАЧИНАЯ С КОЛЕНА

Timothy J Suchomel, Brad H Deweese

SM (ing), n.º 8, anno III, settembre-dicembre 2017, pp . 42-51

Силовое взятие на грудь из полуприседа (power clean) и силовой рывок из полуприседа (power snatch) могут быть использованы в процессе обучения упражнениям толчёк и рывок потому что в них делается акцент на позиционную силу во время переходной фазы, используя технику сгибания коленных суставов, и развивается разгибание суставов бедра, колена и голени.

СИЛОВОЕ ВЗЯТИЕ НА ГРУДЬ ИЗ ПОЛУПРИСЕДА (POWER CLEAN) И СХЕМЫ АКТИВАЦИИ МЫШЦ ВО ВРЕМЯ ПРИСЕДАНИЙ С ОТЯГОЩЕНИЯМИ (SQUAT) РАЗЛИЧНОГО ТИПА

Slater V Lindsay & Hart Joseph M

SM (ing), n.º 8, anno III, settembre-dicembre 2017, pp . 52-63

В спортивных программах часто используются двухсторонние приседания. Активация мышц нижних конечностей может изменятся в зависимости от выравнивания колена во время выполнения упражнения. Цель данного исследования заключалась в сравнении моделей активации мышц нижних конечностей во время приседаний выполняемых с разной техникой. Двадцать восемь спортсменов (19 женщин, 9 мужчин; возраст: 21,5±3 года; рост: 170±8,4 см; вес: 65,76±11,8 кг) без травм, вызвались добровольно участвовать в эксперименте. Электроды элетромиографии, ЭМГ (EMG) были помещены на следующие мышцы: vastus lateralis (латеральная широкая мышца), vastus medialis (медиальная широкая мышца), rectus femoris (прямая бедренная мышца), biceps femoris (двуглавая мышца бедра), и на gastrocnemius (икроножная мышца) доминирующей ноги. Участники выполняли 5 приседаний целенаправленно направляя колено вперёд (ML malaligned) и 5 приседаний с контрольным выравливанием (control). Нормализированные данные ЭМГ (MVIC) были ведены до 100 баллов и представленны в процентах от цикла прседания (50% соответствовали максимальному сгибанию колена и 0% и 99% полному разгибанию). Активность следующих мышц: vastus lateralis, medialis и rectus femoris уменьшалась во время медиально-латерального прседания по сравнению с контрольным приседанием. Во время передне-заднего приседания активность мышц vastus lateralis, medialis и rectus femoris уменьшалась во время начального спуска и финального подъёма; однако во время начального подъёма увеличивалась активация мышц vastus lateralis и rectus femoris по сравнению с контрольным приседанием. Мышцы biceps femoris и gastrocnemius продемонстрировали повышенную активацию во время обоих преднамеренно модифицированных приседаний по сравнению с контрольным приседанием. В заключении участники изменили схемы (pattern) активации мышц во время приседаний с преднамеренной фронтальной и сагиттальной модификацией, что было продемонстрировано изменением активации мышц quadriceps, biceps femoris, и gastrocnemius во время цикла приседания.

ДОБАВКИ БЕТА-АЛАНИНА У ПРОФЕССИОНАЛЬНЫХ СПОРТСМЕНОВ

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Принятие бета-аланина, через пищу или в качестве пищевой добавки, приводит к его сочетанию с гистидином и к образованию карнозина. С физиологической точки зрения повышение мышечного карнозина повышает внутриклеточную буферную способность. Эффективность бета-аланиновых добавок быда подверждена в некоторых исследованиях в которых изучался эффект высокоинтенсивных упражнений у профессиональных спортсменов и у людей занимающихся спортом в свободное время. На основе результатов современных исследований можно сказать что добавки бета-аланина могут быть эффективными для высокоинтенсивной деятельности продолжительностью 60-300 секунд. Исследования изучающие употребление бета-аланина спортсменами профессионалами убедительно показывают что добавки бета-аланина повышают уровень мышечного карнозина, что связано со значительным улучшением эффективности высокоинтенсивной мышечной деятельности.


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