



SCIENTIFIC MAGAZINE

The official journal of the European Weightlifting Federation. Year 1 Number 2 - August-December 2015

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SUPPORT OF



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SCIENTIFIC MAGAZINE



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ACCOUNT MANAGER

Marino Ercolani Casadei

PROJECT AND LAYOUT

Dino Festa
Calzetti & Mariucci Editori

PUBLISHER

Calzetti & Mariucci Editori
By Roberto Calzetti Editore srl
Via del Sottopasso 7 - Loc. Ferriera
06089 Torgiano (PG) Italy
Phone / Fax +39 075 5997310 - 5990017
E-mail: info@calzetti-mariucci.it
Web: www.calzetti-mariucci.it

PRINTED BY

Studio Stampa New Age
Strada Cardio 58 - Zona industriale Galazzano
47899 Repubblica di San Marino

studiostampa
NEW AGE

CORRESPONDENCE

EWF - Viale Tiziano 70 Roma
E-mail: presidente@federpesistica.it
E-mail: secretariat@ewfed.com
E-mail: info@calzetti-mariucci.it

COMUNICATION AND WEB AREA

- Baumgartner Christian
- Buckley Colin
- Steve Cannon
- Hasan Akkus

IMAGES & ARTWORKS BY

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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.

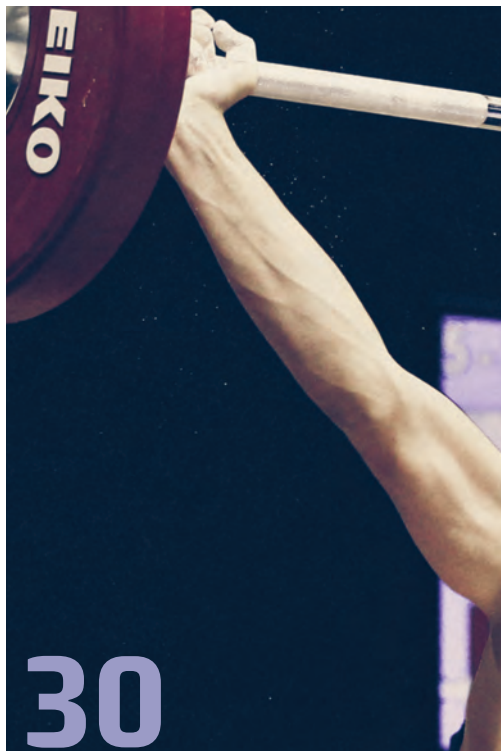


SUMMARY



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Weightlifting has a long tradition in the development of scientifically based, sophisticated training methodology and exercise techniques. This development has created the conditions for female weightlifters to raise weights once reserved for only the world's strongest men.



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In general, the technical analysis of a sports movement is realised by a systematic observation of the entire movement, breaking down the overall aim of the action into different motor tasks, each of which is to be carried out through a characteristic motor pattern whose efficacy influences the efficiency of the action

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Female Strength **The first thirty years of women's weightlifting**

1984. Each story carries and conveys a wealth of human feelings, science and conscience, reason and emotion. This story then, like many others, is rich, intense and above all, experienced through emotions, sweat, joy and pain, encompassing the full range of human resources. It all began in 1984, when the IWF Congress approved the practice of women's weightlifting, including it in its statute and in the technical regulations of the 1984-1988 Olympic Cycle. Furthermore, the term "for men only" was abolished at the IWF Congress in Los Angeles, thus opening the doors definitively for women in weightlifting. Details such as weight categories, weigh-in procedures, referees and equipment all had to be resolved before the official competitions took place.

1986 - The first international tournament

The first IWF international female tournament was organised in conjunction with the Pannonia Cup in Budapest, on 21-23 March 1986. A couple of years prior to this event, women lifters were already very active at national level. Championships were organised in the USA, China, India, Australia and in various European countries. The first official competition organised by the IWF in Budapest, saw the participation of 23 women, representing China, Hungary, Great Britain, Canada and the USA. America's Arlys Kovac, achieved the best technical result, with a 75

kg performance in the snatch and 90 kg in the clean and jerk 67.5 kg category.

1987 - The first Women's World Championship

The following year, Budapest organised the first Women's World Championship. It was only natural that the American Weightlifting Federation should host this first World Championship at Daytona Beach, Florida, because female weightlifting in that country had already developed to a very high level, both in terms of organisation and in sporting success. 100 participants from 23 countries took part, 38 from European nations, representing Great Britain, Spain, Norway, Hungary, Bulgaria, Italy, (here we are!), France, Finland and Iceland. Eight Nine of the winners came from China, and one from the United States of America, Karyn Tarter (nee Marshall).

1988 - The first European Championship

The first European Senior Championship was organised in 1988 in San Marino by the EWF; the driving force of the organising committee was Marino Ercolani Casadei. 67 women from 13 nations competed. Present in San Marino for this first continental championship organised by the EWF were: Italy, Greece, Great Britain, Finland, Hungary, Spain, Portugal, Austria, Bulgaria, France, Germany, San Marino and Norway. Among the winners were Maria Christof-

ridi, Greece and Milena Trendafilova, Bulgaria. These two women went on to become two of the most successful female lifters in the history of European weightlifting, along with Hungary's Maria Takacs. Italy won its first gold in the 48 kg category with Genoan, Roberta Sforza. The 1989 and 1990 editions were organised following the same formula, in other words, a separate championships from the men's. Then in 1991 in Varna, a women's competition was held along with the European Junior Championships for male athletes. Only from 1998, in Riesa, Germany, did female athletes compete at the same time and in the same place as their male counterparts in the Senior Championships. The biggest turnout of women recorded at a continental championships was the 2004 edition in Kiev, Ukraine, when 110 athletes took part, mainly because of the fact that the Championships was an Olympic qualifying event. Strong weightlifting nations such as Russia and Poland brought female teams to the Europeans in 1993 and 1996. Valentina Popova is one the most famous Russian female lifters, whereas Agata Wrobel is to date the most well-known female Polish weightlifter. Today, the EWF has no less than 45 affiliated federations, each representing a country and all with a female weightlifting section.

2000 - Women's Weightlifting at the Olympic Games

The IOC admitted women's weightlifting into the Olympic Games for the first time in Sydney in 2000. This first edition marked the dawn of equality with men's weightlifting. In Sydney, no less than 85

female lifters from 47 countries competed for a place on the podium. 26 of these hailed from 14 European nations. No European athlete took home a gold medal, however, Popova (Russia), Markus (Hungary) and Poland's Wrobel, all won silver, whereas Greek lifter, Chatziioannou clinched a bronze. The statistics of the 2004 Athens Games were exactly the same of the 2000 edition: 85 female lifters from all over the world: 28 from 11 European nations. This time the Europeans had better luck: 2 gold, Taylan, from Turkey, in the 48 kg category, and Skakun, from Ukraine won gold in the 63 kg category.

1998 - European Junior Women's Championships

The first Junior Women's Championships was organised in Sofia, Bulgaria, in conjunction with the European Junior Men's Championships in 1998.

1994 - The first European Women's Under 16 and Youth Championships

Once again the EWF made another successful step with regard to female weightlifting. The first European Under 16 Championships was held in 1991 in Kosice, Slovakia, open only to male athletes 14- 16 years old. In 1994, in Ljubljana, the girls joined their peers and it was a resounding success: 39 girls from 12 countries took part. Since then the number of girls has been on a constant increase. Dortmund, Germany 2003, registered the highest number of female competitors, 94, to be precise. In 2013 the EWF introduced the U15 category in Klaipeda, at these Championships we had 95 women competitors.

In 2003, the title of the event was changed to European Under 17 Championships.

You have no doubt got the message: these are not just dates, they are stories of dates and data: before and after stories, stories of women who changed the way of interpreting sport and indeed, life. They paved new roads: in lifting weights, they also raised awareness of who they were and what they were doing. They made it clear that muscular strength was not taboo for women, it was a gateway to growth and fulfilment. In sport, as in life, strength was everything and it was becoming more and more evident. They explored new and undiscovered paths: it was a beautiful understanding and enlightenment. Training led to knowledge and experience. Sport improved everything, because there was the basis for growth and for studying the growth of performance: athletes that wanted to succeed and that could, simple and straightforward means of training, truly significant. It was a pioneering age, a Once Upon a Time in the West moment. But it also stood for progress, breaking down barriers. Obstacles and difficulties. It was a moral and ethical journey that is the soul of sport today. It started from far away, taking little steps that soon became bigger and more confident. Tomorrow it will run, of that we can be certain. It will run and lift weights, that's how training makes progress. But under those weights, there's a good head on the shoulders.

Antonio Urso
EWf President

FUNCTIONAL TRAINING AND MOVEMENT TRAINING

From the very beginning. Our body is made up of 100,000 billion tiny elements, cells, that form its entire structure. The cells that make up the human body are not all the same. Groups of cells that present the same characteristics form what is called tissue. Groups of similar tissues are known as systems. The main systems of the body are the muscular system and the nervous system. The “communication” systems that connect all the body parts are called networks.

BY ALBERTO ANDORLINI



The main networks of the human body are: the neural network, the circulatory network and the fibrous (myofascial) network.

When, on the other hand, different tissues join together to carry out the same function, they form an *apparatus*. The main apparatus of the human body are: *integumentary, skeletal, respiratory, cardiovascular, digestive, uro-genital, articular, glandular and sense organs system*.

The apparatus and systems that materially control the movement are: *the skeletal system, the articular system and the muscular system*, often defined collectively as the *locomotor system*.

The action of the locomotor system is regulated by the *nervous system*, whereas the raw material for its operation is supplied by the *respiratory, cardiovascular and digestive systems*. It is possible to train the cellular function: by the resynthesis mechanisms of energy substrates both aerobically and anaerobically. The major vital functions - cardiovascular, respiratory, nervous and muscular - can also be trained.

It is possible to train the functions of the systems: driving muscular contraction (concentric, eccentric and isometric), acquiring and improving kinesthetic and proprioceptive sensitivity, the dynamic stability of complex joints, pre-programmed (*feed forward*) and reactive (*feedback*) control of motor responses, the integration of the responses into finalised motor patterns and the sense-perception processing of the visual, auditory and vestibular nerves. Training works and ma-

kes things work but very often it cannot be targeted, directed and focused on what we believe to be the “temporarily” preeminent human function, because training is a victim of a vision limited to a partial context (aesthetic standards, available time, social orientation). This qualifies training as “functional” because it can induce detectable changes, but also “non-functional” if it does not meet the requirements, the needs and not least, the limits of the individuals the training is geared towards.

There is an objection, a hypothesis, an alternative. You can train the Function of the communication networks - neural, circulatory and fibrous - by maintaining a close relationship of adjacency and proximity between all the elements not of a system, but of *the system*. Training such a Function - between the three communication networks - means training what exactly? In-depth perceptive *communication* and external relational *communication*.

The Body is the agent. Movement is the catalyst. There's nothing new there. Nothing that the first humans on earth had not already unconsciously experimented with. Something that has been passed down like a precious inheritance. For the past 2,500 years, we have been toing and froing between the preparation of a real and realistically finalised movement (daily movement), the quest for a movement that interprets emotional tension (artistic movement) and the perfection of a movement with a competitive edge (sports movement). Along the way we have

often lost our bearings, forgetting that if it is true that movement is the product of various functions, it is equally true that in a finalistically orientated synthesis, movement has one, single function: Social Relations. Social Relations is made up of economy (daily movement), aesthetics (artistic movement), strength (sports movement). **Movement itself is not one thing or another, it is a syncretic combination of basic elements.** Training is a process aimed at consolidating such elements - so-called Fundamental Movements -, based on a motor *continuum* that combines ability and skill, expression and condition, adaptability and adaptation. As human beings, we progressively acquire one scope of motility, based on a pattern that adapts our vital functions to our surroundings. In this way we learn how to roll, get up, stand up, walk, run, jump, lift, push, pull, bend, turn around and climb. All these activities take place on three cardinal planes, sagittal, frontal and transverse. All three respond to specific components - coordination, type of muscular contraction, energy source, speed and range of movement - which characterise and distinguish the action based on the “instant” requests, the variability of the situation and surrounding disturbances. Each individual component of the training movement must be viewed not as a single element in itself, but as piece of the bigger picture. If each component is addressed individually, it may appear inconsistent, weak and even superfluous. Training draws strength and clarity from the united force of various

elements. Rediscovering the ingredients that make up Movement does not necessarily lead us to the invention of new equipment or the identification of new techniques, it brings us closer to **the movement of the actual training**, following a highly personalised and code. Movement Training implies a conscious acquisition process: **the Body is the instrument (with which...), Movement is the means (by which...), the Body in Movement is the purpose (of which...)**; commanding the body, producing an

efficient movement is the aim of our daily activity, the aesthetics of expressive gestures, the efficiency of sports language. Naturally, movement cannot be compartmentalised, labelled, categorised. It can, however, be interpreted, gracefully adaptable to situations, concatenations, and improvisations. The perfect gym does not exist. There are, however, places that elicit motor responses (the town square and urban fabric); a theatre of efficiency (nature); a mobile gym (objects and people).

Over the last hundred years or so, training has neglected an aspect - the functionality of movement - and has exalted the function of not the Body, but of the parts that make up the Body as a system; it has forgotten that the main skill of the body in movement is Social Relations, and it has insisted on the ability of the systems to make the body stronger, more resistant, faster; it has adapted the body more, yet made it less adaptable. In the last fifty years (an infinitesimal amount of time in relation to



the history of Movement), we have shifted attention towards Functioning, and left Functionality out in the cold.

On one side of the scales, the one occupied by wall bars, climbing stages, horses, bars and parallel bars, we have put heavy iron machines, treadmills, exercise bikes and vibrating platforms; on the other side we have left sticks, ropes, sacks and balls. And the scales, as was clearly inevitable, gave us an answer that was both obvious and useless.

Now, in the last years, our interest has turned to Functional Training, not that it did not previously exist, but simply because training is an ever-recurring cycle.

Today, being the hopeless enthusiasts of comparison and testing that we are, we have once again put on one side of the scale (having jilted iron and steel), techniques and disciplines (Tai Chi, Pilates, Yoga, Feldenkrais, Calisthenics...); and on the other (having removed the small equipment) we are placing evidence extrapolated from scientific studies and research (Kinetic Chain, Sensory Motor Program, Motor Learning, Neuromuscular Training, Proprioception, Stabilization, Balance).

On one hand we have placed the weight of global intervention (de-fragmentation), and on the other local intervention (fragmentation).

The next beneficial step will be to weigh up Body and Movement, in an attempt to understand what is the right balance between Fun-

ctioning and Functionality, and what is the relationship between *training in vitro and real situations*.

As previously mentioned, by making the *body* an instrument, *movement* the purpose and *the body in movement* the result, Training is not Functional Training, it is **MOVEMENT TRAINING**;

it does not discover original elements, it rather “rediscovers” original structures, in a sort of “*back to basics*” as simple as it is essential.

There are THREE basics of Movement Training. Three connected and concurrent domino blocks:

1) “The body functions like a kinetic chain” (J. Noth 1992) and as such, the body’s behaviour as a whole (integrated analysis) cannot correspond to the behaviour of the sum of its parts (mechanistic analysis). In reality, we are as strong as the weakest link in the chain (Gambetta & Gray, 1995); and from the moment the links in the chain are connected by functional links, the simplest regional movement is the result of a “far off” activation that has widespread effects on all the areas.

2) “The brain thinks in terms of movement, not of muscles” (K. Bobath). The activation of a kinetic sequence depends on the motor programme. The motor programme is considered a pre-structured set of commands that contains the patterns of muscular contractions and decontractions

that define movement (Adams 1987), determining which muscles to contract, in what order, with what force and for how long (Schmidt 1976).

3) “Isolating a motor component interrupts the kinetic chain; integrating more components improves the transfer of the load and the transmission of the information inside the system” (J. Noth, 1992). “The fact that a muscle in a given situation can exert a certain force, is no guarantee that the body will be able to use this force in all situations” (Perfetti, 1988). Integration is the key to Training. Teaching all the muscles to work together as opposed to individually (Roskopf, 2005).

Today. Recently, correlated terms, directed both at designing specific intervention areas and at defining work proposals based on the peculiarity of the means used and of the contents proposed (Core Training, Gravity Training, Resistance Training, Body Weight Training, Balance Training, Suspension Training) have become part of everyday language. In fact, by the same nature of the terms used and for the vast scope of activity they refer to, the methodologies and techniques are subject to various interpretations.

Undoubtedly, the meaning and the comprehension of the word “training” has become more and more vast and now includes unexplored frontiers (brain training, mind rooms, etc.) and “live and vital” spaces, in constant transformation

(parkour, skate, free running, natural movement, wild fitness). For some, the extent of vision represents a limit, for others the consistency of such “transformation” is associated with a new idea of movement.

Nowadays, living Movement, understanding Movement and interpreting Movement means travelling on the edge of change; a fast-moving change, sudden and unpredictable as is the rhythm of evolution and word of mouth.

A first step: re-interpreting Exercise and Equipment and reintroducing the Body to Movement. Our reflections lead us along a conceptual line that goes from *being able* to move to *knowing how* to move, from movement being activated by a muscular contraction and produced by two articular heads coming together, to the coordinated sequence of movement designed to achieve a desired goal. Up until now, the journey that has incited this desire to train has placed many roads before us, each with several turning points. Each crossroad can indicate different destinations (energetic, mechanical, coordinative). Each road can lead to a particular type of technique or method. Techniques and methods can vary in terms of form (changing the shape of the body) or function (improving the functions). There are few techniques and methods that change the Shape of the Body, optimizing its relationship with the world; there are few techniques and methods that adapt the Form of Movement to the Form of the Function. Still today, whatever

road is taken, traditional training forgets about the Body, as an indivisible part, and Movement, as an unrepeatable expression, and reaches its destination by availing of two means alone, which are always the same: Exercise and Equipment.

We can change the effect of the exercise and the use of the equipment by varying sequences (sets, reps, kilos, minutes, etc.). Reevaluating and re-interpreting the two elements, Exercise and Equipment, the core elements of traditional training (*which I identify as Resistance, Insistence and Reiteration*), and transferring them onto an original map, represents the first step towards an interpretation of other terms, Form and Function, that no longer refer to Exercise and Equipment, but to Body and Movement (*a prickly, yet at the same time delicate topic that will be the conceptual cornerstone of the next article*).

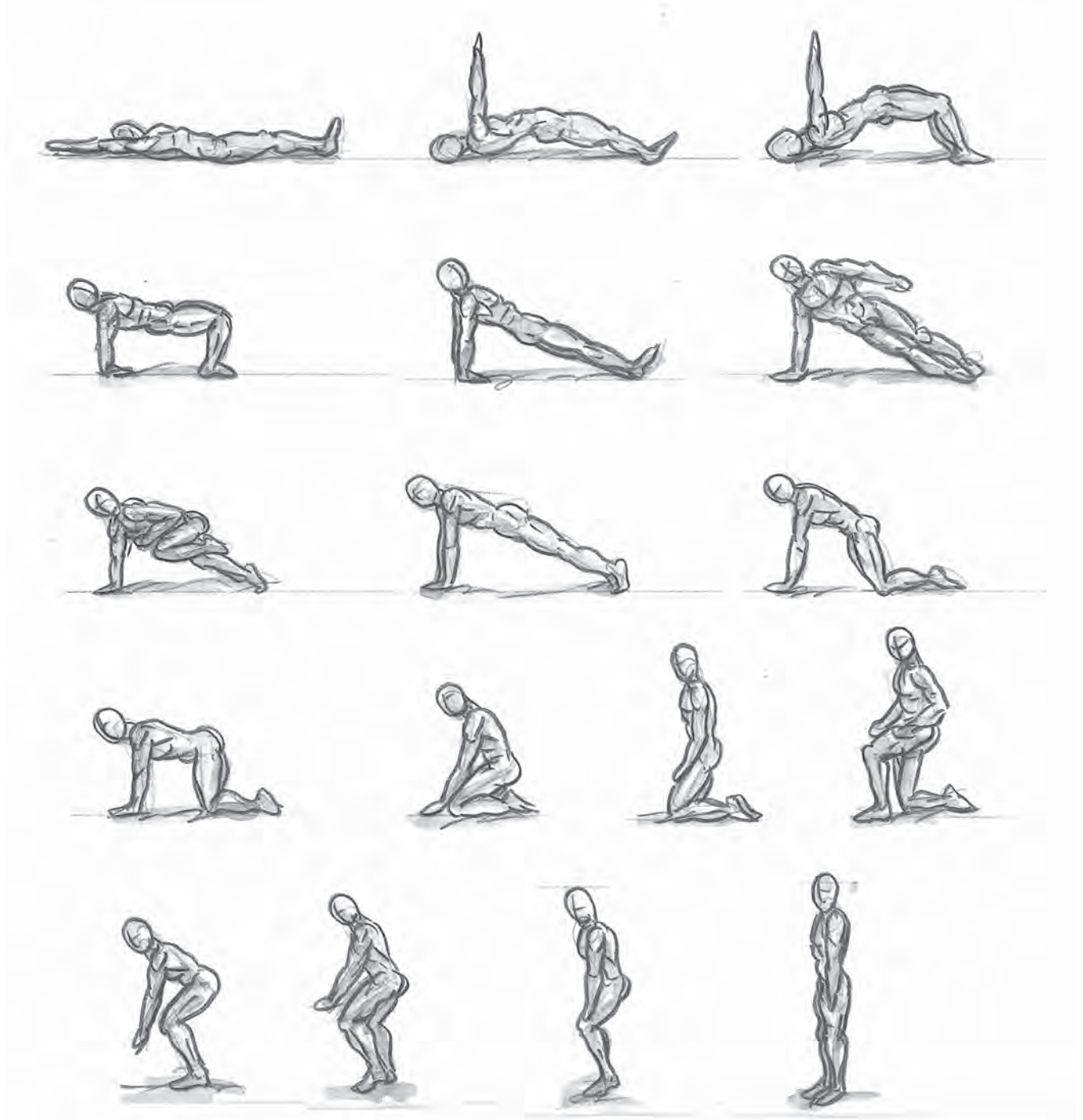
Let's take a look at how Exercise works:

- it involves the whole body (*Body Work*),
- it exploits the body weight (*Body Weight Training*),
- it uses the instability determined by proprioception enriched environments (*Balance Training*),
- it exploits the counteraction of small equipment (*Functional Tools*),
- it uses the overload of free weights (*Free Weight*),
- and it controls the situational variability dictated by neuromuscular stimuli (*Neuromuscular Training*).

Based on the relationship between Exercise and real movement, in other words, movement that occurs daily, Exercise can be divided into 5 levels:

1. the level of selective muscular sensitivity (e.g. the use of the diaphragm and the pelvic floor muscles);
2. the level of activation in a horizontal position of the myofascial chains (e.g. the *plank* in *Horizontal Holding Postures*);
3. the bi/monopodal stance in a vertical position (e.g. *squat*, *lunge*, *one-legged exercise*);
4. the level of the closed/open-ended chain (*open-ended chain*; e.g. *squat and lift or lunge and reach*);
5. the level of locomotion (running, climbing, jumping, walking, crawling, etc.).

From level 1 to 5, the Form of the Exercises gradually adapts to the Function that life asks of it, moving from isolation to integration, from activation to finalisation, from a horizontal to a vertical position, from stationary to locomotion, from position to action (fig. 1). By gradually losing points of contact with the ground, the Form/Body explores simple patterns of movement, it discovers a stable/mobile structural alignment and it prepares for the gravitational “impact” that the execution of the relational function requires. There are, on the other hand, three levels that involve the world of Equipment: the monoarticular “distancing” of the isotonic machines that isolate the muscle and interrupt the kinetic chain (e.g. *leg extension*); the multi-articular

**FIGURE NO. 1**

STANDARDIZATION OF THE EXERCISE IN 5 LEVELS IMITATES THE NATURAL PROGRESSION THAT GUIDES FROM A LYING DOWN POSITION TO AN ERECT POSITION. THE POSITION IS INITIALLY STATIONARY AND THEN LOCOMOTORY.

"approximation" of the machine that cooperates (e.g. *leg press*); the "credibility" of a machine that integrates various movements, facilitating a comprehensive action (*Pilates, Gyrotonic, Kinesis, Free Motion Cable Column, Gravity, etc.*) (fig. 2).

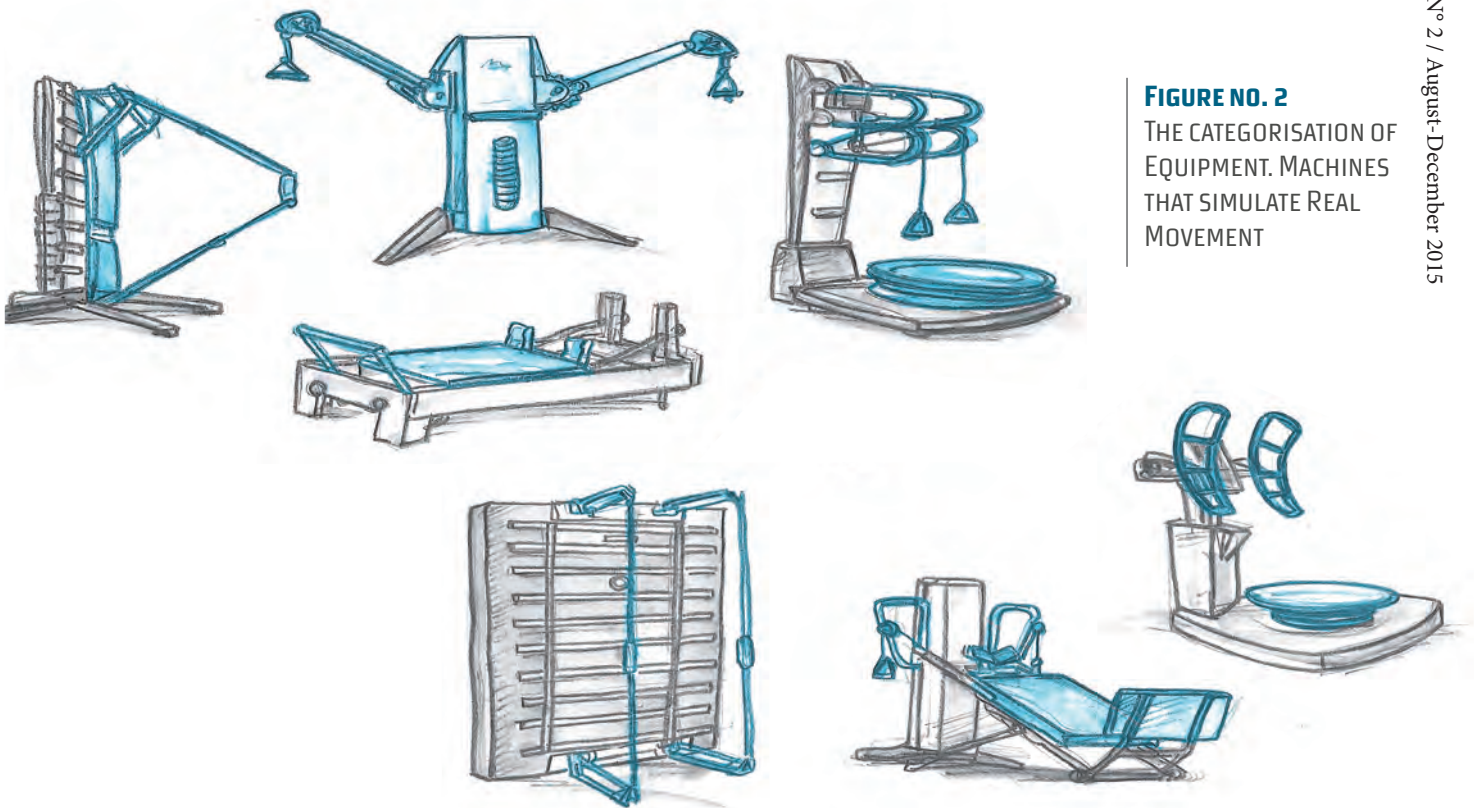


FIGURE NO. 2
THE CATEGORISATION OF
EQUIPMENT. MACHINES
THAT SIMULATE REAL
MOVEMENT

FORM AND FUNCTION OF THE BODY AND MOVEMENT

The principle “form follows function”¹ means that the shape of a building or object should be primarily based on its intended function or purpose. The body is a “designed” system; it preserves the features and properties of a structure that is plastically adaptable to the demands made on it. It may be “designed”, it is not unchangeable. Movement is an expression which can be “designed”; and as such, it is subject to modifications and changes determined by the plasticity of the Body and the variability of situa-

tions. It can be designed, using diverse stylistic techniques and with a variety of chromatic solutions. Applying the two terms “form” and “function”, not to separate elements but to “macro” structures (Body, Movement), consents us to obtain alternative information. We will travel along the thin line of a terminological discussion. The saying “form follows function”, coined in the twentieth century, in relation to the world of architecture and design, will become the unconventional “compass” which will guide

us; it will basically be the first aid to a reflection on the sense and meaning of the process that we call “training” (diagram 1).

THE BODY. The first object of study, or rather, of comparison, is the **BODY**.

The form of the Body. The fact that the BODY has a **FORM** is not, so to speak, an original observation. However, by studying and interpreting its form and the relationships that connect the volumes that make it the actual form, we can acquire a vision that is qui-

1. This saying was originally attributed to the American sculptor, Horatio Greenough; the architect, Louis Sullivan cited it and thus made it famous in relation to architectural, functional and aesthetical implications in the article “The Tall Office Building Artistically Considered” (*Lippincott’s Magazine*, March 1896).

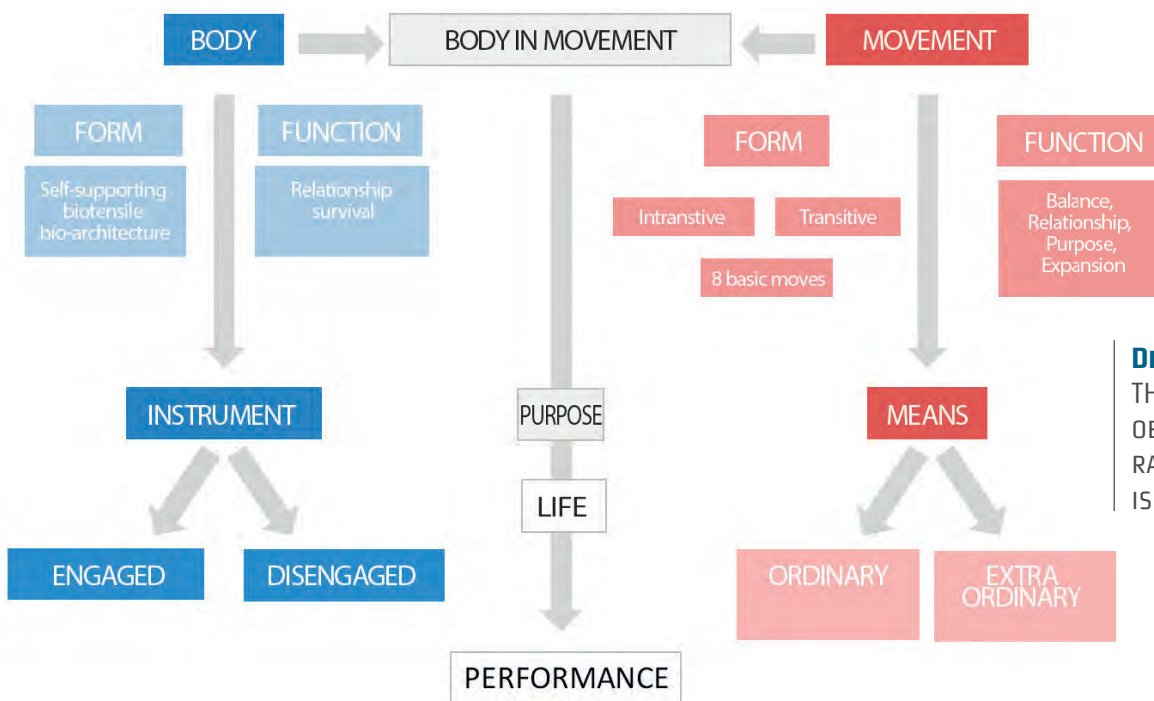


DIAGRAM NO. 1
THE BODY. THE FIRST
OBJECT OF STUDY, OR
RATHER, OF COMPARISON,
IS THE BODY.

te different to what is commonly perceived. Samuel Butler (1835-1902), a nineteenth century British writer, remarked that *“The body is but a pair of pincers set over a bellows and stewpan and the whole fixed upon stilts”*.

Burne Hogarth, American cartoonist and illustrator (1911-1996) and author of *Dynamic Anatomy*, stated that *“The torso mass is the central double form to which all other forms attach. Any movement in the upper lower torso will immediately throw the secondary forms (legs, arms and head) out of their previous positions and into a new relationship. The merest movement of the rib barrel produces an immediate displacement of arms and head, while a pelvic shift compels total deployment of all the body forms.”*

According to aesthetic (non-anatomic) standards, the Body has a Form, the result of the fusion of various parts (the torso, abdomen and pelvis make up the proximal segments; the upper and lower limbs make up the distal segment; the hands, feet and head are the terminal parts of the body). Each segment, in connecting with the adjacent segment, generates a kinetic chain.

From another mainly anatomically point of view, we have a conventional vision of the Form/Body in its entirety - as a building made of bricks, in which each floor corresponds to a different segment (feet, legs, pelvis, abdomen, torso, arms and heads). It is a well-structured building, from the conventional perspective, the floors are aligned along the axis

of gravity, held together by increasing compression. The only defect of this interpretation of the Human Form is that, albeit stable and aligned, the building is made of bricks and therefore does not move. If we want a bio-architectural model that is more similar to the plasticity and fluid nature of the Body, then we must look to the Geodesic Dome designed by Buckminster Fuller; the lightest, strongest and most efficient structure ever made. In Buckminster Fuller’s model, it is tension, not compression that supports the framework. If we applied the same model to the Human Form, we would have bones that work as internal spacers as opposed to bars that support the compression.²

In our “design”, the BODY therefore becomes a self-supporting tensile

structure that moves by virtue of a Chain Reaction. It stands, without any foundation, thanks to the tension applied on the rigid elements by chords and wires. The bones “float” in the muscular matrix; they are “spacers”, not “bricks”; they act as levers in the complex traction process carried out by the muscles and tendons. The Chain reaction is the kinetic expression of the activation of a muscular or myofascial chain. This chain can be defined as open-ended or closed depending on the type of resistance applied to the extremities of the chain itself. We use an open-ended chain to *move*, whereas to *move ourselves* we use a closed chain.

There is no such thing as a pure chain, only open-ended or closed, they are kinetic combinations that guide the body in an open space and define balance and dynamic posture.

The Chain Reaction allows us to overcome, or at least, neutralise the effects of gravity. Overcoming gravitational restraints comes about by virtue of diagonal activation patterns that: create a resultant kinetic effect (*“serape” effect*), from the ankle to the opposite shoulder; they act locally on one or more joints; they activate cocontractions that control the articular “disturbances”; they stabilise, generate and transmit force in the three planes of movement or in the three dimensions.

The Function of the Body. Investigating the Function of the Body

may seem a banal subject to address. In truth, on closer examination, the research becomes extremely problematic and open to various interpretations.

We can say that the primary FUNCTION of the human body (in terms of Form) is the social life, or rather, “social survival”. Relating to people or things, projecting movement internally or externally; activating motor sequences aimed at a precise goal, keeping control of one’s comfort zone; this is Function.

Social, daily, occupational or sport functions are nothing more than the product of the Kinetic Chain, in other words, the coordinated, consecutive and sequential activation of the interconnected and interdependent segments³, that contribute to placing the farthest segment (hand, foot and head) in the required position, at the necessary speed, with the timing suitable to the set goal.⁴

The synchronous, simultaneous and synergic motor wave of acceleration/stabilisation/deceleration that travels through the links of the kinetic chain in the segments, generates a coordinated flow that transmits force and generates purposeful movement. In this sense and with such a formal and functional characteristic of the body, Movement can become the enabling agent and optimise performance, or else lose the properties of the element that *enables* the Function of the Body, to drive only the *di-*

sabling interferences. The body deforms, it ceases to function and/or it becomes dysfunctional.

MOVEMENT. MOVEMENT is the second element on which we must verify the application of the FORM/FUNCTION principle.

The Form of Movement. MOVEMENT is an incredible, complex concert of coordinated actions by a network of sensory-motor impulses. As such, it has two Forms and eight expressions of form. On a par with a verbal form, it may be: 1. intransitive, *to move oneself*, or 2. transitive, *to move*.

Movement can “come to a halt” on the body’s system, travelling through the infinite spectrum of kinetic chains, or it can transit along the same system, finalising the action of the CHAIN itself, grasping an object, carrying out a social assignment, reaching a goal.

In order for a “finalised movement” to be optimal, it must be designed to transmit the movement, throughout the entire system. To operate effectively as a KINETIC CHAIN, the joints must be stabilised in the precise moment that the force is transmitted and transits through the system.

Every movement produced by the kinetic chain and expressed in an intransitive form (I move myself) or in a transitive form (I move something), has its motor origins in the Basic Movements.

2. Thomas W Myers, *Anatomy Trains*, Churchill Livingstone, Edimburgo, 2001, 23-29.

3. Kibler WB, Press J, Sciascia A; *The Role of Core stability in Athletic Function*, Sports Med 2006.

4. Putnam CA, *Sequential motions of body segments in striking and throwing skills: descriptions and explanations*. J Biomech. 1993; 26:125-135.

There are eight Basic Movements: 1. *Rolling*, 2. *Squatting*, 3. *Pulling*, 4. *Pushing*, 5. *Lunging*, 6. *Bending*, 7. *Twisting*, 8. *Gait: walking, running, crawling*⁵.

Each movement is “core-dependant” and therefore is strongly connected to the correct functioning of the central core stabiliser and the peripheral stability platforms (coxofemoral joints and the humeral scapular complex).

they act as anchors for the upper and lower limbs.⁶

The three stabilising fulcrums create a mechanical model similar to that of a four-wheel drive vehicle, as each of them, inserted in a different mechanical segment (front axle, wheelbase and rear axle), control the rotational speed of each single part, ensuring the dynamic stability of the entire vehicle. (fig. 3).

for the final gesture (catch, pull, push, move something and move) and expand the comfort zone.

To describe the fourfold function of movement, we can use invisible structures: the gravitational axis, the line that “measures” distance, the cone of action and the shadow zone. These “invisible” structures are basically visualisations of portions of space, within which we control and direct movement.

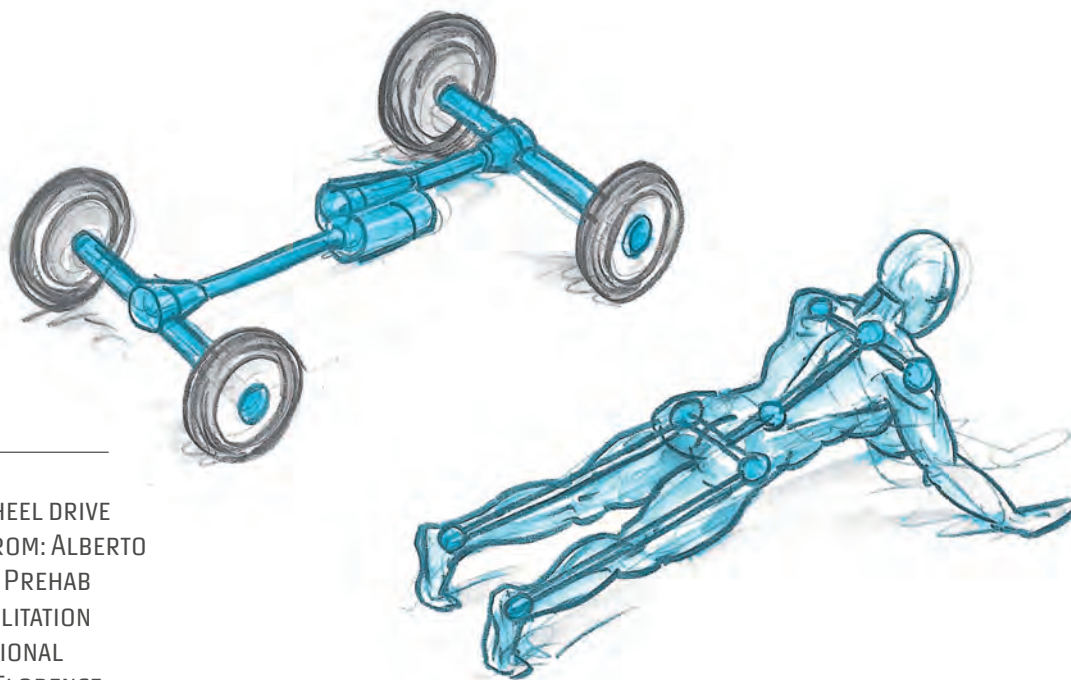


FIGURE NO. 3

THE BODY IS A 4-WHEEL DRIVE VEHICLE. IMAGES FROM: ALBERTO ANDORLINI, “FROM PREHAB TO REHAB: “REHABILITATION AND TRAINING” NATIONAL AIPAC CONGRESS, FLORENCE, 25.05.2009.

The pelvic region, alongside the coxofemoral joint and the humeral scapular complex, like the core, are simultaneously motor links and stabilising joints; they increase the energy and force generated; they consent the passage of movement and at the same time,

The Function of Movement. Movement has a Function, or rather, it has four complementary Functions (fig. 4): it must balance against gravity the segments that make up the “body” system, consent a relationship with external forms (objects, people), prepare

We will use them as a sort of “geometric map” where we can find the paths of Balance, Relationship, Purpose and Expansion.

The control of each “invisible structure” is entrusted to the mechanisms of an in-depth perception (see “Proprioception”).

5. Check P, Movement That matters, Publisher: C.H.E.K. Institute, May 15, 2001.

6. Kibler WB, Role of the scapula in the overhead throwing motion. *Contemp Ortho*. 1991;22:525-532.

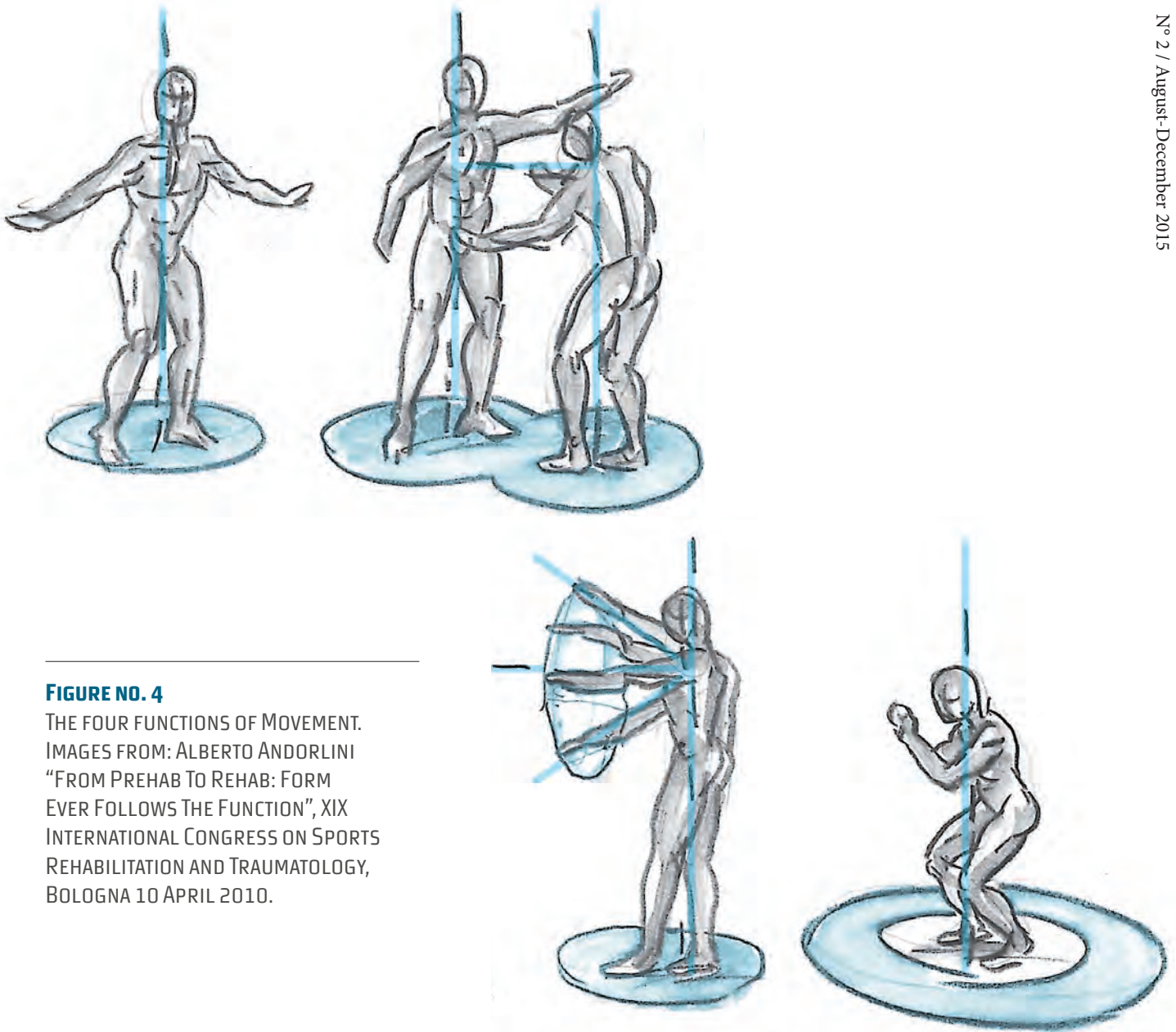


FIGURE NO. 4

THE FOUR FUNCTIONS OF MOVEMENT. IMAGES FROM: ALBERTO ANDORLINI "FROM PREHAB TO REHAB: FORM EVER FOLLOWS THE FUNCTION", XIX INTERNATIONAL CONGRESS ON SPORTS REHABILITATION AND TRAUMATOLOGY, BOLOGNA 10 APRIL 2010.

The gravitational axis is a line that passes through the body, through the spine and falls within the circle of gravity. The perception of the gravitational axis in relation to the surrounding elements consents greater dynamics in movement.

By learning to perceive imbalance along the gravitational axis, you can become aware of your circle of gravity, in other words, the cir-

cle described by the projection of the barycentre to the ground in a position of maximum imbalance before having to take a step to compensate.

The line is the distance that separates man from people or objects. The distance can be perceived dynamically, as a line that connects the gravitational axis with that of the surrounding forms, thus crea-

ting an infinite number of central lines according to the position of the volumes we relate to.

Around the central line we can imagine a cone, whose vertex coincides with the objective of our action. The central line passes through the vertex of the cone, whereas the base is represented by our body. Perceiving the central line, controlling the cone of action, acting within the cone with

a reactive action of the distal segments and effectors (hands, feet) allows us to find the shortest path to execute the movement.

The shadow zone is a proprioceptive and kinesthetic dimension in which we lose the ability to correctly handle the event and to interact with the surrounding environment. The comfort zone, therefore, is defined as the complementary dimension of the shadow zone, that is, the zone where we are aware of the event and consequently find the most functional solution.

The second step: re-interpreting the Body and Movement to bring Form and Function together.

In the theoretical review addressed in the previous article, we had put forward the possibility to enable the Function of the Body by means of various Forms of Movement and, through these Forms of Movement we could induce changes in the Forms of the Body.

Form and Function are appropriate, albeit, unusual terms; deriving from architectural terminology, in this context they adapt to the description of the kinematic relationships between biostructures. Body and Movement are primary

elements that are changeable, deterministically speaking, yet unalterable in the teleological sense.

Let's try to decipher this concept. The body seeks balance, a relationship, a purpose, to expand its comfort zone; during this quest it alters its alignment and interaction between the various segments that make it up. Movements are the essential aids to carry out the function of the body, its social relationship. If it can guide the forms of movement towards acquiring Balance, relationship, Purpose and Expansion of its Comfort Zone, then the Body will better

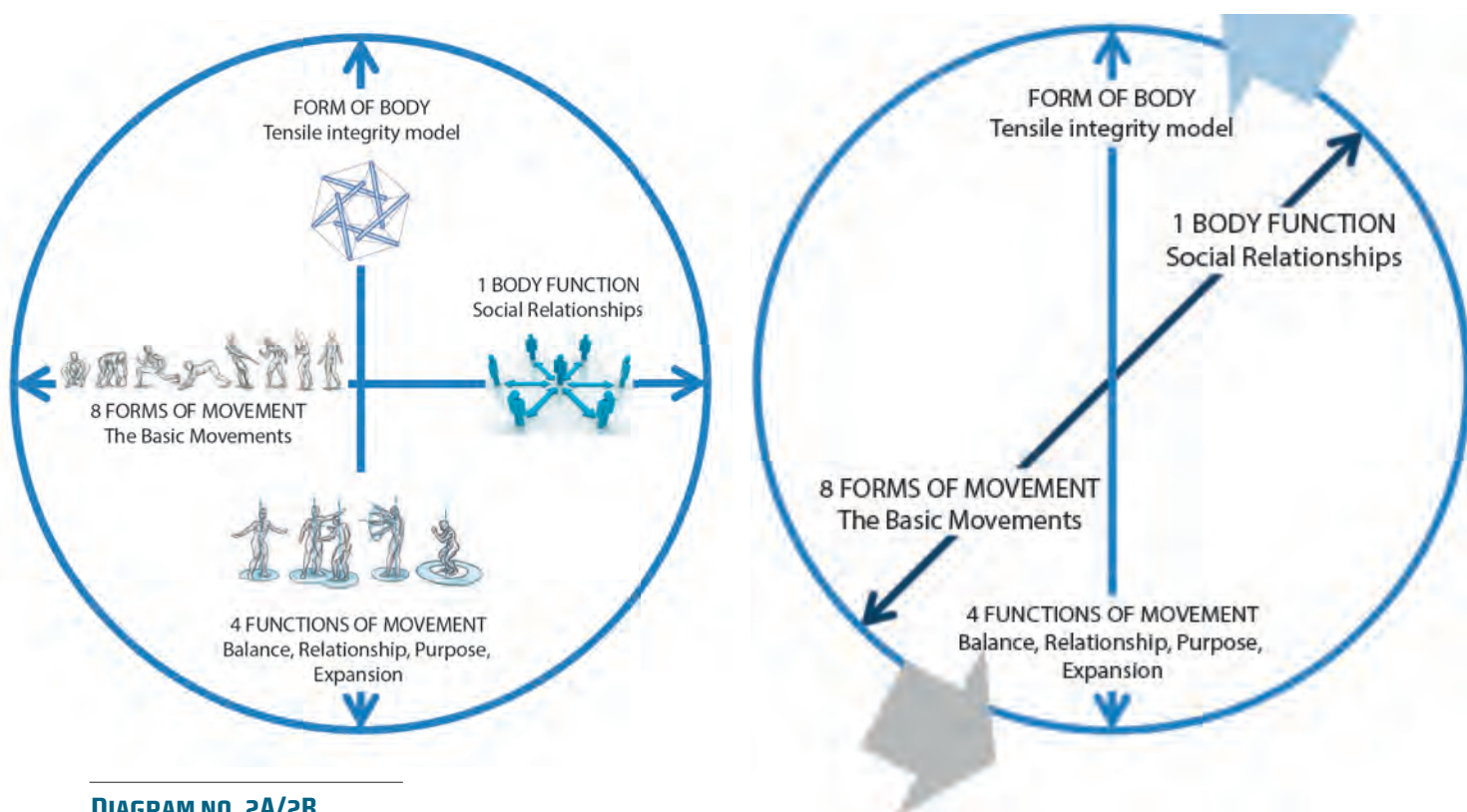
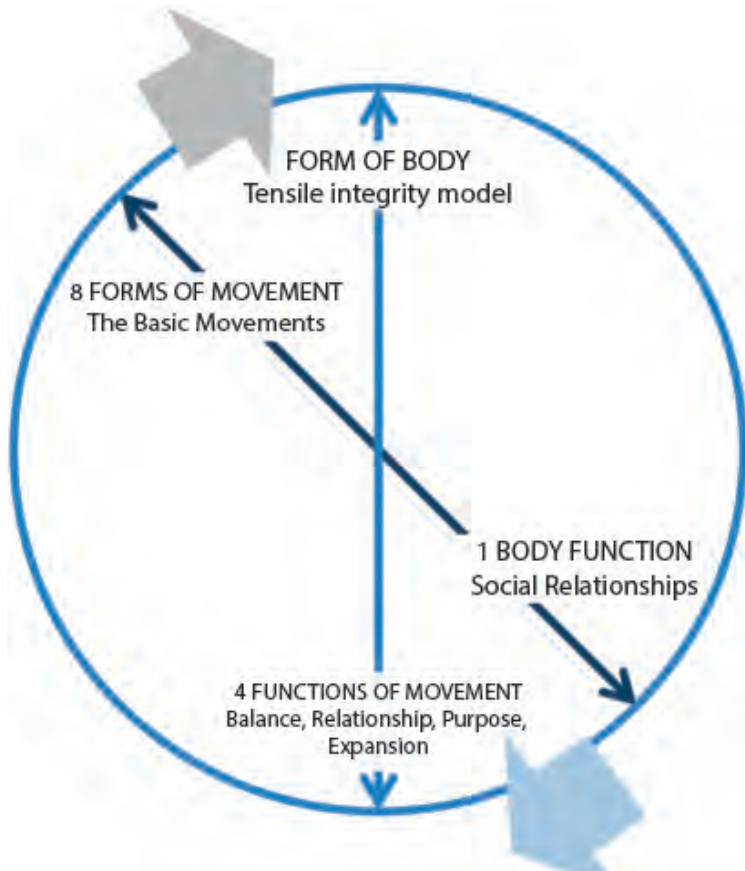


DIAGRAM NO. 2A/2B

2A) THE "FORM/BODY" FOLLOWS THE FUNCTIONS EXERTED BY MOVEMENT; THE FORMS OF MOVEMENT FOLLOW THE FUNCTIONS OF THE BODY. 2B) THE CLOSER THE FUNCTION OF THE BODY GETS TO THE FORM OF THE BODY, THE MORE THE FORMS OF MOVEMENT MUST ADAPT, UNTIL THEY COINCIDE WITH THE FUNCTION OF MOVEMENT ITSELF.



adapt to its functional destination (diagram 2b). The more the bio-tensile plasticity of the Body is adapted to the Basic Movements, or vice versa, the more the Basic Movements act on the Forms of the Body. The more the Function of the Body and the Function of Movement align, they generate a “survival” package based on an optimal harmony of Balance, Relationship, Purpose and Expansion. (diagram 2c).

DIAGRAM NO. 2C

2C) THE MORE THE FORM OF THE BODY ADAPTS TO THE FORMS OF MOVEMENT, THE MORE THE FUNCTION OF THE BODY AND THE FUNCTION OF THE MOVEMENT BECOME ALIGNED.

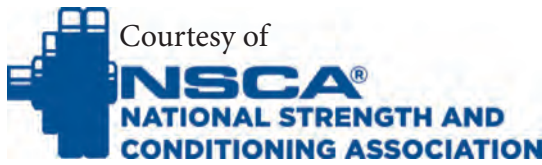


ALBERTO ANDORLINI

AFTER EXTENSIVE EXPERIENCE AS A PHYSICAL EDUCATION TEACHER, TODAY HE IS A SPORTS TRAINER AND REHABILITATOR. HIS ACTIVITY HAS LONG BEEN CONNECTED TO HIS INTEREST IN THE EVOLUTION OF MOVEMENT AND THE DEVELOPMENT OF PERFORMANCE.

HE HAS WORKED FOR FIORENTINA F.C., SIENA F.C., AL ARABI SPORTS CLUB, CHELSEA F.C., HE WAS THE PHYSICAL THERAPIST AND SPORTS TRAINER FOR THE ITALIAN WOMEN’S FOOTBALL TEAM. HE IS CURRENTLY THE REHABILITATOR AT PALERMO SPORTS CLUB. HE COLLABORATES WITH THE FLORENCE TRAINING LAB AND LECTURES IN SPORTS SCIENCE AND TECHNIQUES AND PREVENTATIVE AND ADAPTIVE MOTOR SCIENCES AT THE UNIVERSITY OF FLORENCE.





HOW THE FEMALE WEIGHTLIFTER OUTGREW THE “LADY BAR”

It has been said that man is “fearfully and wonderfully made.”

Wilton M. Krogman, 1951

BY ANDREW “BUD” CHARNIGA





Whoever said “man is fearfully and wonderfully made” in all probability could not even imagine a member of the “weaker sex” raising 193 kg over her head.

The first official women’s world weightlifting championships took place in 1987. By 1989 the world record in the clean and jerk of the female +82.5 kg (unlimited bodyweight) class was 137.5 kg, the same weight as the 82.5 kg record. At the end of 1993, the year the new weight classes were introduced, the world record had already grown to 155 kg. This 155 kg constituted approximately 124% of the bodyweight of the 125 kg female lifter who raised it.

In 1997 the International Weightlifting Federation decided to introduce the lady bar. The new 15 kg bar with a smaller diameter grip became the official bar for female competitions. By this time the female world record in the clean and jerk had flat-lined by remaining the same 155 kg level established in 1993.

Up until 1997 when the lady bar debuted on the international scene, both sexes used the same equipment. A bar with a smaller diameter for the smaller hands of the females, especially the little girls in the 46 – 59 kg classes, seemed appropriate. All of the other specifications of weight and di-

mension of the official equipment remained unchanged.

When a number of factors are taken into account, practical experience clearly indicates the weaker sex has outgrown the shorter and smaller in diameter 15 kg bar.

The realization in weightlifting sport that alterations in the competition equipment designed for the female lifter are needed is not a problem, but a reason for envy. Weightlifting has a long tradition in the development of scientifically based, sophisticated training methodology and exercise techniques. This development has created the conditions for fema-



At the present time the world record in the +75 kg (unlimited weight class) is 193 kg which was set by 106.21 kg Tatiana Kashirina (RUS). This weight is 182% of her bodyweight, i.e., 38 kg more weight lifted by an athlete with 21 kg less body mass than the record of 1993!

FIGURE NO. 1

THE RELATIVELY HUGE BEND IN THE BAR FOR THIS 190 KG LIFT IS CAUSED BY A NUMBER OF FACTORS: THE PROPORTIONALLY LARGER WORKING LENGTH OF THE BAR; THE SMALLER DIAMETER OF 25 MM GRIP; THE STRENGTH OF THE ATHLETE; THE LIMITED SPACE ON THE SLEEVE TO LOAD THE DISCS ACCORDING TO THE PROTOCOLS.

le weightlifters to raise weights once reserved for only the world’s strongest men.

Consequently, the present circumstances are a tribute to the more than 100 year history of the technical expertise of weightlifting sport science.

PROBLEMS WITH THE SPECIFICATIONS OF THE 15 KG BAR

Renowned Israeli weightlifting sport scientist Genadi Hiskiya had been given the task to determine appropriate dimensions of the lady bar which was based on the size of the athlete and the anticipated stresses imposed on the equipment of a “weaker” sex.

Hiskiya did the math and decided a 15 kg bar should have a diameter of 26 mm. The 2,010 mm length of the bar would be shorter than the 2,200 mm male bar. However, Hiskiya’s calculations were cast aside when it was decided the bar would have a 25 mm grip. In all probability, since a 25 mm diameter steel is a common dimension, consequently, it would be cost effective to produce one. Besides the most any female could lift was 155 kg and many would have logically thought that this, if not the ceiling, was close to it.

However, even though the grasping portion of the lady bar (space between the collars) is the same distance: 1,310 mm; the space on the loading portion of the bar known as the sleeve is 415 mm for the male bar, whereas it is only 320 mm for the female bar. The diame-

ter of each sleeve is same for both bars at 50 mm; the same discs are used for both bars.

Consequently, it is logical for one to assume a 25 mm diameter grip and a sleeve length of 320 mm would be enough space to load discs for a female weightlifter; an athlete with serum testosterone levels of just 10% of a male weightlifter.

The 320 mm loading area of each of the lady bar sleeves constitutes 15.9% of its 2,010 mm length.

So, approximately 31.8% of the lady bar constitutes the area for loading the discs. On the other hand, each sleeve of the men’s bar is 18.9%, or the combined area for loading discs of 37.8% of its total length, i.e., not just a larger area, but disproportionately larger for the athlete with ten times the serum testosterone of a female weightlifter.

Furthermore, the distance between the center and end of the lady bar is 1,005 mm, which, like the 1,100 mm dimension of the male



FIGURE NO. 2-3
A 15 KG LADY BAR LOADED TO 193 KG WITH THE 1.5 LOADED NOT ACCORDING TO THE PROTOCOLS; LESS THAN 2 CM SPACE LEFT AT THE END OF THE BAR. COMPARE THIS TO THE 195 KG ON THE MALE BAR WITH COLLARS EXPANDED BY THE OPENING THE THREADED END.

bar, constitutes 50% of its total length. The specified width of each inside collar on both bars is 30 mm. Therefore, that means the distance between the outer surface of the inside collars, i.e., the closest point the first discs on the bar approach its center, is the same for both bars. That is because the width of the inside collars is the same 30 mm and the distance between the grasping portion of both bars is the same 1,310 mm.

However, the distance between the exact center of the bar and this point on the outer surface of the sleeve is 1,035 mm for the lady bar or 51.2% of its length. The distance of 1,035 mm is identical for men's bar, but it constitutes only 47.01% of its total length.

Because of the differences in relative distance between the center of the bar and outer surface of the sleeve, the diameter of the male and female shaft, one would expect the case hardened steel constructed lady bar to flex disproportionately more for a given weight than would be anticipated of the male bar. The reason is because the first discs loaded on the sleeve segment are disproportionately further from the center of the lady bar.

In effect, this would be similar to loading the first disc on the men's bar not flush up against the inside area of the collar but several centimeters further out from its center.

THE “WORKING LENGTH” OF THE BAR

Soviet sport scientist Ilya Zhekov, author of *Biomechanics of the Weightlifting Exercises*, which some aptly have called God's book of weightlifting, referred to the distance from the precise center of the bar to the point where the discs are loaded up against the inside collar as the “working length” of the bar (Zhekov, 1976).

Zhekov recognized when a weightlifter produces a rapid bend in the barbell, timing this bend so that the recoil will assist the upward lifting of the barbell in the jerk from the chest, was a complex skill crucial for the high class weightlifter to master. The problem connected with mastering this skill is the amount of weight required in order to bend and utilize the recoil in the jerk. A weightlifter needs to lift weights in the jerk from the chest heavy enough to practice the precise conditions of bar bend.

It was Zhekov's idea to reproduce the bending/recoil conditions of lifting a heavy weight from the chest in training by increasing the “working length” of the bar. This is accomplished by moving the discs further out on the collars from the nearest point to the center of the bar.

For instance, by making the appropriate calculations, a lifter, who had difficulty timing the bend with (for him) a maximum weight of 200 kg could practice these conditions with say 120 kg simply by moving innermost discs on the sleeves

further out away from the center of the bar.

In this manner a lifter could practice the springy conditions inherent to lifting a maximum weight in the jerk from the chest with a sub-maximum weight, i.e., get in more practice with more lifts of a lighter weight.

When this concept is applied to the design of the lady barbell, it is obvious the working length of the lady bar is proportionally greater than that of the male bar, i.e., the discs are placed further out from the center of the bar. This means it is possible that the lady bar can flex more in both relative and absolute terms, because the working length is greater than the male bar, which, of course, is only exacerbated by its smaller (25 mm) diameter (see photos).

Men lift bigger weights than women. Bigger weights can cause the bar to bend more. In absence of precise calculations, it would appear the ladies have a slight advantage in the jerk from the chest with a proportionally greater working distance on a 15 kg bar. This perceived advantage would be the potential to create and utilize the elastic energy from a springier barbell.

“The oscillation of a given barbell increases along with its increasing weight.” I. P. Zhekov, 1976

However, other factors need to be taken into account.

Besides a larger working length, as already noted, there is less space to place the discs on the 15

**FIGURE NO. 4-5**

OBVIOUS DIFFERENCES IN BEND OF BOTH BARS LOADED NEAR THE MAXIMUM AVAILABLE SPACE.

The lever of the collar is designed to lock down the discs and collars to prevent shifting during the act of lifting. In and of itself, this should suffice. However, the two piece threaded design most manufacturers employ allows the length of the collar to be expanded by unscrewing the portion abutting the discs.

If, for instance, the unexpanded length of a collar of a category ‘A’ barbell is 68.22 mm, it can be elongated to 93.78 mm. Unexpanded, each collar takes up 68.22/320 mm equaling 21.3% of the length of the 15 kg bar sleeve. This compares to 68.22/415 mm equaling 16.4% of the 20 kg bar sleeve. Consequently, not only is the loading area of the lady bar smaller in absolute terms, but using the same collars for both bars means the collars take a disproportionate amount of space on the 15 kg bar, and effectively disproportionately increases its working length.

Furthermore, if one of the 0.5 – 2.0 discs is loaded on the outside of the collars, as the loading protocols stipulate, this disc can be shifted further from the center by elongating the collar, i.e., artificially increasing the working length of the bar. This effect, in turn, is slightly pronounced because the lighter segment of the collar is shifted towards the discs pushing the heavier segment further out, along with the disc loaded on the outside.

kg bar. The smaller space is often exacerbated by: first, the loading protocols stipulating the 0.5 kg – 2.0 kg discs be outside the collars and second, the manner in which the collars are fixed to the barbell. The rules require the discs be fixed to the bar by means of collars. The rules specify the collars weigh 2.5 kg each and the diameter of the

hole be 5.0 cm. The same collars are used for both 15 kg and 20 kg bars.

The problem associated with the requirement of collars is not their weight, but their design. Collars are designed with a lever to secure the discs from sliding and at the same time fix the position of the collar on the barbell.

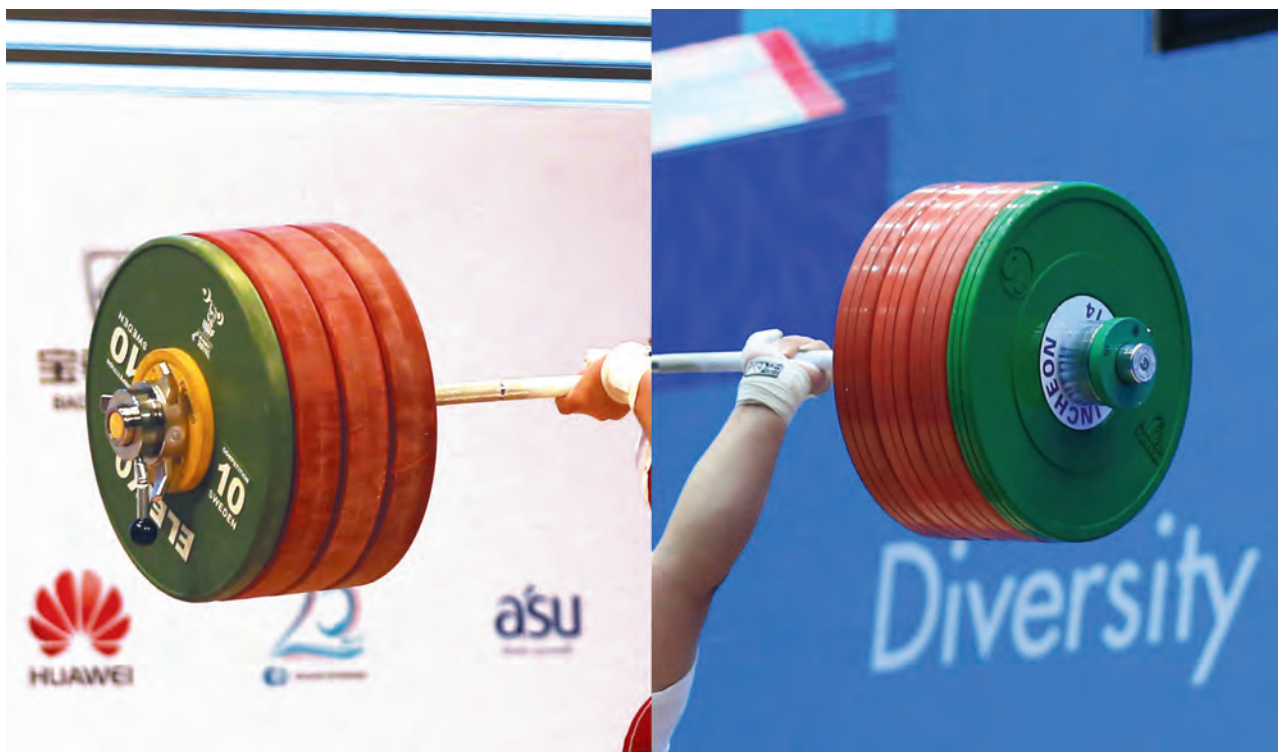


FIGURE NO. 6

REGARDLESS OF DIFFERENCES IN A MANUFACTURER'S DISCS OR COLLARS; THERE IS NOT ENOUGH ROOM LEFT ON A LADY BAR TO PREVENT EXCESSIVE OSCILLATION. HERE THE LADY BARBELL LOADED TO 193 DOES NOT FOLLOW THE PROTOCOL BECAUSE THE 1.5 KG DISC IS LOADED ON THE INSIDE. FURTHERMORE, THE COLLAR HAS BEEN EXPANDED, I.E., UNSCREWED PUSHING IT FURTHER OUT ON THE SLEEVE.

So, a situation where fixing the collar on the barbell with the least effect on the working length of the bar would be unexpanded (a length of 68.22 mm) with a 0.5 kg disc on the outside. Conversely, circumstances are created with the largest effect on the working length would be a fully elongated collar (93.78 mm) with a 2.0 kg disc loaded on the outside.

However, if a record attempt, of say 194 kg, is loaded on a lady barbell, not only is there no room to expand the collar, but placing the 2.0 kg on the outside will definitely affect the oscillation of the barbell and with it, the athlete's ability to control it.

SOME OF THE FACTORS AFFECTING OSCILLATION OF THE BARBELL NOT CONNECTED WITH THE DESIGN OF THE EQUIPMENT

Apart from the amount of weight, other factors which affect oscillation of the bar, independent of the design of the equipment, are the hand spacing, stance, width of the shoulder girdle, width of the pelvic girdle and the suppleness of the athlete.

Generally, the further the lifter's hands are fixed to the bar from the edge of the shoulder joints, the more the grasp supports the bar further from its center. This tends to reduce oscillation in the pull

phase of the clean and, of course, bar bend and recoil in the jerk. Whereas, in the opposite case, the closer the hands are spaced to the shoulders, the more oscillation one can expect.

When the barbell is resting on the chest prior to the jerk, a wide shoulder girdle provides more support with slightly less oscillation while a narrower shoulder girdle provides slightly less support creating slightly more oscillation. The relative width of a lifter's pelvis probably has little effect on bar oscillation but a stance significantly wider than hip width would.

What does all of this have to do with the problem with the lady bar? Women generally have pro-

portionally wider pelvic girdles, narrower shoulder girdles and smaller feet. Although most select a hand spacing for the clean and jerk in between what is considered wide and narrow (hands almost touching deltoid muscles) and a stance of approximately hip width, some of the elite females do not.

Some of the top female lifters gasp the barbell with a narrow hand spacing combined with an atypical stance where the feet are inside the width of the pelvis. A female (or male for that matter) lifter who employs a narrow hand spacing, along with a foot spacing (feet inside the width of the pelvis), shifts the lifting force acting on the barbell closer to the center of the bar, i.e., increasing the working length of the bar from the inside out.

In order to counterbalance the weight in the jerk from the chest, many female lifters place their feet in the starting position such that the foot of the leg which is shifted forward in the split is slightly in front of the other, i.e., artificially increasing the length of the base of support. The female body is more complex than a man's body. Consequently, this technique is instinctive, a natural predisposition of a complex organism to accommodate to complex conditions.

So, a proportionally narrower shoulder girdle and a close hand spacing along with feet inside pelvis width stance will facilitate barbell oscillation and recoil in the jerk, especially when this technique is employed with a bar that has a 25 mm grip and an already proportionally longer working length.



There is not much research in weightlifting about oscillation of the barbell from lift off to fixation overhead. Generally, most people recognize the bar bends before lift off from the floor or on the chest in the jerk, but few recognize the bar can hyper bend, especially if the lifter's movements are fast.

The accompanying pictures illustrate two forms of oscillation in the jerk from the chest. The 151 kg barbell has straightened out after recoil; in part because the lifter has a wide hand spacing. The other 157 kg barbell is bending in a slight hyper recoil with this athlete's narrow hand spacing. This hyper recoil of the barbell means the center of the bar is bowing down, while the discs are bowing up (see figure no. 8 next page).

Ultimately, the extra, hyper recoil is added to the force of the weight

FIGURE NO. 7

EXAMPLE OF FEMALE LIFTER INCREASING THE WORKING LENGTH OF THE BAR WITH NARROW STARTING POSITION OF FEET AND NORMAL HAND SPACING CLOSE TO SHOULDER WIDTH.

on the athlete's body when she locks her arms to fix it overhead. Furthermore, this additional recoil is magnified with the heavier the weight, the longer working length of the 15 kg bar, the narrower the hand spacing and the narrower stance. An excessively springy barbell becomes more and more difficult to control at the chest, at full extension of the arms, as well if the weightlifter struggles out of the squat with a maximum weight. An example of an unexpected problem of a too springy bar was the clean and jerk competition in the 58 kg class at the 2012 Olympics (<https://www.youtube.com/watch?v=X7AulgVE86A>).

**FIGURE NO. 8**

A WIDER HAND SPACING WILL TEND TO SUPPORT THE BAR SO THAT THERE IS LESS BEND. ON THE OTHER HAND A CLOSER TO SHOULDER WIDTH HAND SPACING WILL PROMOTE MORE FLEX IN THE BARBELL INCLUDING THE HYPER-FLEXION OF THE BAR OPPOSITE ITS DIRECTION OF INERTIA, I.E., THE CENTER IS BOWED DOWNWARD WITH THE ENDS BOWING UPWARDS.

Two of the BLR 58 kg girl's lifts were turned down for oscillating the barbell in the jerk.

The rules stipulate a lifter cannot purposely move in such a manner prior to jerking the barbell from the chest as to make the bar oscillate for additional assistance in the upward lifting.

In this instance, this lifter's hand spacing for the jerk was very close to the shoulders. She raised the barbell off her chest after recovery from the squat to switch to a thumb-less grip, which the rules permit. However, in the process switching to this grip she expanded her grasp such that the base of her thumbs were brushing up against her shoulders. Consequently, the 127 and 133 kg barbells she was lifting oscillated a little more than would be expected had she retained the original grasp.

This action increased the working length of the bar, as noted before, from the inside out.

Even though she paused briefly before beginning to jerk the barbell, it continued to oscillate after the clean. Two of the three referees apparently noticed the barbell oscillating; assuming the lifter was in violation of the rules, they turned the lift down. The rules do not stipulate a length of pause from recovery to jerk only that the athlete become motionless. A prolonged pause to wait for a 133 kg female barbell to stop oscillating is unrealistic. The athlete was penalized for the moving bar even though there was no deliberate attempt on her part to flex the barbell in order to gain an advantage. The fact here is not to point a finger but to make a point: the strength of today's women lifters is

beyond the equipment which was originally designed for a “weaker sex,” whatever that is.

Another factor, not easily quantified, is the fact that females generally have greater flexibility, greater overall suppleness and larger range of motion in joints which is sometimes referred to as lax articulations. Suppleness and lax articulations are desirable qualities for raising heavy barbells.

A very supple, flexible athlete can perform complex movements while experiencing less of what the Russian sport scientists call “internal resistance.” A large range of motion in joints coupled with less internal resistance means movements of the modern female weightlifter can be mechanically more efficient in lifting maximum weights.

Elite female lifters can raise big weights while performing less work against gravity by means of less resistance to the body's movement while raising the barbell to a lower height. The high class elite females instinctively achieve a resonance, i.e., a rhythm of stretching tendons and ligaments (biological springs) with the oscillation of the barbell.

CONCERNING THE PRESSING NEED FOR ALTERATIONS TO THE FEMALE BARBELL

The obvious problem associated with an excessive bend (see picture of 190 kg clean) in the lady bar created by the heavier weights being raised is an important issue, but perhaps not the most significant from a safety standpoint.

A hyper bend in the barbell just before the lifter locks the elbows in the jerk or multiple, imperceptible to the naked eye, oscillations in the barbell when a lifter is struggling out of the squat or trying to become still with a maximum weight overhead in the jerk pose bigger threats to safety and performance.

A number of factors have coalesced to create the conundrum of excessive oscillation with the lady bar. The following are the most significant factors affecting excessive oscillation of the 15 kg bar:

- 1) the strength of the female weightlifter;
- 2) the 1,310 mm dimension of the grasping area between the inside surface of the collars;
- 3) the 25 mm diameter of the grip;

- 4) the specified 30 mm width of the inside collars of the sleeves;
- 5) the expandable collar;
- 6) the loading protocols to fix the 0.5 – 2.0 kg.

Of the factors affecting excessive oscillation of the 15 kg bar, the unanticipated, astonishing strength of the female weightlifter is not the fault of engineering. The fault lies in the modern methods of preparing weightlifters, especially the modern concepts of weightlifting technique which is a positive development for weightlifting, to say the least.

Of all the alterations to the lady bar to consider for the safety of the female lifter, asking them to become weaker so they will not bend the bar too much is not a viable option.

The 1,310 mm dimension of the grasping area between the inside surface of the collars stands out as the most irrational dimension of the 15 kg bar. The idea to make a smaller diameter grip, even though the 25 mm is now too small, is understandable. This is to accommodate smaller hands, so the small girls will not have to strain just to hold on.

However, at least part of the rationale behind the 1,310 mm grasping area between the collars is to accommodate the lifter whose arms are so long the lifter needs to grip the bar with hands up against the inside collars. It is illogical to assume someone with arms that long to require 1,310 mm of space will have hands so small as to need a 25 mm grip.

Consequently, the first dimension of the lady bar that should be altered is the 1,310 mm dimension between the inside portion of the collars. This dimension disproportionately increases the working length of the lady bar. It is highly unlikely anyone will need that much area to grasp the bar. Along with reduction in the 1,310 mm, the 30 mm required width of the inside collars should be reduced as well. These two alterations would reduce the working length of the bar and free up space on the sleeve for the strongest female lifters.

If those reduced dimensions were applied to a bar with a 26 mm diameter, the barbell will still be springy, but not excessive.

As far as the collars are concerned, the simplest, logical solution is to direct the loaders not to expand the collar. It is unlikely unscrewing the collars after the lever is tightened will contribute anything substantial to holding the weights on the bar. Of course, in the long term an expandable collar is unnecessary. Furthermore, eliminating the threaded two piece design will save unnecessary retooling.

There are a number of factors which affect oscillation of the modern weightlifting barbell such as the amount of weight, the working length of the bar and the width of the hand spacing. However, the unanticipated current and still growing strength of the modern female weightlifter has antiquated the bar designed specifically for this athlete. This has created safety and performance issues which can only be addressed with design changes in the lady bar.

AFTERWARD

It is a quirk of fate that the stagnation of the male world records which necessitated the change in weight classes combined with an unexpected strength of the female lifter is that the strongest lifters

of both genders face the same problem of oscillation.

From the pictures of the ends of the barbells of both sexes, you can see there is not enough room to safely load the weights required

of the strongest lifters. For the men it would be appropriate to introduce the already approved 30 kg 450 mm discs, and, as already mentioned, to eliminate the threaded collar.



FIGURE NO. 9

CURIOUSLY THE STORMY GROWTH OF THE FEMALE RECORDS AND THE STAGNATION OF THE MALE RECORD HAS CREATED THE SAME CIRCUMSTANCE WITH NOT ENOUGH ROOM AT THE END OF THE BAR TO SAFELY FIT THE DISCS ON ACCORDING TO THE CURRENT RULE PROTOCOLS. IN ALL THREE PICTURES THE COLLARS ARE EXPANDED UNNECESSARILY TAKING UP THE TOO LITTLE SPACE LEFT ON BOTH BARBELLS.





ANDREW B. CHARNIGA

WEIGHTLIFTING SPORTS SCIENTIST AND TRAINER WITH A DEGREE IN EXERCISE SCIENCE FROM EASTERN MICHIGAN UNIVERSITY (USA) AND A MASTERS IN KINESIOTHERAPY FROM TOLEDO UNIVERSITY (SPAIN). THE FOUNDER OF SPORTIVNY PRESS IN 1980, MR. CHARNIGA HAS ALSO EDITED 15 BOOKS TRANSLATED INTO RUSSIAN AND DOZENS OF ARTICLES ON WEIGHTLIFTING TRAINING, BIOMECHANICS, RECOVERY, ETC. HE REGULARLY PUBLISHES SPECIALISED ARTICLES AND TRANSLATIONS ON THE WEBSITE: WWW.SPORTIVNYPRESS.

References

1. Charniga, A., A De-masculinization of Strength, Sportivnypress, Livonia, Michigan, 2102
2. Zhekov, I.P., Biomechanics of the weightlifting exercises, English translation: Sportivnypress, Livonia, Michigan, Original publication in Russian: Fizkultura I Sport, Moscow, 1976



BIOMECHANICAL MODEL OF THE BASIC SNATCH TECHNIQUES

The Snatch is the lift of modern Olympic Weightlifting which involves lifting the barbell from the ground to an overhead position a single, continuous movement, showing perfect postural control with all the central joints of the anatomic segments in full extension [1].

BY DONATO FORMICOLA





INTRODUCTION

The upward trajectory that the barbell completes during the execution of the Snatch generates great interest from the scientific literature that deals with sports biomechanics, as it is a demonstration of how it is possible to develop specific motor strategies that can lift a load, which, in the specific case of this movement, can reach almost two and a half times the body weight (Liu Xiaojun, 2013 world record holder, who lifted 176 kg in the Snatch, about 2.3 times his body weight of 76.4 kg). The trend of the barbell trajectory is represented by a characteristic “S” shape [2] and is delineated by the mechanical contribution of the joint levers that, in altering their spatial disposition during the entire evolution of the movement, mainly generate three propulsive periods [3]:

- 1) the pull, characterised by the action of the lower limbs and the rearward displacement of the barbell;
- 2) the thrust, which involves raising the pelvis and a forward displacement of the barbell;
- 3) the push, when the shoulders are fully raised with the simultaneous extension of the lower limbs to allow the barbell to reach maximum height [4].

In the modern evolution of the technique, aimed at improving the mechanical efficiency of lifting increasingly heavier loads producing increasingly faster actions, the trajectory of the barbell tends to assume a less curved trends. Two examples of technical variations of this type are (1) the changes that are occurring in the “dou-

ble knee bend” phase (plyometric action leg) that, to reduce the horizontal displacement in the first pull, loses the countermovement, becoming therefore, a “single knee bend” [5], and (2) the exasperation of the explosive component of the thrust through the accentuation of the jump action at the end of the triple joint extension of the lower limbs, in order to limit the rotation of the arms at the maximum height of the barbell in the push [6].

However, in the Snatch, the barbell goes beyond the athlete’s centre of gravity with a change in the vertical direction of the extension of the upper limbs and a relative variation of the dynamic vertical thrust: when the arms are stretched downwards, the legs develop a vertical acceleration of the barbell through a linear inertial force that exploits the reaction force generated by the support surface; whereas, when the arms rotate upwards, the upward force of the barbell is ensured by the moment of inertia produced by the interaction between the athlete’s centre of gravity and that of the barbell. Based on the morphological and athletic characteristics, some lifters prefer to coordinate the rotation of their weight mass as opposed to that of the barbell, while others fail to control the rotations of the barbell while maintaining constant the positions of the inertial mass of their body [7]. The elevation of the upper limbs during the third push therefore requires the management of a roto-translation strategy of the centres of gravity of the athlete mass-barbell mass couple, whose

effect inevitably has an impact on the curve of the barbell trajectory. Much research is underway in the field of sports biomechanics regarding the weight contribution of the athlete and the barbell, in order to define a standardised efficient execution of the modern technique of the Snatch and to minimize the dispersion of muscle forces engaged in the development of the performance of Olympic Weightlifting [8].

In general, the technical analysis of a sports movement is realised by a systematic observation of the entire movement, breaking down the overall aim of the action into different motor tasks, each of which is to be carried out through a characteristic motor pattern whose efficacy influences the efficiency of the action [9]. This type of procedure is known in literature as qualitative biomechanical analysis and involves the evaluation of the motor actions, in order of effectiveness, through the outcome of the pre-set task and, in order of efficiency, comparing its implementation with a reference model [10]. Therefore, if for the technical analysis of the effectiveness of a phase, it is sufficient to check the execution of a motor task, for the evaluation of the efficiency, it is crucial to have a reference model obtained through a process of digitizing the movement composed mainly of five consequential stages:

- 1) *designing a system capable of capturing motion* which can collect the information on the position in space of the different parts of the body involved in mo-

tor action to be analysed (usually these systems are composed of sensors, such as accelerometers placed on the body segments in motion [11], or computer vision applications which use multiple cameras to record the position of the anatomical points of interest from different angles and then reconstruct the position in a virtual environment [12]); 2) *recording a series of executions of the same motor action* performed by one or more individuals, according to the degree of intra-subjectivity [13] and/or inter-subjectivity analysis; 3) *normalizing the motor action* by means of statistical procedures, with the aim of obtaining a single motor action from the average of all tests recorded, thus emphasising the recursive motor strategies and reducing the effects of the complementary ones [14]; 4) *integrating experimental data* with anthropometric data collected from literature [15] to allow biomechanical assessments which require the weight contribution of the individual body segments (the anatomical positioning of the centres of gravity of the body masses is determined only by direct methods of dissection investigation); 5) *simulation of the action* with different mathematical optimization methods of the motor performance model [16]. Specifically, in scientific studies on Weightlifting, it is interesting to note that the biomechanical analysis that presented a model of the Snatch execution technique, took into consideration the best performance of individual cases

or a few subjects, conducted in a controlled environment.

In this study, we present a description of the Snatch movement, using a standardised, anthropomorphic, biomechanical model, dividing the execution of the action into different positions characterising the overall technical movement and which can be achieved by a series of key, basic motor strategies. This simulation aims at offering a new method of qualitative analysis of the movement in favour of the study of technical efficiency, which meets the biomechanical and ergonomic properties of the human body. The new biomechanical approach adopted would allow us to calculate the only postural attitudes that the athlete, according to his/her anatomy, can assume to effectively satisfy the fundamental phases of the Snatch.

MATERIALS AND METHODS

The anthropomorphic biomechanical model used for the study was carried out by integrating the data collected from the literature regarding the biomechanical [17] and anthropometric [18] components. The shapes and the masses of the body of a virtual athlete have been simplified in the association of six anatomical regions (foot, leg, thigh, torso, arms, head) represented by the same number of coplanar linear segments that originate from their centre of mass and end in their distal and proximal joints. The use of a two-dimensional anthropomorphic model of this type is supported by the total contralateral symmetry that

the Snatch requires in order to be performed in a condition devoid of motor skills and of subjective compensations associated with morphological causes. The length and position of the centre of mass of the anatomic segment of the upper limbs were calculated from the maximum possible distance that can be obtained between the articular centre of the shoulder and the longitudinal axis of the barbell, assuming that the athlete grips the bar with taut wrists and elbows and at a width that allows the head to pass under the barbell during all phases of the lift. In representing the pelvic volumes, the two-dimensional model of the torso was characterised by a quadrangular area, defined by the iliac spines above and below by the sagittal protrusions of the stomach, gluteus and pyramidalis muscles, and by a line representing the longitudinal axis of the spine, which combines the hip joint to that of the shoulder without considering the metameric joints of the spine, the latter presumed in a static conformation capable of integrally preserving its physiological curves. The volumes of the lower limb were illustrated with the longitudinal axes of the different anatomical segments joining the hip (aligned to the landmark of the greater trochanter) with the knee and the ankle. Finally, in the anthropomorphic model, the foot is defined by a triangular shape which joins the ankle to the rear bony protrusion of the calcaneus and to the distal end of the last phalanx of the big toe. A fourth anatomical point of biomechanical interest was also identified on the

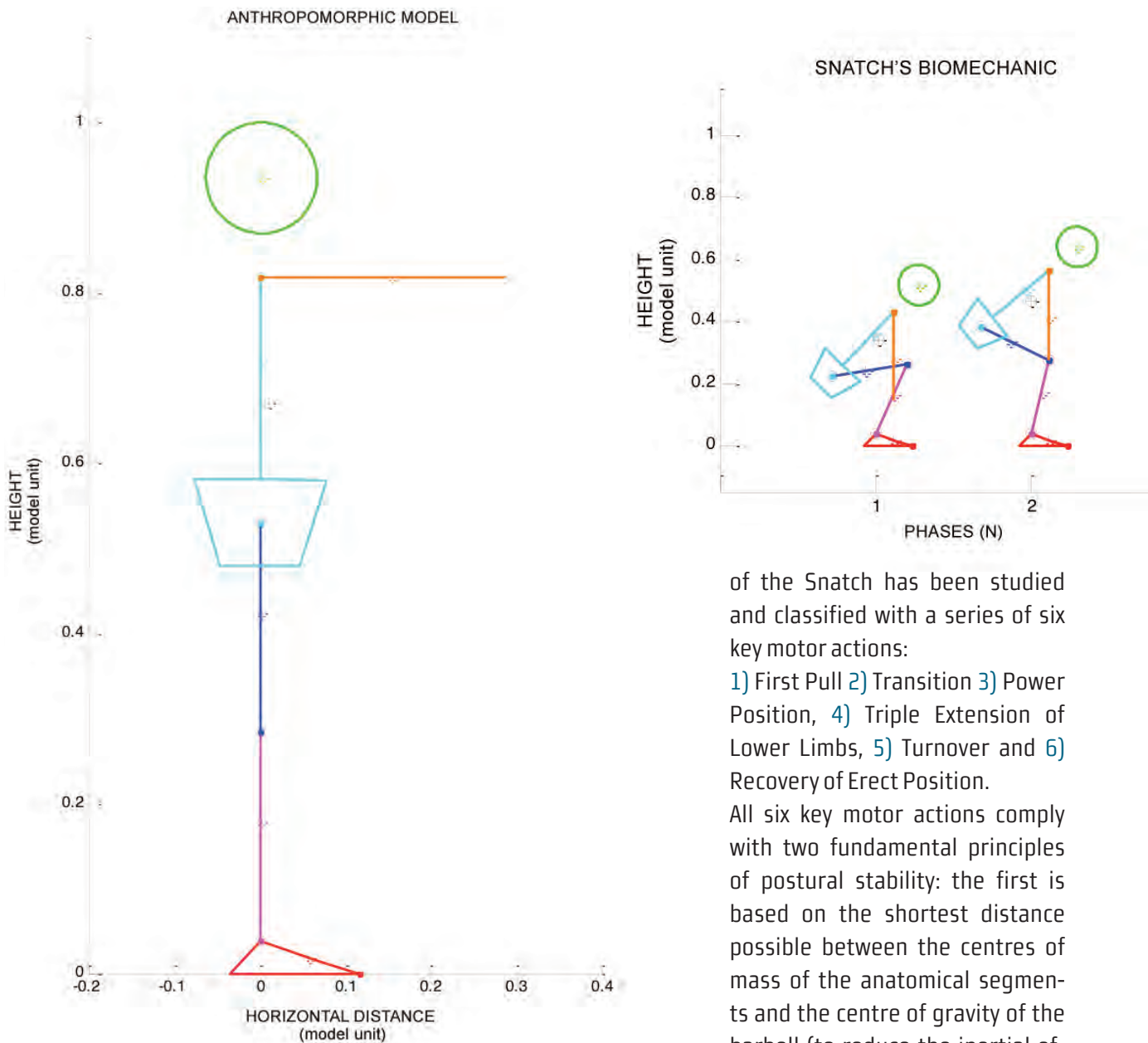


FIGURE NO. 1
GRAPHICAL REPRESENTATION OF THE MULTI-SEGMENT ANTHROPOMORPHIC BIOMECHANICAL MODEL. THE MODEL COMPRISES SIX SEGMENTS: FOOT (IN RED), LEG (IN PURPLE), THIGH (IN DARK BLUE), TORSO (IN LIGHT BLUE), ARM (IN ORANGE), HEAD (IN GREEN). THE CENTRES OF MASS OF THE INDIVIDUAL BODY SEGMENTS HAVE BEEN IDENTIFIED (THE ASTERISKS BEAR THE SAME COLOURS AS THE BODY SEGMENTS) AND THE MASS OF THE ENTIRE BODY (CROSS CIRCLED IN BLACK). THE ORDINATE VALUES ARE EXPRESSED IN MODEL UNITS (FRACTIONS OF HEIGHT OF THE ANTHROPOMORPHIC MODEL).

articulation metatarsophalangeal joint) and forefoot (the phalanges of the toes). Figure 1 shows the foot into hindfoot (from the ankle to the protrusion of the posterior calcaneus), midfoot (from the ankle to the metatarsophalangeal

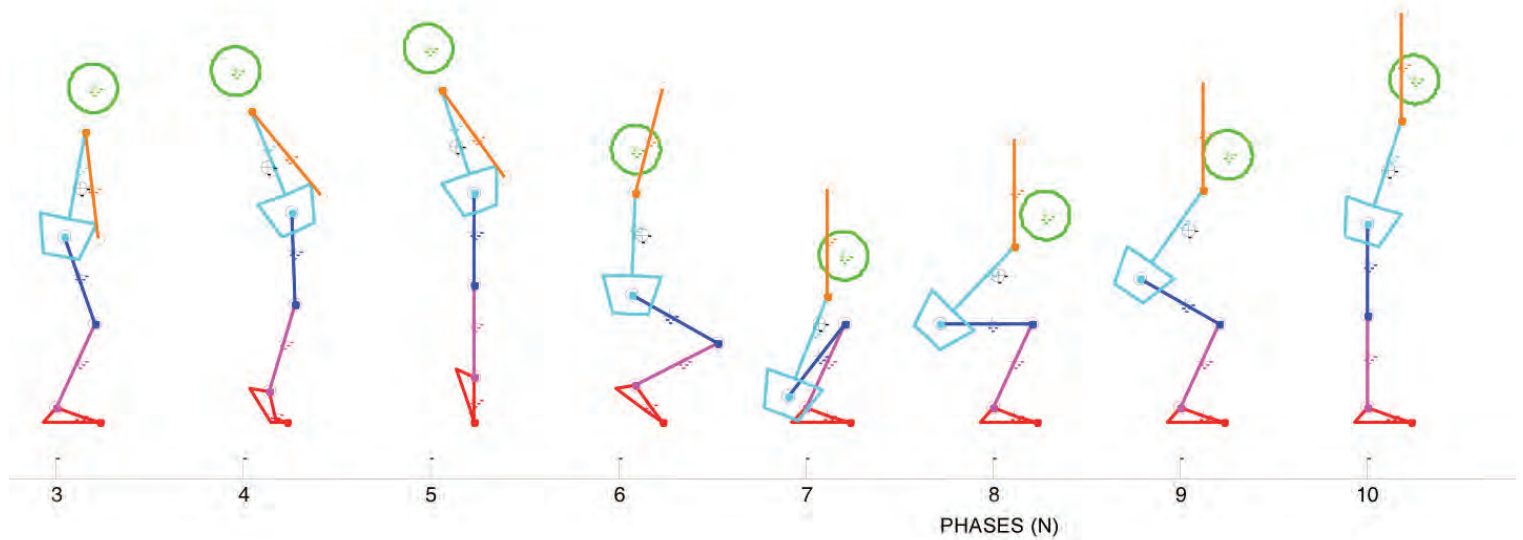
joint) and forefoot (the phalanges of the toes). Figure 1 shows the anthropomorphic model.

Following the guidelines defined by literature [19], the movement

of the Snatch has been studied and classified with a series of six key motor actions:

1) First Pull 2) Transition 3) Power Position, 4) Triple Extension of Lower Limbs, 5) Turnover and 6) Recovery of Erect Position.

All six key motor actions comply with two fundamental principles of postural stability: the first is based on the shortest distance possible between the centres of mass of the anatomical segments and the centre of gravity of the barbell (to reduce the inertial effects of their mutual movement), the second requires that the vertical projection of the centres of gravity of the barbell and of all the body masses, including the total mass, must fall within the area of the supporting surface corresponding to the plantar section of the midfoot, at half the total length of the foot [20]. The qualitative biomechanical analysis of the Snatch has been illustrated in Figure 2, where we can observe the ten stages in which the athlete assumes some characteristic postures of the six key motor actions.


FIGURE NO. 2

BASIC PHASES OF THE SNATCH TECHNIQUE. THE MULTI-SEGMENT BIOMECHANICAL MODEL REPRESENTS THE DISTINCT SOLUTIONS OF TEN POSTURAL POSITIONS THAT CHARACTERISE THE SNATCH TECHNIQUE. THE UNIVOCITY OF THE SPATIAL LAYOUT OF THE MODEL WAS REACHED BY RESPECTING THE ARTICULAR RANGES OF THE DIFFERENT BODY SEGMENTS AND THE TWO BASIC PRINCIPLES OF POSTURAL STABILITY: MAXIMUM PROXIMITY OF THE CENTRES OF GRAVITY IN RELATION TO THE VERTICAL LINE OF THE MOVEMENT AND THE PROJECTION OF THE CENTRE OF MASS OF THE ATHLETE'S BODY WHICH FALLS IN THE CENTRE OF THE MIDFOOT. THE ORDINATE VALUES ARE EXPRESSED IN MODEL UNITS (FRACTIONS OF HEIGHT OF THE ANTHROPOMORPHIC MODEL).

First Pull. In this first motor action the centres of mass of the foot, the barbell and the tibia are aligned in a straight line and perpendicular to the support plane that intersects the shoulder joint in order to make the direction of the barbell ascent vertical (Figure 2, Phase 1). Therefore, by knowing the position of the knee and the horizontal component of the shoulder, the hip can be placed in the plane of the anthropomorphic model (also called the homographic plane) at the point of intersection articular radii of the torso and thigh. The two coordinates of the hip and the shoulder height (three unknown) therefore constitute the only solution of a system of three

equations (the straight line of the arms, the torso circumference with radius on the shoulder, thigh circumference with centre on the knee). The Phase described by this biomechanical simulation shows how the upper edge of the iliac crests, defined by the point of intersection between the main axis of the torso and the upper side of the pelvic quadrangle, is parallel to the knee and hip, and placed below the knee line, places the vertical projection of the centre of gravity of the body masses slightly ahead of the ankle, making it fall even so, within the support surface of the midfoot, to guarantee total postural stability.

Transition. From the position adopted in the motor action of the First Pull, the barbell is raised, continuously touching the legs that extend by the concurrent effect of a retraction of the knee and a hip lift, which are indispensable in order to ensure the verticality of the barbell trajectory. The final moment of this phase, where for purely explanatory purposes, we consider null the anatomical volumes of the joints and the cross sections of the barbell, is described by a superposition of the central knee joint with the longitudinal axis of the barbell (Figure 2, Phase 2). The segments of the thigh, torso and arms thus define a scalene triangle, whose centre of gravity represents the horizontal component that falls on the perpendicular of the ankle, on the posterior margin of the midfoot but still within the limit of postural stability.

Power Position. After the transition to the knee, the barbell continues its upward movement,

sliding along the longitudinal axis of the thigh until the plane of the arms intersects the line of the iliac spines on the upper margin of the pelvic quadrangle of the basin, in the geometric arrangement where, in the average anthropomorphic model, the barbell is at approximately the same height of the hip (the greater trochanter). This postural configuration is achieved with a forward displacement of the knees that realigns the vertical line of the centres of mass of the torso, thigh and legs with that of the foot (Figure 2, Phase 3) and corresponds to an interesting biomechanical configuration (said athletic posture or power position), in which the articular segments of the thigh and torso in relation to the arms and the front section of the iliac crest, behave like a mechanical pantograph (the shoulder, iliac spine, knee and hip are the vertices), capable of multiplying the upward force and simultaneously cause a forward displacement of the barbell.

Triple Extension of Lower Limbs.

The motor action subsequent to the power position is when the joints of the ankle and knee are fully extended, while the athlete attempts to hyperextend the torso in order to lift the barbell as high as possible (Figure 2, Phases 4 and 5) which, as seen in the previous strategy, is resting on the torso with the arms fully extended. This strategy is characterised by a rapid increase of the thrust of the foot on the support plane, for a displacement of the centre of pressure from the midfoot to

the forefoot, with a reduction of the foot contact surface (Figure 2, Phase 4) and for a total involvement of extensor musculature of the lower limbs which produces a strong increase in the thrust, so as to ensure the constant application of an upward force on the barbell, even when the foot support is reduced only to the balls of the feet (Figure 2, Phase 5), or is even non-existent during a jump. In this geometric configuration, the vertical line that aligns the foot in full plantar flexion, the leg and thigh, intersects the line joining the centres of mass of the upper limbs. This point is the hub of two mechanical levers where the barbell acts as resistance: one of the first type, the power of which is represented by direct muscle strength on the shoulders, extending to the torso, and a third type, whose power is the muscular strength that extends the lower limbs and pushes the hip upwards. The first type of lever generates a rotational force that simultaneously moves the barbell forward and upward, while the second type of lever produces an additional upward thrust that enhances the effects of the first lever.

Turnover. The fifth motor action of the Snatch begins when the barbell reaches its maximum height against the annullment of the constraining forces of the support surface. From this moment onwards, both the athlete and the barbell continue their rise until the gravitational pull counteracts their inertia and reverses the direction of their vertical motion. While the bar is raised under the

propulsive effects accumulated in the previous motor actions, this is the only moment in which the athlete is free of the load, and can extend the arms upward (Figure 2, Phase 6), preparing to halt the fall of the barbell with arms stretched overhead (Figure 2, Phase 7). The final position that the athlete assumes at this stage is accomplished by restoring full foot support in a characteristic squat, where the lower margin of the pelvic quadrangle is in its lowest position (in this regard, please note that the international regulation of Olympic Lifts forbids athletes to bring the gluteus, or other parts of the body other than the soles of the feet, in contact with the competition platform). The centres of mass of the tibial segment and the foot will produce the vertical axis of the movement, to indicate the point of ground pressure for maximum postural stability and to align the longitudinal axis of the arms with respect to the shoulder and the centre of gravity of the barbell.

Recovery of Erect Position. The Snatch is successful when the athlete resumes an upright position, maintaining the barbell overhead with extended arms. This latter position is achieved with a distension of the lower limbs, while the arms are vertically aligned to the centres of mass of the foot and leg, ensuring the projection on the ground of the weight of the barbell on the tying point of maximum postural stability. During the extension of the lower limbs, the pelvis initially rises, dropping backwards (Figure 2, Phase 8) and then tilting forwards (Figure

2, Phase 9) until maximum leg extension is reached. The torso leans forward, its centre of mass being vertically aligned with the centre of mass of the foot (Figure 2, Phase 10). In this position, the vertical axis divides the masses of the body segments and the barbell in two distinct mechanical sections, which are in a state of static equilibrium by reciprocity of their counterweights, which relieve the extended joints of excessive muscle tension. Once the ten phases that describe the characteristic actions of the Snatch had been defined, it was possible to calculate the angular and linear kinematics from the virtual model of the athlete. Figure 3 illustrates the articular ranges of the foot, ankle, knee, hip and shoulder, whereas Figure 4 shows the vertical components of the ankle, knee, hip, shoulder and barbell and Figure 5 shows the trajectories of the centres of mass of the athlete and the barbell.

RESULTS

The ten phases defined in the qualitative biomechanical analysis of the Snatch in Figure 2, show two particular motor strategies that make up the overall movement. The first is achieved by a rotatory movement of the torso, which first tilts the pelvis backwards (Phase 1 and 2) and then moves it forward until it comes into contact with the barbell (Phases 3, 4 and 5), with the aim of transferring to the latter a sufficient quantity of motion to continue its ascent even when there is no longer any contact (Phases 6 and 7). The second motor strategy, which is performed at the same time as the first, is the

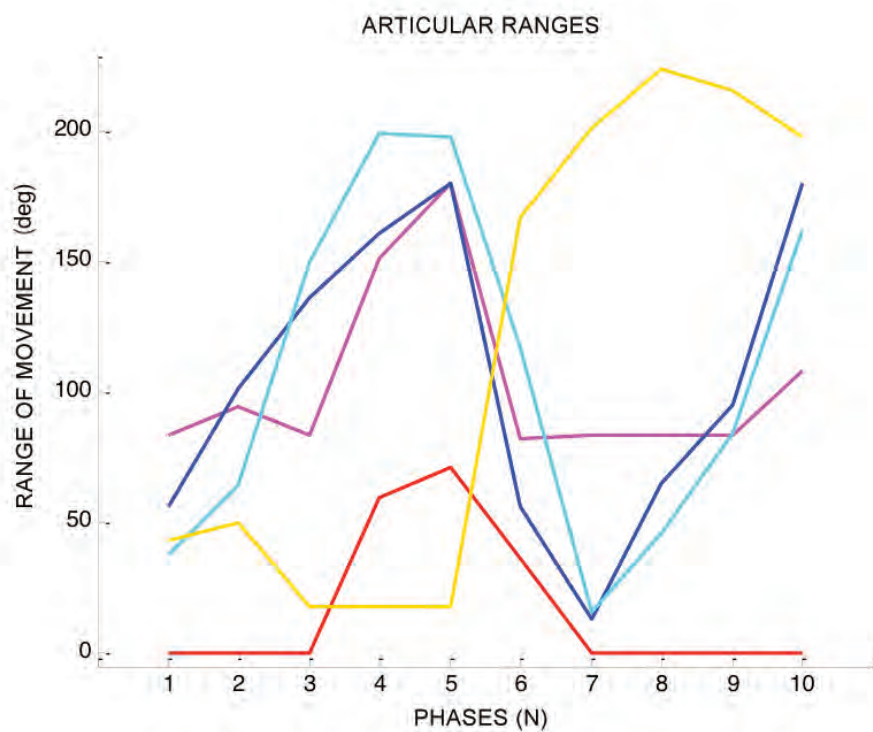


FIGURE NO. 3
ANGULAR RANGES. THE ARTICULAR RANGES (IN DEGREES) ARE ILLUSTRATED FOR EACH OF THE TEN PHASES OF THE SNATCH: SOLE OF THE FOOT IN RELATION TO THE SUPPORT SURFACE WITH VERTEX ON THE METATARSOPHALANGEAL JOINT (IN RED); ANKLE (IN PURPLE); KNEES (IN DARK BLUE); HIPS (IN LIGHT BLUE); SHOULDER (IN ORANGE).

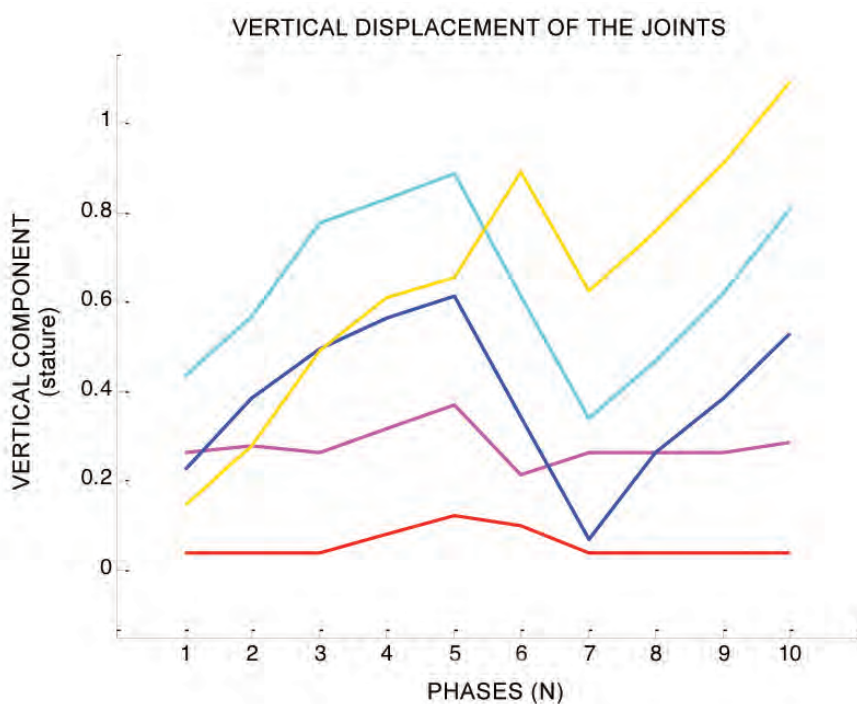


FIGURE NO. 4
VERTICAL DISPLACEMENT OF THE JOINTS. THE TEN PHASES OF THE SNATCH HAVE BEEN CHARACTERISED BY THE VERTICAL COMPONENT OF FIVE JOINTS: ANKLE (IN RED), KNEE (IN PURPLE), HIPS (IN DARK BLUE), SHOULDER (IN LIGHT BLUE), HAND (IN ORANGE). THE HAND'S CENTRE OF MASS INTERSECTS THE MAIN AXIS OF THE BARBELL. THE ORDINATE VALUES ARE EXPRESSED IN MODEL UNITS (FRACTIONS OF HEIGHT OF THE ANTHROPOMORPHIC MODEL).

extension of the lower limbs that takes the barbell to such a height that it exploits the thrust from the pelvis and remains suspended in the air long enough for the athlete to squat with arms outstretched before regaining control. Note how the height reached by the barbell in Phase 5 matches that reached in Phase 7, and therefore the lift of the barbell during Phase 6 is related to the time required for the athlete to completely bend the knees, and the lifting force applied on the barbell, obtained from the jump and the pelvic thrust, is much greater than the reduced speed of the athlete's squat. Taking into account the first five phases of the Snatch, we observe how the athlete moves his/her centre of mass back to compensate the anterior displacement of the barbell and to facilitate the drop of the body during Phase 6.

The interaction between the rotation motor strategy of the torso and the extension of the lower limbs is visible in Figure 3. It is to be noted that this figure, as Figure 4, is realised by using an irregular graphic representation so as to guarantee readability of data. As the x-axis is set out in phases and not in a timeframe, instead of a linear trend, it was necessary to opt for a histogram graph. The broken lines that join the different articular ranges, obtained during the ten phases of the Snatch, show a continuous trend without, however, giving information on the time path of the complete movement. An analysis of the technique's time path of gesture is outside the object of this study, because it is subject to individual

morphological parameters, such as the joint length - in technical terms, such as the ability to manage the interaction between the inertial masses and the load of the barbell and performance-wise, such as the concatenation of the different contributions of strength developed by the muscles activated during the lift. In the description of the articular ranges, Figure 3 illustrates the opening of the hips (the torso rotation strategy) and the knees (extension of the lower limbs strategy) that are formed in a linear and continuous trend (from Phase 1 to Phase 5). A first opening of the ankle angle, keeping the feet on the ground, allows the athlete to pass the barbell over the knees without losing stability (Phase 2) and then (Phases 3, 4 and 5) to start opening the knees and ankles with a simultaneous plantar flexion of the foot up to the moment in which the barbell, connected to the athlete's body, reaches its maximum height (Phase 5). After the barbell breaks away from the athlete's torso, there is a reduction of all the joint angles of the lower body, in correspondence with an increase of the shoulder joint angle (Phases 6 and 7). The barbell is held by fully extended arms with the athlete in a full squat position, and is then lifted with a thrust of the lower limbs, mainly originating from the hips and knees (Phases 8, 9 and 10). Figure 4 shows how the first five phases of the Snatch are characterised by an increase in the vertical positions of all the joints which are not grounded. Phases 6 and 7 show a complete closure of the hip and knee joints without a

drop in the height reached by the barbell in Phase 5.

In this way, the athlete can re-use the thrust of the legs that had been exhausted during the maximum articular extension in Phase 5, to continue the upward path of the barbell until the motor task has been completed. The effects of the pelvic rotation strategy can be seen in the interaction between the centre of mass of the athlete and the barbell described in Figure 5. If in Phases 1 2 and the centre of mass of the athlete withdraws to ensure a vertical movement of the barbell, during Phases 3, 4 and 5 these becomes the centre of rotation of the torso and, due to the thrust of the vertical lower limbs, rises without being moved horizontal. If the athlete manages to get off favouring the gravitational pull, Phase 6 is also characterised by a straight portion of the centre of mass that reverses only in Phase 7, when the feet come back into contact with the ground and bending of the legs must stabilize to create a solid base support able to arrest the fall vertical barbell. The progress of the barbell of Phases 3 and 4 the effect forward displacement of the pelvis, while the lifting height of the barbell Phase 5 highlights the contribution the full extension of the limbs lower. The bell-shaped trajectory that the barbell tends to form in Phases 5, 6 and 7 is due to the circling of the limbs higher realized under the effect of the acceleration vertical etched to barbell in the phases in which the athlete has generated lifting force remaining in support Plantar. In a simulated situation like the one described in

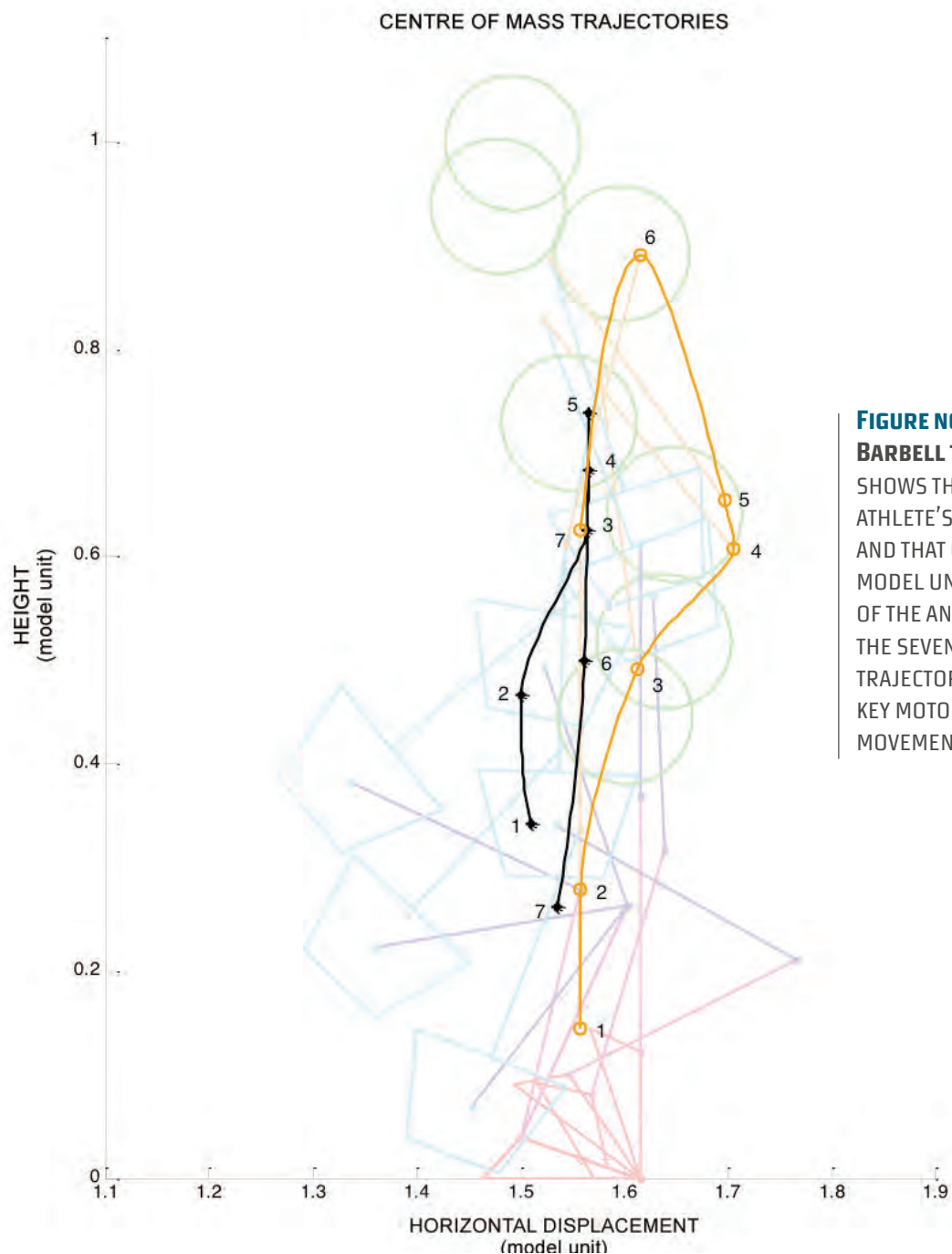


FIGURE NO. 5
BARBELL TRAJECTORIES. THE GRAPH SHOWS THE TRAJECTORIES OF THE ATHLETE'S CENTRE OF MASS (BLACK) AND THAT OF THE BARBELL (ORANGE) IN MODEL UNITS (FRACTIONS OF HEIGHT OF THE ANTHROPOMORPHIC MODEL), IN THE SEVEN PHASES (POINTS 1-7 ON THE TRAJECTORIES) THAT MAKE UP THE FIVE KEY MOTOR ACTIONS OF THE TECHNICAL MOVEMENT OF THE SNATCH.

this representation of graphical Snatch is possible to observe that the lack of translatory movements fixing the horizontal axis vertical movement on a single point of the supporting surface for all seven of the Phases described.

DISCUSSION OF RESULTS

The search for a technique Lifting Weights high level Efficiency is the key objective of all the biomechanical analysis studying the gestures Raise the Olympic sports. Currently the specific literature presents bio-

mechanical models the technique of lifting weights constructed on the basis of direct observations on athletes, introducing errors intersubjectivity movement correct. Many of these models were made with performance ceilings that do not respect the canons of the current elite athletes. A biomechanical model Virtual respecting the morphological characteristics an average athlete can serve to identify strategies motor that realize uniquely the technical act of Alzate Olympic. The uniqueness of the realization an exercise as the strain, for example,

is based on a series of postures key, each of which is capable of achieve one and only one of individual phases that constitute the gesture. This study presented a biomechanical model anthropomorphic designed for the realization the lift of the Olympic Snatch in ten attitudes postural, each of which obtained calculating the only solution mathematics can satisfies the position in the plane Euclidean constraints articular constitute the model. The representation graphical model anthropomorphic allowed to observe the trajectories the centres of mass of the segments anatomical which constitute the body of an athlete, the trends of the amplitudes articular and the vertical displacements of individual body segments. From these parameters it was possible distinguish two motor strategies particular, one dedicated to rotational movement of the torso and one that involves the extension of the lower limbs. Efficient synergy between these two strategies demonstrates how the athlete preserves its vertical axis without moving horizontally and controls, in the two phases of full extension of the legs, the change of direction of the barbell using the weight of his body as a counterweight. Furthermore, the heights of the barbell can reach in the phases of Total extension of the torso and Full squat arms outstretched are dependent on the capabilities athlete to generate force. Finally, the linear trend and continuous amplitude knee joint shows as the technique of double bending of the legs can be limited to the flexion-extension tibial tract ensuring so the realization of power position with a continuous extension of the leg, turning to stretch tibial the task of calling up properties plyometric muscle extensors of the thigh. Although a technical analysis of this type is based on a biomechanical model of the body of an athlete the limits of which are joint anatomical and not neuromeccanci, without considering the muscle forces the individual parts of the body and calculating the sequence of unique postures through the solutions of static problems, its realization allows detect those basic positions that must be present in the technical act Snatch falls outside of all the subjective factors that affect performance.

PRACTICAL APPLICATIONS

The biomechanical model presented anthropomorphic in this study was developed through average values of anthropometric parameters and ergometric of male subjects, but its total integration makes it scalable for any condition subjective. The mathematical approach used can therefore be applied to anthropometry and ergonometry of individual athletes or a group specific athletes, and can help identify postural structures that characterize the phases of the Snatch technique, referring exclusively to anatomical limitations. Eluding conditions athletic of individuals, as imbalances district muscle strength and elongation of the muscle-tendon, is it possible to quantify the criticality of different postures that must be overcome for improve the overall efficiency of technical movements. Collect anthropometric data of an athlete, beginner or expert, and then create a model mathematician of his biomechanics, can help technicians to quantify individual goals of a training program, such as amplitudes reach particular joint and postural certain structures, with the aim of improving the technical efficiency of the Olympic Alzate.



DONATO FORMICOLA
MASTERS DEGREE
IN SPORTS SCIENCE,
TECHNIQUES AND TRAINING.
DR. FORMICOLA

SPECIALISES IN BIOMECHANICAL MODELS TO ASSESS MOTOR AND SPORTS SKILLS BASED ON MOTION CAPTURE SYSTEMS. HE IS CURRENTLY A LECTURER IN MOTOR SCIENCES AT THE TURIN GRADUATE SCHOOL. HE IS A IV LEVEL CONI EUROPEAN COACH, FIPE MASTER OF WEIGHTLIFTING AND MEMBER OF THE NATIONAL FIPE SCIENTIFIC COMMITTEE.

References

1. Derwin BP (1990) SPORTS PERFORMANCE SERIES: The snatch: technical description and periodization program. *Strength & Conditioning Journal* 12 (2):6-15
2. Vorobyev AN (1978) A Textbook on Weightlifting (trans: Brice WJ). International Weightlifting Federation, Budapest, Hungary
3. Medvedev A (1988) Three periods of the snatch and clean jerk. *Strength & Conditioning Journal* 10 (6):33-38
4. Whitehead PN, Schilling BK, Stone MH, Kilgore JL, Chiu LZ (2014) Snatch technique of United States national level weightlifters. *Journal of Strength & Conditioning Research* 28 (3):587-591
5. Bai X-l, Wang H-s, Zhang X-a, Ji W-t, Wei G-f, Wang C-t (2009) Three-dimensional kinematics simulation of snatch in male weight lifter and knee joint movement analysis. *Journal of Clinical Rehabilitative Tissue Engineering Research* 13 (35):6879-6882
6. Stone MH, O'Bryant HS, Williams FE, Johnson RL, Pierce KC (1998) Analysis of Bar Paths During the Snatch in Elite Male Weightlifters. *Strength & Conditioning* August 20 (4):30-38
7. Campos J, Poletaev P, Cuesta A, Pablos C, Carratala V (2006) Kinematical analysis of the snatch in elite male junior weightlifters of different weight categories. *Journal of Strength & Conditioning Research* 20 (4):843-850
8. Szabó AS (2009) Some special biomechanical questions of olympic weightlifting. *International Quarterly of Sport Science* 2 (57-60)
9. Duane Knudson, Morrison C (2002) Qualitative Analysis of Human Movement. 2nd edn. Human Kinetics,
10. Lees A (2002) Technique analysis in sports: a critical review. *Journal of sports sciences* 20 (10):813-828. doi:10.1080/026404102320675657
11. Godfrey A, Conway R, Meagher D, ÓLaighin G (2008) Direct measurement of human movement by accelerometry. *Medical Engineering & Physics* 30 (10):1364-1386. doi:http://dx.doi.org/10.1016/j.medengphy.2008.09.005
12. Moeslund TB, Hilton A, Krüger V (2006) A survey of advances in vision-based human motion capture and analysis. *Computer Vision and Image Understanding* 104 (2-3):90-126. doi:http://dx.doi.org/10.1016/j.cviu.2006.08.002
13. Ho KWL, Williams MD, Wilson CJ, Meehan DL (2011) Using three-dimensional kinematics to identify feedback for the Snatch: a case study. *Journal of Strength & Conditioning Research* 25 (10):2773-2780
14. Schwameder H (2007) Issues and challenges of applied sport biomechanics research. *Journal of Biomechanics* 40, Supplement 2 (0):S14. doi:http://dx.doi.org/10.1016/S0021-9290(07)70013-1
15. Cai Q, Aggarwal JK (1999) Tracking human motion in structured environments using a distributed-camera system. *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 21 (11):1241-1247. doi:10.1109/34.809119; Aggarwal JK, Cai Q (1999) Human Motion Analysis: A Review. *Computer Vision and Image Understanding* 73 (3):428-440. doi:http://dx.doi.org/10.1006/cviu.1998.0744
16. Bai X, Wang H, Zhang Xa, Wenting J, Wang C (2008) Three-dimension kinematics simulation and biomechanics analysis of snatch technique. *Proceedings of 1st Joint International Pre-Olympic Conference of Sports Science & Sports Engineering 1 - Computer Science in Sports:291-296*
17. Winter DA (2009) *Biomechanics and Motor Control of Human Movement*. Wiley
18. Tilley AR, Associates HD (2002) *The Measure of Man and Woman: Human Factors in Design*. vol 1, Wiley
19. Ho LK, Lorenzen C, Wilson CJ, Saunders JE, Williams MD (2014) Reviewing current knowledge in snatch performance and technique: the need for future directions in applied research. *J Strength Cond Res* 28 (2):574-586. doi: 510.1519/JSC.1510b1013e31829c31820bf31828.
20. Liu Y, Chen W (2001) Foot Pressure Study During Pulling Phase of Snatch Lifting. Paper presented at the 19 International Symposium on Biomechanics in Sports, San Francisco, June 26, 2001

DEFINING SPORTS TRAINING. VAIN AMBITION OR NECESSITY?

BY PASQUALE BELLOTTI





I have always thought – from a very young age, when I knew nothing – that it was essential, for a trainer or anyone involved in the world of sporting activity, to be able to provide a complete and thorough definition of sports training. I thought that being unable to do was a serious affair, because it would be similar to a worker, who for 40 years carries out a task or a profession, reaches retirement and does not know exactly what he has been doing all those years. Therefore, defining (placing borders and clarifying what goes within them) is fundamental, it is the first skill a trainer must possess. What does training mean? What exactly is this phenomenon we call training?

In my experience as an instructor I have spent hours on end, days on end and many many words trying to convey the importance of this aspect to students, that first and foremost training in a clear and unequivocal manner. By estab-

lishing, declaring, describing the phenomenon through its distinguishing and essential elements, we provide - in my opinion - a clear, distinct idea of all its aspects which, in addition to characterising, contain the entity of sports training on a conceptual level. Precisely for these reasons, I have always been in search of a definition of sports training that fully explores the factor complexity and expresses the basic and inevitable features, indicating at the same time, how vital it is to broaden our knowledge. I think that such a definition would constitute an authentic guide for daily practise: in other words, a definition is a good starting point for serious training! Whilst mulling over these things, I did as much research as I possibly could, reading and asking around: I don't think that anything escaped me. However I was by no means happy, because the scene that unfolded before me in Italy was far than comforting, as if the trainers

(many of whom considered themselves authors: I have gathered a varied selection of embarrassing documentation by these would-be Italian experts in the field of training, full of mistakes both in terms of language and content. They should be ashamed and poor Dante would turn in his grave), as I was saying, as if the trainers thought about and dealt with a completely different subject.

There was not much input from the international scene either. It was my belief that without this basic explanation (a definition) to put all misinterpretations to rest, it was impossible to really understand anything. Toni Nett's definition in *Der Lauf*, in 1960 made me laugh, quoting from a certain Dr. Hueppe (my research on this character has been fruitless), who affirmed that "training is the organisation of victory through self-discipline". A wonderful way of starting a debate on training without any foundation whatsoever.

In the 1980's, Carlo Vittori made an interesting definition, in my opinion the first destined to go a long way. This was his second merit, his first having been setting up an Italian school for sports training (which unfortunately closed down due to our inability to keep good things up and running, especially when it is someone else's brainchild), which made a great effort in defining sports training. Vittori laid the foundation and then three of us came together on the project: Alessandro Donati and myself, joining Vittori. Very often Donati and I worked on this project by



night and during any free time between meetings on the very subject of training. Dozens of hours spent over single words, a verb or an adverb. At the time it seemed of vital importance. And today I am still of the same opinion. It means laying the foundation stone on which all else is built.

This was the definition. I have called it Definition 1 (and it is a cornerstone in both my professional life and my humane approach), because in this essay there are others that will follow with a progressive number that takes us up to the present day. I have another number ready for tomorrow, but I have not yet the definition. I think that, if I can manage to elaborate another definition, it will be even closer to the truth, that is unattainable for the ignoramuses who talk their heads off at conventions as it is for the handful of real experts whose voices often go unheard.

1

Definition 1: Sports training is a complex pedagogical-educational process put into effect by the systematic organisation of physical exercise, repeated in such quantities and with such intensity so as to produce progressively increasing loads that stimulate the body's overcompensating physiological processes and favour the increase of physical, psychical, technical and tactical processes of the athletes, in order to consolidate and enhance performance in competition.

On the night that this very definition was presented to a group of high level Italian trainers, I had a brainwave that made me not so much refuse this definition, as treat it with some diffidence. I had gone from elation to doubt in a short time. I, however, kept my doubts to myself and took some notes, which I still have. I was not so sure and I didn't want to be a spoilsport, I had great respect for the work in which I had been a big part of. Those few notes complicated my life, for reasons I will soon reveal. I told myself that, if I changed even one word in that definition, the meaning would be understood better, the phenomenon of training would be better identified, broadening the confines, the function, the prerequisites and the destiny. To define training is indeed an ethic fact, a bioethical operation. It is not merely a description of what it contains, of what it is made of, of how it unravels over a brief season or over the entire career of a champion who beats everyone or a non-champion who always beats himself. And, I told myself, it would have indubitably emphasised the various and serious responsibilities of those who should monitor the movement, intended as a resource and a principle of people, from birth to death.

What did I do? I removed "put into effect" and replaced it with "completed". It was like turning on a powerful spotlight. I immediately understood so much more and I was ready to take further steps in defining. And in fact, that is precisely what I did. But that's an-

other story. Definition 2 (let's call it the brainwave definition) was as follows:

2

Definition 2: Sports training is a complex pedagogical-educational process completed by the systematic organisation of physical exercise, repeated in such quantities and with such intensity so as to produce progressively increasing loads that stimulate the body's overcompensating physiological processes and favour the increase of physical, psychical, technical and tactical processes of the athletes, in order to consolidate and enhance performance in competition.

The new verb did not simplify the understanding of the others (actually, when I started to talk about it, years later, I found many people critical, uncertain and irritated precisely for the fact that it required a series of new lines of reasoning): the passage was as follows: in order to be clear and unambiguous, a definition of training must recover (and include) all the motor skills of man and plant its roots in practicing movement from an early age. Training does not begin a process, it follows it through. It lays the foundations of the entire motor activity from an early age with the aim being - note carefully - not sport, but life per se. Only if the basic motor skills are formed (I have often written and spoken about, so I'll be brief here) can training begin. Training is the completion, the crowning, the in-

depth analysis of a process which has been underway for years. Always. Otherwise it would be better not to start at all.

It was easy to be more precise, in a third definition (which we will call Definition 3 here), it came easy to me, it seemed taken for granted, however it made me understand new aspects of the process and invited me to delve deeper into the subject of the motor skills development that is compulsory for life and the sports training that can come about, or not come about, in a person's life. Now I had clearly distinguished between an obligation of society (motor skills development) and a possible choice made by an individual (sport and specialisation).

3

Definition 3: Sports training is a complex pedagogical-educational process, which develops over long periods of time, possibly starting from childhood, and is completed by the systematic organisation of physical exercise, repeated in such quantities and with such intensity so as to produce progressively increasing loads that stimulate the body's biological processes of adjustment, adaptation and overcompensation and favour the increase of physical, psychological, technical and tactical processes of the athletes, in order to reasonably increase, consolidate and enhance performance in competition.

A careful reader will notice the journey made and the recovery of the motor activity that originated in childhood. Training starts in youth and comes to completion when the body is capable of doing so. It therefore begins at quite an early age and over time becomes complete. But isn't this a contradiction? Isn't it absurd to start sports training so young? No, we are off track and it is clear that the problem must be addressed in a different manner because we are speaking of two different phenomena, with different laws, different goals, different purposes and different paths.

So I came up with Definition 4 - a new, more precise and richer definition. In fact, I consider this to be rather more complete.

4

Definition 4: : Sports training is a complex pedagogical-educational process, bioethically grounded and developed over long periods of time, possibly starting from childhood, which is completed by the systematic organisation of physical exercise, repeated in such quantities and with such intensity so as to produce progressively increasing loads that stimulate the body's biological processes of adjustment, adaptation and overcompensation and favour the increase of physical, psychological, technical and tactical processes of the athletes, in order to reasonably increase, consolidate and enhance performance in competition.

I must underline at least the two aspects - the bioethically grounded concept (given the times, it's better to base training on bioethics) and reasonably at the end of the definition, because it implies the acceptance of a calculated risk, never a gamble, and because it takes us to a limit without exceeding it. What is beyond the limit? What do scientists tell us? I remember that in the 80s and 90s they said that man had reached his limits and that there was no margin for improvement. What do they say today, the scientists of years gone by, now that those "insurmountable" limits have actually been trashed many times in a stunning, unbelievable, unimaginable and indignant way?

With definition 5 (we are in 2003 more or less), I wanted to clarify the necessary reference to an "ini-



tial and essential phase of development and physical and psychical initiation". The definitions were getting longer, but they remained clear, actually - it seemed to me - that they were progressively simpler.

5

Definition 5: Sports training is a complex pedagogical-educational process, bioethically grounded and developed over long periods of time, possibly starting from childhood, and which - after an initial and essential phase of development and physical and psychical initiation - is completed by the systematic organisation of physical exercise, repeated in such quantities and with such intensity so as to produce progressively increasing loads that stimulate the body's biological processes of adjustment, adaptation and overcompensation and favour the increase of physical, psychical, technical and tactical processes of the athletes, in order to reasonably increase, consolidate and enhance performance in competition.

Definition 5 came along while I was telling the whole story to students, encouraging them to keep going, to question themselves, to ask, to search, to reflect, to go over concepts again and again. What do you do when you are training? How do you approach the task? Don't you feel like the makers of a creative phenomenon that requires immense skill, that not everyone possesses? Do you understand the importance of your work and your endeavour?

In definition 6, new concepts are added, to try to include what had escaped me in the definition of sports training. A completely different problem (that did not appear in any definition, excluding an entire world) was the relative one, I mention but I do not discuss collective training, team work. Here, the question is: is it possible to train a group? The work done on a single athlete can be done with a group? I will not go into it here, it would take time and space. Perhaps the reader will reflect and will find my vision ridiculous. I would be happy to change my mind about this, but here is definition 6.

6

Definition 6: Sports training is a complex pedagogical-educational process, bioethically grounded and developed over long periods of time, possibly starting from childhood, and which - after an initial and essential phase of development and physical and psychical initiation - is completed by the systematic organisation of physical exercise, repeated in such quantities and with such intensity and density, based on forms and levels of difficulty and with degrees of efficacy so as to produce progressively increasing internal loads that stimulate the body's biological processes of adjustment, adaptation and overcompensation and favour the increase of physical, psychical, technical and tactical processes of the athletes, in order to reasonably increase, consolidate and enhance performance in competition.

One student who had been listening to me became infatuated and took me literally. He did this to make me realise that I had often spoken during lectures about



the necessity to personalise the whole training process and that I had not placed (as was necessary: he told me; and I refer to it here, to pay tribute to young people, from whom I have learnt so much over the years) emphasis on this aspect (that I declared as being vital) in the definition. Therefore, this aspect was then included and today stands out in two points (at the beginning and at the end) of definition 7.

7

Definition 7: Sports training is a complex pedagogical-educational process, personalised and bioethically grounded, which develops over long periods of time, possibly starting from childhood, and which - after an initial and essential phase of development and physical and psychological initiation - is completed by the systematic organisation of physical exercise, repeated in such quantities and with such intensity and density, based on forms and levels of difficulty and with degrees of efficacy so as to produce progressively increasing internal loads that stimulate the body's biological processes of adjustment, adaptation and overcompensation and favour the increase of physical, psychological, technical and tactical processes of each athlete, in order to reasonably increase, consolidate.

Sometimes I count the words, to tell students that by increasing the number of words, you increase the geometric progression of the possibility to capture the essence of training. Today, I define training with a number of words which is approximately 4 times more than when I started out. And naturally, I have made many other considerations, that bring me to definition 8, where - instead - I place the emphasis on the necessity to revise the concepts of adaptation and supercompensation (I strongly fear that these phenomena do not exist and I'm sorry for all those who feel orphans of adaptation and of Matveev) and start to underline what really happens when you train. The muscles respond with an authentic transformation. I will discuss it at length elsewhere. Here is definition 8 with its small, yet at the same time enormous, modifications!

8

Definition 8: Sports training is a complex pedagogical-educational process, personalised and bioethically grounded, which develops over long periods of time, possibly starting from childhood, and which - after an initial and essential phase of development and physical and psychological initiation - is completed by the systematic organisation of physical exercise, repeated in such quantities and with such intensity and density, based on forms and levels of difficulty and with degrees of efficacy so as to produce progressively increasing internal loads, always diversified but progressively incremented, that stimulate the body's biological processes of adjustment, adaptation and real structural transformation and favour the increase of physical, psychological, technical and tactical skills of each athlete, in order to reasonably increase, consolidate and enhance performance in competition.



I read over my old and new definitions and I remember the journey, the path that over decades has taken me here, the thousands of students who I have met over the years. I realise that in the final definition I have taken into account the 10 crucial aspects that a trainer must be aware of. I will try to list them, to conclude this short, fragmented history of an Italian definition of sports training. I say short, but I do not wish to make light of it, because in reality it contains the power of thoughts that reaches for the light, that wants to understand and move forward. This is a trainer's life.

A trainer must ensure that in his definition of training there is:

- a wide-ranging and well-structured process;
- a phenomenon that comes about in its own time (which cannot be influenced);
- an educational approach (with its various aspects);

- complexity (constitutive and interpretive). The same complexity as indicated in the "science of complexity";
- a connection to the motor skills history of the individual, which means understanding the legacy, the personality, the vital action of the environment, the individual responses of each athlete, the consequent indulging the aptitudes and individualisation of the approach;
- a practical approach that uses physical exercise to perfect the movement;
- trial and error to measure the physical exercise and its effects;
- the practical aspect (even if of uncertain interpretation) of the so-called parameters of the workload;
- the professional code of conduct of the phenomenon in question;
- connecting the limits and training ability of the individual.

I conclude by reminding that saying more does not necessarily mean complicating things, very often the result is a progressive simplification. All journeys have a starting point, a path to follow and a destination.

The same applies to training, and to its definition, you try to define it, you pursue it, you reach it, but you are never entirely satisfied with it.



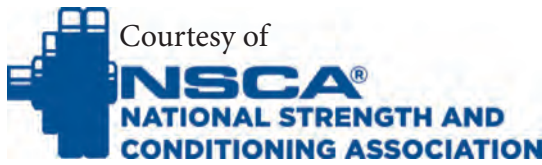
PASQUALE BELLOTTI

(PASQUALE.BELLOTTI@GMAIL.COM; PASQUALE.BELLOTTI@UNITO.IT), MEDICAL PHYSICIAN AND EXPERT IN MOVEMENT AND TRAINING, HE CURRENTLY LECTURES IN SPORTS ETHICS AND BIOETHICS AT THE TURIN GRADUATE SCHOOL.

HE IS THE AUTHOR OF MANY BOOKS AND ARTICLES.

HE IS ALSO PRESIDENT OF AMÀCA ONLUS, AN ASSOCIATION CONCERNED WITH NUMEROUS AID AND SUPPORT PROJECTS IN AFRICA (AND IN ITALY): WWW.AMACAONLUS.ORG.





THREE- DIMENSIONAL KINEMATIC ANALYSIS OF THE SNATCH TECHNIQUE FOR LIFTING DIFFERENT BARBELL WEIGHTS

**BY HADI GÖKHAN; AKKUŞ HASAN;
HARBILI ERBİL**





INTRODUCTION

The aim of Olympic weightlifting competitions is always to lift higher weights successfully. Lifting higher weights in snatch lifts requires a multifactor performance including technique, power, explosive strength, and flexibility ^(2,5,9,10,15-18,22). When the snatch technique is analyzed as a whole, it can be seen that the synchronization and perfection of the system consisting of the body and barbell is the key to a successful lift ^(2,5). The performance pattern of the snatch technique requires the barbell to be lifted from the floor to a straight-arm overhead position in one continuous movement ^(2,5,15-18). The first 5 phases (first pull, transition, second pull, turnover under the barbell, and catch phase) are considered to be the most important phases of the snatch lifts, and increasing the barbell weight has an important effect on all biomechanical factors during these phases ⁽¹⁵⁻¹⁸⁾. Determining the exact effects of the increased barbell weight on the barbell and body kinematics might help to understand the effective technical factors and the biomechanics of successful lifts of higher weights.

A great majority of the published studies on the biomechanics of weightlifting have usually focused on the kinematics of the barbell and body segments of elite weightlifters who participated in national ^(1,7,8,10,17,19,24,25) and international competitions ^(3,4,6,9) and world championships ⁽¹²⁾. The common aim of those studies was to determine the biomechanical differences between the different phases and to evaluate the technical components of snatch lifts. These studies reported that the mechanical work during the first pull was higher than that

of the second pull and that the vertical velocity of the barbell reached maximum levels during the second pull ⁽¹⁷⁾. On the other hand, it was expressed in a large number of studies that mechanical power was higher in the second pull compared with that in the first pull ^(2,5,9,12). The mechanical work and power outputs showed that the first pull was characterized by force, whereas the second pull was largely of power nature ⁽¹⁸⁾. Therefore, the higher power output seen during the second pull was reported to be a result of the combination of a greater velocity of the barbell and a shorter duration during the second pull ⁽¹³⁾. Isaka et al. ⁽²¹⁾ stated that optimizing the barbell height after the second pull and minimizing the decrease after the maximum height of the barbell were effective factors for a successful lift.

Similar results were reported in a study by Burdett ⁽³⁾ showing that lifting the barbell to the lowest possible height by talented weightlifters created a certain advantage, and minimizing the decrease of the barbell height during the turnover under the barbell resulted in savings at total work. The horizontal displacement pattern of the barbell during the lift is also important ⁽²⁵⁾ in that the horizontal movement during the first pull and transition phase allows the storage of elastic energy into the extensor muscles of the knees during the flexion of the knees and its use during the following concentric contraction of the knees, resulting in an explosive power output during the second pull ⁽¹⁶⁾. The horizontal displacement of the barbell is a toward-away-toward pattern: The barbell is pulled toward the body during the first pull and the transition phase, and, during the second pull, it

moves away from the lifter's body, and finally, it drops toward the body from the maximum height ^(16,20). Stone et al. ⁽²⁵⁾ reported that the barbell was displaced horizontally by 10–20 cm during the snatch lifts by elite weightlifters. However, these anterior-posterior displacements of the barbell should be small to avoid unnecessary energy consumption ⁽¹⁶⁾.

There were relatively a limited number of studies available in literature examining the effects of the increased barbell weight on the biomechanics of the barbell and body ⁽¹²⁾. In their study, Garhammer ⁽¹²⁾ found that a small decrease in weight, about 5%, could often increase power output substantially because of a considerably greater movement speed and shorter time interval for the completion of the lift. In the light of these findings, the kinematic analysis of the body and barbell during the snatch technique may provide important information to increase performance by determining the mechanical factors that are effective in lifting higher weights. Increasing the barbell weight results in a decrease in power output, vertical velocity, and maximum height of the barbell. A detailed analysis of the kinematics of the increased barbell weight may provide useful information for coaches and weightlifters, who always aim to lift higher weights.

The purpose of this study was to investigate the effects of increased barbell weights on the barbell and body kinematics of elite weightlifters at different percentages (60, 80, and 100%) of 1 repetition maximum (1RM) in the snatch lifts and to evaluate the biomechanics of the snatch technique.

METHODS

Experimental Approach to the Problem

To determine the changes that the increased barbell weight caused on the body and barbell kinematics, the kinematic data obtained from the subjects were studied by 3-dimensional biomechanical analysis. The reason for the preference for the 3-dimensional analysis was that other studies reported that 2-dimensional analysis adversely affected the reliability of angular kinematics (2).

Subjects

This study was performed on 7 elite male weightlifters (Table 1) at different categories of the Turkish weightlifting national team during their preparation camp for the 2007 European Championship. The subjects were medal-winning weightlifters in previous international competitions. All the subjects provided written informed consent approved by the local ethics committee of the Selcuk University.

Procedures

To determine the 3-dimensional kinematic data of the barbell and body segments during the snatch tech-



FIGURE NO. 1

PLACEMENT POINTS OF REFLECTIVE MARKERS ON THE BODY AND BARBELL.

nique and to digitize the data provided with higher precision, a set of 14 reflective markers were stamped on tiptoe, ankle, knee, hip, shoulder, elbow, and wrist on both sides of the body and 2 markers on the chin and forehead. The other 2 markers were placed at the right and left ends of the barbell. The reflective markers on the body and the barbell were digitized by using an Ariel Performance Analysis System (San Diego, CA, USA). To obtain a clearer vision of the markers, an illumination source of 500 W of power was placed on each camera (Figure 1). Four digital cameras (Sony DCR-TR-

V18E, Tokyo, Japan) capturing 50 fields per second with approximately 3 minutes of rest between lifts were positioned on the diagonal level of the platform at a distance of 7 m away from the platform forming an angle of about 45° with the sagittal plane of the weightlifter. Cameras 1 and 2 were placed to view the right side of the barbell and the body, and cameras 3 and 4 recorded the left side. There was an angle of about 90° between the optical axes (Figure 2).

The cameras were synchronized using the lift-off of the barbell, and 3-dimensional coordinates were constructed

SUBJECTS	AGE (Y)	BODY MASS (KG)	HEIGHT (CM)	CATEGORY (KG)	BARBELL MASS (KG)			WR*	WR† (%)
					60%1RM	80%1RM	100%1RM		
GA	27	58	150	56	66	88	110	143	78
SA	31	60	162	56	72	96	120	138	87
EB	20	64	156	62	72	96	120	153	78
YA	29	70	163	69	84	112	140	165	85
TS	22	81	171	77	78	104	130	174	75
HY	25	100	175	94	96	128	160	188	85
BS	32	107	176	105	96	128	160	200	80

*WORLD RECORD. †THE RATIO BETWEEN 100%1RM AND WR.

TABLE NO. 1

CHARACTERISTICS OF THE SUBJECTS AND THE BARBELL.

using the direct linear transformation method. To calibrate the viewing area in 3 dimensions, a rectangular cube with 12 control points of 250-cm length, 100-cm breadth, and 200-cm height was used. The video recordings were taken at the fourth week of the 4-month preparation camp before the 2007 European Championship. Only successful lifts of each weightlifter at 60% (60%1RM), 80% (80%1RM), and 100% of 1RM (100%1RM) were recorded. A low-pass digital filter with a cutoff frequency of 4 Hz was used for the smoothing of the raw data (^{15,16,18}).

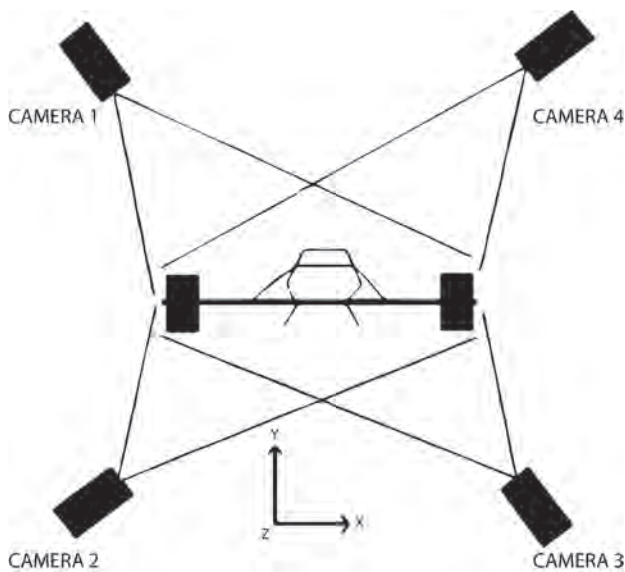


FIGURE NO. 2

TOP VIEW OF THE POSITIONS OF THE CAMERAS RECORDING SNATCH LIFTS.

The snatch technique was divided into 5 phases according to the changes in the knee angle and the vertical position of the barbell as the first pull, the transition, the second pull, the turnover under the barbell, and the catch phase (Figure 3).

The linear kinematics of the body and barbell and the angular displacements of the knee joint were calculated. The vertical work done on the barbell during the first pull and the second

pull was calculated from the change in mechanical energy, which is defined as the sum of kinetic and potential energy (¹¹). The work done in elevating the center of gravity (CG) of the body was calculated from potential energy, and the horizontal work done on the barbell was calculated by multiplying the horizontal displacement of the barbell by the horizontal force, obtained from the multiplication of horizontal acceleration of the barbell by its mass. The power output of weightlifters during the first and second pulls was calculated by dividing the work of each phase by its duration. Technical efficiency was calculated by dividing the vertical work by the total work on the barbell. All of the work, power values, and technical efficiency were calculated according to the methodology described by Garhammer (¹¹).

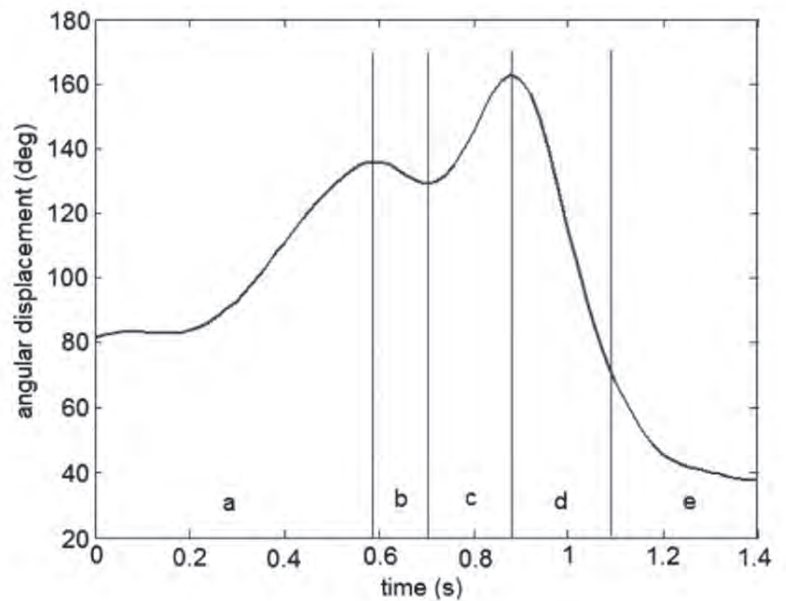


FIGURE NO. 3

PHASES OF THE SNATCH TECHNIQUE BASED ON THE ANGULAR DISPLACEMENT AT KNEE ANGLE. (A) THE FIRST PULL, (B) THE TRANSITION, (C) THE SECOND PULL, (D) THE TURNOVER UNDER THE BARBELL, AND (E) THE CATCH.

Statistical Analyses

Multivariate test Wilks' lambda (λ) and post hoc test with Bonferroni correction were used for the statistical analysis of the linear kinematics and energetics of the barbell. Normality of data was verified by the Kolmogorov-Smirnov test. The level of statistical significance was set at $p \leq 0.05$.

Results

No significant differences were found between the durations of the phases, except for the first pull (Table 2).

It was indicated that there were significant differences between the maximum height of the barbell during 60%1RM, 80%1RM, and 100%1RM snatch lifts (Figure 4) and between the maximum vertical velocity of the barbell (Figure 5). The maximum height and vertical velocity of the barbell decreased significantly during 60%1RM, 80%1RM, and 100%1RM snatch lifts, respectively. Significant differences were also found in the maximum ver-

	MEAN ± SD			WILKS' LAMBDA
	60%1RM	80%1RM	100%1RM	
FIRST PULL (s)	0.42 ± 0.06	0.40 ± 0.03‡	0.46 ± 0.04	0.149K
TRANSITION (s)	0.10 ± 0.01	0.11 ± 0.01	0.13 ± 0.03	0.591
SECOND PULL (s)	0.14 ± 0.03	0.13 ± 0.01	0.12 ± 0.01	0.524
TURNOVER UNDER THE BARBELL (s)	0.24 ± 0.03	0.24 ± 0.03	0.23 ± 0.02	0.880

*1RM = 1 REPETITION MAXIMUM.
 †SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 80%1RM.
 ‡SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 100%1RM.
 §SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 60%1RM.
 KP<0.05.

TABLE NO. 2
 DURATION (SECONDS) OF THE PHASES IN SNATCH LIFTS.*

tical displacement and vertical velocity of CG during the turnover under the barbell. Another significant difference was observed in the drop distance of the barbell from maximum height (Table 3).

It was found that there were significant differences between the percentages of 1RM in vertical work done during the first pull and in the total vertical work. The vertical work in the first pull and the total vertical work were significantly greater at 100%1RM, 80%1RM, and 60%1RM snatch lifts, respectively. Another significant difference was found between 80%1RM and 100%1RM in the total vertical work done in elevating CG during the lifts. There was also a significant difference between the vertical work values of CG in the second pull. In addition, the technical efficiency value was found to be significantly greater at 100%1RM than at 60%1RM. However, no significant differences were found between the percentages of 1RM in the total horizontal work or the vertical or horizontal work in the second pull (Table 4).

It was found that there were significant differences between the percentages of 1RM in the vertical power of both the first and the second pulls. The total vertical power and the total horizontal power values of 60%1RM, 80%1RM, and 100%1RM were also significantly different. Although the multivariate test showed no significant differences between the values of the horizontal power in the second pull ($\lambda = 0.304$; $p = 0.051$), the Bonferroni test showed that the horizontal power in the second pull for 80%1RM was significantly higher than that of 100%1RM ($p < 0.05$). Another significant difference was observed in the total vertical power values of CG. On the other

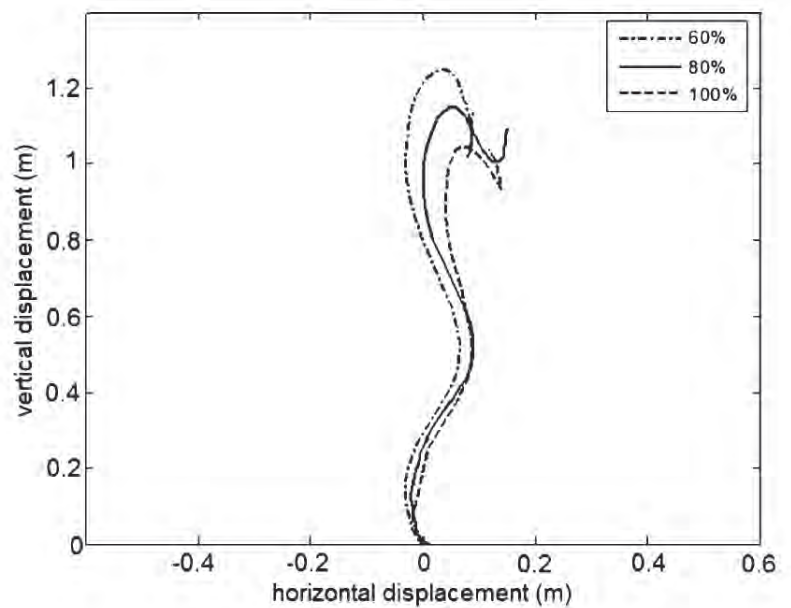


FIGURE NO. 4
 TRAJECTORIES OF THE BARBELL IN THE SNATCH LIFTS OF TS: FROM LIFT-OFF TO THE CATCH PHASE.

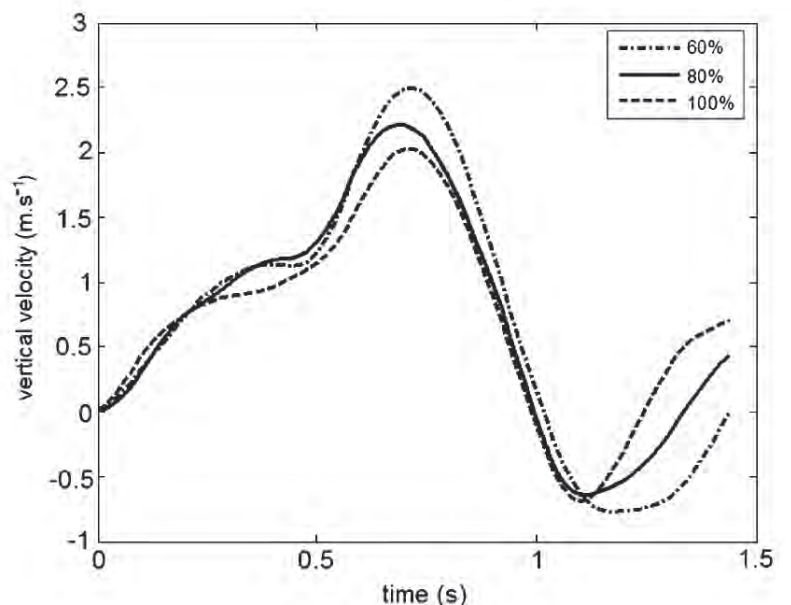


FIGURE NO. 5
 THE LINEAR VERTICAL VELOCITY OF THE BARBELL IN THE SNATCH LIFTS OF TS: FROM LIFT-OFF TO THE CATCH PHASE.

	MEAN ± SD			WILKS' LAMBDA
	60%1RM	80%1RM	100%1RM	
MAXIMUM HEIGHT OF THE BARBELL (M)	1.38 ± 0.09†	1.29 ± 0.08‡	1.18 ± 0.09§	0.027K
MAXIMUM VERTICAL DISPLACEMENT OF CG (M)	0.45 ± 0.04	0.44 ± 0.03	0.43 ± 0.03§	0.118K
MAXIMUM VERTICAL VELOCITY OF THE BARBELL (M·S ⁻¹)	2.30 ± 0.18†	2.02 ± 0.18‡	1.79 ± 0.17§	0.030K
VERTICAL VELOCITY OF CG DURING THE TURNOVER UNDER THE BARBELL (M·S ⁻¹)	21.49 ± 0.16†	21.73 ± 0.14‡	21.97 ± 0.13§	0.077K
DROP DISTANCE OF THE BARBELL (M)	0.24 ± 0.07†	0.16 ± 0.04	0.13 ± 0.03§	0.107K

*1RM = 1 REPETITION MAXIMUM.

†SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 80%1RM.

‡SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 100%1RM.

§SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 60%1RM. KP<0.05.

TABLE NO. 3

KINEMATICS OF THE BARBELL AND CG DURING SNATCH LIFTS.*

hand, there was no significant difference between the vertical power values of CG during the second pull ($\lambda = 0.326$; $p = 0.061$); nevertheless, as far as the results obtained by Bonferroni test are concerned, the vertical power of CG in the second pull of 100%1RM was significantly lower than that of 60%1RM ($p < 0.05$). It was also found that there were no significant differences between the absolute total power values ($\lambda = 0.345$; $p = 0.070$), but the Bonferroni test results showed that the absolute total power of 60%1RM was significantly higher

than that of 80%1RM ($p < 0.05$). As for the relative total power values, however, no significant difference was observed. On the other hand, in the second pull, significant differences were found between the absolute total power values and between the relative total power values of the different percentages of 1RM (Table 5). The analysis of linear vertical acceleration during snatch lifts, an indicator of the magnitude of the force applied on the barbell, revealed 2 peak acceleration values during the first pull of 60%1RM, whereas only 1

peak was seen during the first pull of the other 2 lifts. When the transition phases of the 3 lifts were investigated, it was found that the acceleration of the barbell decreased sharply in 60%1RM snatch lift, whereas in the other 2 lifts, it decreased relatively mildly as the weight of the barbell was increased. It was also observed that the barbell was accelerated positively again in vertical direction during the second pull, 100%1RM being the highest and 80%1RM the lowest. Another finding was that the barbell was accelerated negatively during the

	MEAN ± SD			WILKS' LAMBDA
	60%1RM	80%1RM	100%1RM	
VERTICAL WORK IN THE FIRST PULL (J)	389.00 ± 127.98†	503.00 ± 154.34‡	630.85 ± 180.72§	0.049K
VERTICAL WORK IN THE SECOND PULL (J)	446.42 ± 78.02	467.00 ± 84.26	511.14 ± 97.72	0.529
TOTAL VERTICAL WORK (J)	835.42 ± 151.13†	1,014.28 ± 182.93‡	1,142.14 ± 217.33§	0.054K
TOTAL HORIZONTAL WORK (J)	50.71 ± 26.71	55.28 ± 40.47	39.28 ± 32.04	0.354
HORIZONTAL WORK IN THE SECOND PULL (J)	38.14 ± 21.65	44.00 ± 33.11	22.85 ± 18.25	0.344
TOTAL VERTICAL WORK OF CG (J)	338.85 ± 119.73	337.85 ± 109.13‡	326.14 ± 104.44	0.256
VERTICAL WORK OF CG IN THE SECOND PULL (J)	140.42 ± 36.60	132.00 ± 41.88	108.85 ± 25.39§	0.209
EFFICIENCY (%)	94.57 ± 1.98	95.28 ± 2.81	97.00 ± 2.00§	0.161K

*CG = CENTER OF GRAVITY; EFFICIENCY = VERTICAL WORK/TOTAL WORK ON BARBELL; 1RM = 1 REPETITION MAXIMUM.

†SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 80%1RM.

‡SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 100%1RM.

§SIGNIFICANT DIFFERENCE AT THE P<0.05 LEVEL IN 60%1RM.

KP<0.05.

TABLE NO. 4

WORK DONE BY CG, HORIZONTAL AND VERTICAL WORK DONE ON THE BARBELL DURING SNATCH LIFTS.*

	MEAN ± SD			WILKS' LAMBDA
	60%1RM	80%1RM	100%1RM	
VERTICAL POWER IN THE FIRST PULL (W)	817.71 ± 239.49†	1,008.42 ± 231.76	1,081.28 ± 199.27‡	0.115K
VERTICAL POWER IN THE SECOND PULL (W)	2,026.71 ± 443.31	2,309.00 ± 462.55	2,595.28 ± 569.45‡	0.229K
TOTAL VERTICAL POWER (W)	1,174.28 ± 231.36†	1,413.85 ± 239.20	1,467.28 ± 241.09‡	0.131K
TOTAL HORIZONTAL POWER (W)	71.14 ± 35.88	76.42 ± 54.79§	48.71 ± 40.40	0.204K
HORIZONTAL POWER IN THE SECOND PULL (W)	170.42 ± 89.89	200.57 ± 155.84§	126.28 ± 118.70	0.304[
TOTAL VERTICAL POWER OF CG (W)	477.14 ± 182.15	469.14 ± 141.89§	417.28 ± 119.90	0.175K
VERTICAL POWER OF CG IN THE SECOND PULL (W)	647.57 ± 239.29	598.71 ± 213.94	558.28 ± 172.81‡	0.326#
ABSOLUTE TOTAL POWER (W)	1,722.57 ± 441.44†	1,959.28 ± 422.40	1,933.42 ± 392.29	0.345**
RELATIVE TOTAL POWER (W·KG ⁻¹)	22.28 ± 2.13	25.85 ± 3.07	25.28 ± 2.98	0.446
ABSOLUTE TOTAL POWER IN THE SECOND PULL (W)	2,844.57 ± 727.61†	3,108.28 ± 804.50	3,279.85 ± 849.77‡	0.262K
RELATIVE TOTAL POWER IN THE SECOND PULL (W·KG ⁻¹)	37.28 ± 4.34	40.28 ± 4.88	42.71 ± 3.03‡	0.287K

*1RM = 1 REPETITION MAXIMUM.
 †SIGNIFICANT DIFFERENCE AT THE P < 0.05 LEVEL IN 80%1RM.
 ‡SIGNIFICANT DIFFERENCE AT THE P < 0.05 LEVEL IN 60%1RM.
 §SIGNIFICANT DIFFERENCE AT THE P < 0.05 LEVEL IN 100%1RM.
 KP, 0.05; [P = 0.051; #P = 0.061; **P = 0.070.

TABLE NO. 5
 POWER OUTPUT DURING SNATCH LIFTS.*

catch phase and the magnitude of acceleration of the barbell that started to fall from the maximum height was higher at 60%1RM when compared with 80%1RM or 100%1RM (Figure 6).

DISCUSSION

The most distinctive effect of the increased barbell weight in snatch lifts in this study was the decrease in the velocity of the barbell and the vertical displacement of the barbell and CG and the increase in the vertical velocity of CG during the turnover under the barbell. It was reported in the studies of Garhammer (9,11,14) that when the barbell weight was increased during competition, maximum vertical displacement values of the barbell were decreased. In addition, it was found in one study (12) that maximum vertical displacement of the barbell during snatch lifts of elite weightlifters was 1.25 m, although this value was 1.15 m in another study carried out by the same authors (15). In this study, the maximum vertical displacement of the barbell at 100%1RM was found to be 1.18 m. The main reason for the inconsistent results found by different researchers about the maximum height of the barbell could be the physical differences of the weightlifters, including the differences in their height.

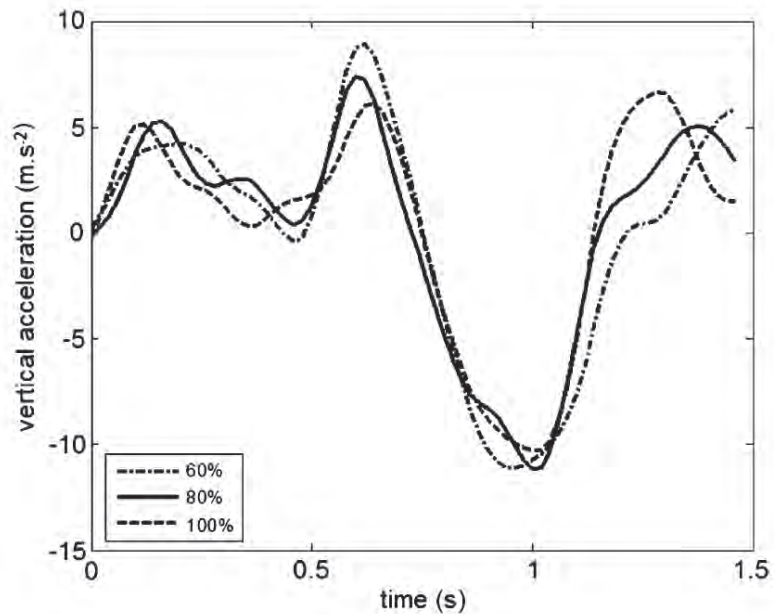


FIGURE NO. 6
 THE LINEAR VERTICAL ACCELERATION OF THE BARBELL IN THE SNATCH LIFTS OF TS: FROM LIFT-OFF TO THE CATCH PHASE.

The velocity-time relationship of the barbell during the snatch lift—especially the maximum vertical velocity of the barbell—is an important point for both coaches and athletes (21). Baumann et al. (2) reported 2 types of velocity curves for the snatch lift of elite weightlifters: The first was with



2 maximum peaks in the vertical velocity during the pull, and the second was with 1 maximum peak. In this study, a slight decrease was observed in vertical velocity during the transition phase in successful lifts, suggesting a curve with almost 2 peaks. Although 1 maximum peak in the vertical linear velocity of the barbell during the pull was reported to be characteristic of better weightlifters, successful lifts by elite weightlifters with 2 maximum peaks were also reported ⁽²⁾. The deceleration of the barbell during the transition phase were characterized by fatigue or higher percentages of their maximum velocities at the end of the first pull and might not cause any notable decrement in performance as long as the loss of the barbell's linear vertical velocity is a small percentage of maximum linear vertical velocity ⁽¹⁸⁾.

Although the maximum vertical velocity of the barbell increased in parallel to the increase of body weight in categories ⁽²⁾, it was observed to decrease in 1RM in general ^(9,10). Therefore, it might be said that increasing the barbell weight is a factor affecting the vertical velocity of the barbell directly. Isaka et al. ⁽²¹⁾ reported similar results

to those of this study regarding the horizontal and vertical displacement of the barbell. Small differences were seen among the values resulted from the physical and technical characteristics of the athletes. The study conducted by Hoover et al. ⁽²⁰⁾ on women weightlifters, and others, support the finding of this study that the maximum vertical velocity of the barbell decreased as the weight of the barbell was increased.

When the body and the barbell are evaluated together as a system, the height and vertical velocity of the barbell decrease as the barbell weight increases, during which the kinematics of the body that constitute the system also change. The most significant indication of this change is the vertical velocity of CG during the turnover under the barbell. When the kinematic characteristics of the system were investigated, it was observed that the full extension of the body was realized at the end of the second pull. At this moment, the CG reached the maximum height and the barbell reached its maximum velocity ⁽²⁾. After this moment, the turnover under the barbell started as the se-

cond pull phase ended. Although the barbell continued its upward motion during the turnover under the barbell, the turnover under the barbell was realized in the direction of CG. The decrease observed at the height of the barbell and at its maximum vertical linear velocity during snatch lifts increased the velocity of the turnover under the barbell of the body and decreased the duration of the turnover under the barbell (Table 3). The most important advantage of the increase in the vertical linear velocity of CG during the turnover under the barbell was the decrease in the drop distance of the barbell; technically, moving faster during the turnover under the barbell resulted in an easier control of the barbell weight, namely, catching the barbell.

The most notable effect of the increase in the barbell weight was that, although it resulted in an increase in the vertical work done during the first pull, it did not produce a similar result in the second pull (Table 4). The increase in the barbell weight also led to an increase in total work values, similarly to those of the first pull. The reason for the increase in the vertical work

and total work values in parallel to the increase in the barbell weight during the first pull might be the longer time period needed to overcome the inertia of the barbell and the relatively decreased vertical velocity⁽¹⁸⁾.

Gourgoulis et al.^(15,18) reported that the work values of the second pull had an average 409 J value, whereas Gourgoulis et al.⁽¹⁷⁾ found that this value was 388 J. The value obtained in our study was 511 J for 80%1RM and 100%1RM. The biggest reason for the difference between the result obtained in our study and those reported in previous studies might be that Gourgoulis et al.^(15,17) did not include the work done by CG in the work calculations, which, therefore, led to lower values in the total work. The second pull work values found in the study of Harbili and Aritan⁽¹⁹⁾ and those of this study, both of which included weightlifters with similar physical characteristics who lifted similar weights, were similar to each other.

It was emphasized that in addition to the vertical movement of the barbell, the horizontal movement was also an important factor in performing the snatch technique⁽²³⁾ because the horizontal displacement of the barbell during snatch lift caused an additional acceleration and work during the lift⁽²⁾. In this study, it was observed that the horizontal work values between the different percentages of the lifts were similar to each other because there was no statistically significant difference between the total horizontal work values. However, technical efficiency is a parameter that supports the importance of the decrease in the horizontal work. Therefore, it was seen that technical efficiency, which showed the effect

of increased barbell weight on the barbell kinematics for snatch lifts, was higher at 100%1RM when compared with 60%1RM and 80%1RM. The values found demonstrated that to make a more efficient lift, athletes presumably increased the vertical work done on the barbell and decreased the horizontal displacement of the barbell.

Garhammer⁽¹¹⁾ used the change of mechanical energy, which expressed the total of potential and kinetic energy, to calculate the work done and expressed that at the end of the second pull, CG reached the maximum point in the vertical direction and that at this moment, the kinetic energy of CG was negligible because its velocity was close to zero. Therefore, he proposed the use of potential energy to calculate only the work done by CG in the vertical axis. It was found in this study that as the weight of the barbell increased, there were decreases in the vertical work of CG in the second pull and in the total vertical work (Table 4). The decrease in the vertical work done by CG was directly related to the drop observed in the height of CG, similarly to the decrease observed in the vertical kinematics of the barbell. However, the increase in the work done on the barbell and the decrease in the work done by CG was in accord. The analysis of the decreasing vertical displacement of the barbell and the change in mechanical energy because of velocity indicated that the only factor that supported the increase in the work done on the barbell was the mass of the barbell. The most important variable here was the contribution of the kinetic energy of the barbell to the vertical work done on the barbell. These findings suggested that weightlifters applied more force

to the barbell in the vertical direction for a successful lift, and the decrease in the horizontal work done on the barbell supported this conclusion.

The pull refers to the initial part of the lift during which the barbell is displaced from the floor to approximately waist height⁽⁵⁾. In a previous study, biomechanical analyses were performed by dividing the pull stage into 3 phases^(2,5,7): The first pull, the transition, and the second pull. The pull, with respect to angular displacement at the knee joint, consists of 2 stages of extension, separated by a period of flexion, known as the double knee bend⁽⁵⁾. This knee flexion is used to realign the lifter, relative to the barbell, and is referred to as the second knee bend⁽⁵⁾. These angular changes in the movement structure of the knee joints made considerable contributions to defining this second pull as the power phase in that these changes transfer the elastic energy stored in knee extensor muscles into the second pull after the knee flexion during transition phase, which was indicative of the biomechanical importance of the double knee bend^(2,17). In addition, during the first pull, the changes in the barbell's kinetic and potential energy were greater, and the lifters had to produce considerable work over a long period to overcome the inertia of the barbell⁽¹⁸⁾. In this study, it was found that as the barbell weight increased, the duration of the first pull extended. This finding supported the result reported by Gourgoulis et al.⁽¹⁷⁾ that the first pull was forceful in nature, whereas the second pull was characterized by power.

According to Garhammer⁽¹²⁾, even a small decrease of about 5% in the barbell weight led to an increase in the movement velocity, which might

increase the power output substantially as a result. It was found in the same study that as the barbell weight increased, power outputs during the first and second pulls decreased. Therefore, the findings of Garhammer⁽¹²⁾ seemed to be inconsistent with the significant increase observed in the first and second pull power values of the different percentages of 1RM in this study. This difference between the 2 studies might have resulted from the fact that unlike the greater difference between the percentages of 1RM in this study, the percentages of 1RM in the study of Garhammer⁽¹²⁾ were performed with barbell weights close to 1RM (92.7, 97.6, and 100%). This closeness in the percentages of 1RM probably forced the limits of the weightlifters' performance.

The mean power output value during the second pull was reported as 2,506 W in a study performed by Gourgoulis et al.⁽¹²⁾ The average value found in our study, however, was 3,279 W. The reason for this difference was probably because Gourgoulis et al.⁽¹²⁾ calculated only the vertical power during the second pull. It was reported in another study that as the body weight increased, so did their second pull power values; as the bar weight was increased, the duration of the lifts extended, and the average vertical velocity, maximum bar weight, and power outputs decreased⁽⁹⁾.

As the barbell weight was increased, the vertical and horizontal kinematics of the body and barbell decreased during the first and second pulls in this study. The decrease in the maximum height and vertical velocity of the barbell observed during the total pull was found to be characterized by

the barbell's decreased and the body's increased kinematics during the turnover under the barbell. With the effect of the increased barbell weight, the values of the work done and power output increased during the first pull, but during the second pull, power output increased, whereas the work done remained unchanged.

PRACTICAL APPLICATIONS

The rationale for this study was that analyzing the effects of increased barbell weights on the barbell and body kinematics of elite weightlifters at different percentages of 1RM (60, 80, and 100%) would facilitate the understanding of the biomechanical demands at each phase in the snatch lift. The results of this study are consistent with those of previous research studies reporting that the strength-oriented first pull and the power-oriented second pull are the most important phases in the snatch technique and that the explosive strength during the second pull is especially important for a successful turnover under the barbell. The decrease in horizontal power despite the increases in vertical power observed in our study indicates that coaches and practitioners should primarily focus on designing training programs for the improvement of the explosive strength for a better pull. Based on the result that the power output in 80 and 100% of 1RM were similar, it is recommended that loads between submaximal and maximal barbell weights (80 and 100% of 1RM) should be chosen in training programs designed for improving strength, preferably loads of 100% of 1RM.



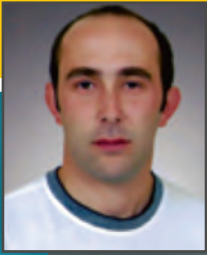
DR. HASAN AKKUS

IS ASSOCIATE PROFESSOR AT FACULTY OF SPORT SCIENCES, UNIVERSITY OF SELCUK, KONYA, TURKEY SINCE 1988. HE HAS DOCTORATE DEGREE FROM HEALTH SCIENCES INSTITUTE OF MARMARA UNIVERSITY ISTANBUL WITH THESIS OF "THE RELATIONSHIPS BETWEEN ANTHROPOMETRIC CHARACTERISTICS, BIOMOTOR ABILITIES, PHYSIOLOGICAL CHARACTERISTICS AND SUCCESS IN ELITE WEIGHTLIFTERS" IN 1994. HE HAS MORE THAN 40 SCIENTIFIC STUDY PUBLISHED IN INTERNATIONAL SCIENTIFIC JOURNAL AND PRESENTED IN INTERNATIONAL SCIENTIFIC CONGRESSES. HE IS EWF GENERAL SECRETARY AND ANTI-DOPING HEARING PANEL MEMBER OF IWF.



DR. ERBIL HARBILI

IS ASSOCIATE PROFESSOR AT FACULTY OF SPORT SCIENCES, UNIVERSITY OF SELCUK, KONYA, TURKEY. HE IS ASSOCIATE PROFESSOR AT SELCUK UNIVERSITY, KONYA, TURKEY. HE HAS BEEN WORKING ON THE TOPICS OF BIOMECHANICS OF WEIGHTLIFTING AND TRAINING SCIENCE SINCE 1999. HE HAS DOCTORATE DEGREE FROM HEALTH SCIENCES INSTITUTE OF HACETTEPE UNIVERSITY ANKARA WITH THESIS OF "THE BIOMECHANICAL ANALYSIS AND MODELLING OF SNATCH TECHNIQUE IN WEIGHTLIFTING" IN 2006.



DR. GOKHAN HADI

HE WAS BORN IN 14.03.1983. HE HAS BEEN WORKING AS RESEARCH ASSISTANT AT FACULTY OF SPORT SCIENCES, UNIVERSITY OF SELCUK, KONYA, TURKEY SINCE 2006. HE GRADUATED MASTER DEGREE WITH THE THESIS OF "THREE DIMENSIONAL KINEMATIC ANALYSIS OF SNATCH IN WEIGHTLIFTING". HE HAS BEEN STUDYING FOR DOCTORATE DEGREE IN HEALTH SCIENCES INSTITUTE OF MARMARA UNIVERSITY ISTANBUL.

References

- Bartonietz, KE. Biomechanics of the snatch: Toward a higher training efficiency. *Strength Cond J* 18: 24–31, 1996.
- Baumann, W, Gross, V, Quade, K, Galbierz, P, and Schwirtz, A. The snatch technique of world class weightlifters at the 1985 world championships. *Int J Sport Biomech* 4: 68–89, 1988.
- Burdett, RG. Biomechanics of the snatch technique of highly skilled and skilled weightlifters. *Res Q Exerc and Sport* 53: 193–197, 1982.
- Campos, J, Poletaev, P, Cuesta, A, Pablos, C, and Carratala, V. Kinematical analysis of the snatch in elite weightlifters of different weight categories. *J Strength Cond Res* 20: 843–850, 2006.
- Enoka, RM. The pull in Olympic weightlifting. *Med Sci Sports* 11: 131–137, 1979.
- Enoka, RM. Load and skill-related changes in segmental contributions to a weightlifting movement. *Med Sci Sport Exerc* 20: 178–187, 1988.
- Garhammer, J. Power production by Olympic weightlifters. *Med Sci Sports Exerc* 12: 54–60, 1980.
- Garhammer, J. Energy flow during Olympic weightlifting. *Med Sci Sports Exerc* 14: 353–360, 1982.
- Garhammer, J. Biomechanical profile of Olympic weightlifters. *Int J Sport Biomech* 1: 122–130, 1985.
- Garhammer, J. A comparison of maximal power outputs between elite male and female weightlifters in competition. *Int J Sport Biomech* 7: 3–11, 1991.
- Garhammer, J. A review of power output studies of Olympic and powerlifting: Methodology, performance prediction, and evaluation tests. *J Strength Cond Res* 7: 76–89, 1993.
- Garhammer, J. Barbell trajectory, velocity and power changes: Six attempt and four world records. *Weightlifting* 19: 27–30, 2001.
- Garhammer, J, Kauhanen, H, and Hakkinen, KA. Comparison of performances by woman at the 1987 and 1998 world weightlifting championships. In: *Science for Success Congress, Jyvaskyla, Finland, 2002*.
- Garhammer, J and Takano, B. Training for weightlifting. In: *Strength and Power in Sport*. Komi, PV, ed. Oxford, United Kingdom: Blackwell Scientific Publications, 1992. pp. 357–362.
- Gourgoulis, V, Aggeloussis, N, Antoniou, P, Chritoforidis, C, Mavromatis, G, and Garas, A. Comparative 3-dimensional kinematic analysis of the snatch technique in elite male and female Greek weightlifters. *J Strength Cond Res* 16: 359–366, 2002.
- Gourgoulis, V, Aggeloussis, N, Garas, A, and Mavromatis, G. Unsuccessful vs. successful performance in snatch lifts: A kinematic approach. *J Strength Cond Res* 23: 486–494, 2009.
- Gourgoulis, V, Aggeloussis, N, Kalivas, V, Antoniou, P, and Mavromatis, G. Snatch lift kinematics and bar energetics in male adolescent and adult weightlifters. *J Sports Med Phys Fitness* 44: 126–131, 2004.
- Gourgoulis, V, Aggeloussis, N, Mavromatis, G, and Garas, A. Threedimensional kinematic analysis of the snatch of elite Greek weightlifters. *J Sport Sci* 18: 643–652, 2000.
- Harbili, E and Aritan, S. Comparative biomechanical analysis of the snatch technique in elite weightlifters. *Hacettepe J Sport Sci* 16: 124–134, 2005.
- Hoover, DL, Carlson, KM, Christensen, BK, and Zebas, CJ. Biomechanical analysis of women weightlifters during the snatch. *J Strength Cond Res* 20: 627–633, 2006.
- Isaka, T, Okada, T, and Funato, K. Kinematic analysis of the barbell during the snatch movement in elite Asian weightlifters. *J Appl Biomech* 12: 508–516, 1996.
- Reiser, FR, Smith, SL, and Rattan, R. Science and technology to enhance weightlifting performance: The Olympic program. *Strength Cond J* 18: 43–51, 1996.
- Schilling, BK, Stone, MH, O'Braynt, HS, Fry, AC, Coglianesi, RH, and Pierce, KC. Snatch technique of collegiate national level weightlifters. *J Strength Cond Res* 16: 551–555, 2002.
- Souza, AL, Shimada, SD, and Koontz, A. Ground reaction forces during the power clean. *J Strength Cond Res* 16: 423–427, 2002.
- Stone, MH, O'Braynt, HS, Williams, FE, and Johnson, RL. Analysis of bar paths during the snatch in elite male weightlifters. *Strength Cond J* 20: 30–38, 1998.

IMPORTANCE OF **APPLIED** **SCIENCE** IN TRAINING PROGRAM DESIGN

BY JAY R. HOFFMAN





The understanding of training program design is based upon a strong knowledge of scientific principle. It is the product of the basic sciences; biology, physics and chemistry, which are combined to an applied field of study such as exercise science that has additional specific emphasis in the study of physiology, biomechanics and biochemistry. The understanding of basic physiological response to exercise is an important aspect in the training of athletes and in providing the background to develop realistic training goals that can be achieved through effort and good coaching. An understanding of science provides us the ability to effectively evaluate the efficacy of various training paradigms and critically examine the broad spectrum of available ergogenic aids and nutritional supplements that are continuously being provided or suggested to athletes. In addition, understanding the applied sciences will allow the sport scientist and coach to better comprehend the physiological, psychological and biomechanical requirements necessary for success in sports and help develop selection criteria that maximizes the chance of athlete and team success.

THE DANGERS OF A LACK OF UNDERSTANDING OF THE SCIENTIFIC PRINCIPLES OF TRAINING

The lack of an appropriate appreciation of the importance of applied science has at times resulted in catastrophic incidents during the training of competitive athletes. In the 10 years spanning

2000 – 2010, 21 deaths occurred during National Collegiate Athletic Association (NCAA) Division I American football workouts (1). These incidents occurred at different Universities, but each one of these deaths occurred during an off-season conditioning workout. In addition, to these fatalities there have been a host of serious events occurring during other training sessions. For instance in 2011, 13 members of the University of Iowa football team were admitted to the hospital following their first workout after their winter break (2). The athletes were diagnosed with rhabdomyolysis, a condition in which muscle tissue is damaged to the point where there is large leakage of skeletal tissue enzymes into the blood stream. Although elevations in muscle enzymes are relatively normal following a training session, the magnitude of the elevation seen during rhabdomyolysis in these enzymes may reach 5 times their normal limit, but often are much greater, with reports suggesting that it can reach more than 50-fold greater (100,000 U/l) than that seen at rest (9). Increases in myoglobin, uric acid and potassium ions are also released from the damaged tissue. The increases in inflammatory markers invade the damaged area of the muscle causing it to swell in size. The increase in the swelling of the muscle, due to the inflammation, can cause compartment syndrome (9), while elevation in the enzymes or electrolytes in the circulation may cause renal impairment leading to kidney failure. Potential changes to the electrocardiography (ECG), indicating impairment of

the heart's conductive system, due to the elevation in potassium ion concentrations in the circulation. These latter changes are potentially lethal. Fortunately, none of these athletes sustained permanent injury, but highlight the potential danger associated with poorly designed workouts. The major issue with all of these incidents is that they are not associated with the normal risk of sport participation. Each incident was preventable, and could have been avoided with the coaches understanding appropriate training progression. Often, it's not the workout itself, but when that specific workout was given in context to the athlete's conditioning level at specific period of time.

RELATIONSHIP OF SCIENCE AND SPORT

The beauty of applied research is that it provides an applied application for the basic knowledge of science and explains how it can be used to understand and enhance athletic performance. It allows the coach to maximize athlete's performance, or perhaps as important, understand limitations of performance. Such information can assist coaches and athletes in setting realistic training goals and performance expectations. It may also provide assistance in setting more objective criteria used for team selection. Applied research provides tools for the coach to use to minimize risk for injury, to reduce the risk of fatigue and overtraining and achieve peak performance at the appropriate time. Most scientists are comfortable working in laboratories and using

laboratory measures to assess human performance. This type of science and data collection has an important role in increasing our scientific understanding of human performance. However, applied scientists are also equally adept at working in a laboratory environment, but also are adept at using the playing fields and courts as their laboratory. The examination of athletes within their competitive environment provides a more specific understanding of the needs and stresses of the sport, and also provides data that coaches may readily comprehend. In addition, the ability and desire to delineate information collected in both field and laboratory based research is a responsibility that applied scientists have in performing research with competitive athletes. Timely communication to the coach and athlete will allow the information learned to enhance their understanding of the needs of their sport and when applicable to develop appropriate training paradigms. An example of this type of research was published in 2003 by Hoffman and Kang on the influence of intensity and volume of training in the in-season training program of American College football players (5). In this study, the investigators provided an in-season training program consisting of the following exercises; squats, bench press, push press, and power cleans. Players were required to train twice per week using 4 sets per exercise at 80% of their 1-repetition maximum. This was equivalent to 4 – 6 repetitions in the power clean and push press exercises, and 6 – 8 repetitions per

set in the squat and bench press exercises. If the required number of repetitions were completed the athletes were encouraged to increase the resistance used in the next training session. One-repetition maximal (1-RM) strength measures of the upper and lower body were measured (bench press and squat, respectively) at the beginning and end (15 weeks) of the competitive season. All player logs were collected and analyzed. Those players who were able to maintain a training intensity of 80% or more for the entire in-season

non-linear training (6). They reported that linear training that required the athletes to train at 80% of their 1-RM twice per week was significantly better in eliciting strength improvements in first-year players than non-linear training (athletes training twice per week, but one workout performed at 90% of their 1-RM, but 70% during the second workout of the week). When examining the data from the linear training group an average of more than 80% per workout was observed throughout the in-season training program.

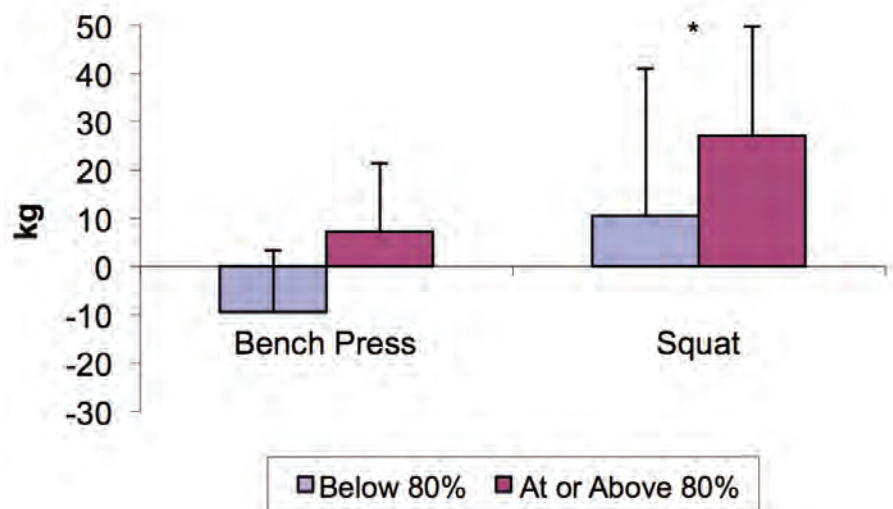


FIGURE NO. 9
EFFECT OF INTENSITY OF TRAINING ON STRENGTH IMPROVEMENT. * = SIGNIFICANT DIFFERENCE BETWEEN GROUPS. DATA FROM HOFFMAN AND KANG, 2003.

training program increased their strength significantly more than those athletes whose training intensity per exercise was less than 80% (see Figure 1). A follow-up study by the same investigators compared linear to

In contrast, the non-linear group trained slightly more than 75% on the lower intensity days, but less than 90% on the heavy days. The non-linear group trained at 80% or more only one day a week, while the athletes in the linear training group trained at an average greater than 80% twice week. Thus, the stimulus for the linear group was greater and this group experienced significantly greater strength improvements than the non-linear group. The results of these studies were used to set the most

appropriate in-season training program for subsequent seasons. The bridge that spans science and sport travels in two directions. It is not only the curiosity of sport scientists that develop the research question, but its often coaches and athletes that become curious on the effectiveness of various training methods or on specific nutritional supplements. Their curiosity often raises important questions that generate specific research ideas for scientists. This two-way communication is integral in spawning the impetus for new research projects. An example of this type of research is reflected by a recent paper that examined the effect of playing time on physical performance changes in professional basketball players (3). This paper revealed some interesting information that indicated that players that were starters or part of the regular playing rotation increased their power performance during the course of the season, while players not part of the regular rotation did not improve power; they were more apt to increase their slow-velocity strength. It was concluded that the stimulus of playing games enhanced power performance, while non-starters may need to perform additional exercises to maintain their power performance during the in-season training sessions. Interestingly, these results supported a previous study on NCAA Division I female college basketball players (4), while a recent study in NCAA Division I female soccer players reported that starters tend to get faster during a season than non-starters (8). Examples of how applied research

is used in improving athletic performance can be seen in the studies that have emanated from the Human Performance Laboratory in the Department of Health and Exercise Science at The College of New Jersey. Different training paradigms for both in-season and offseason conditioning programs have been examined over the past few years. Examples of such studies include the investigation of linear and nonlinear periodization techniques in both in-season and offseason conditioning programs for football players, comparison of Olympic and traditional power lifting training programs in the off-season conditioning program of football players, and the effect of ballistic exercises (i.e. jump

squats and bench press throws) on power development in strength/power athletes. In addition, examination of new training modalities such as thick bars and resistive running on treadmills has also been used to provide important information on exercise performance.

Results of these studies have been used to format training programs in subsequent seasons. In addition, various nutritional supplements such as protein drinks, creatine and -alanine combinations, and pre-exercise high energy drinks have been examined in experienced strength trained athletes to determine the efficacy of these supplements in this population. The critical component attributing

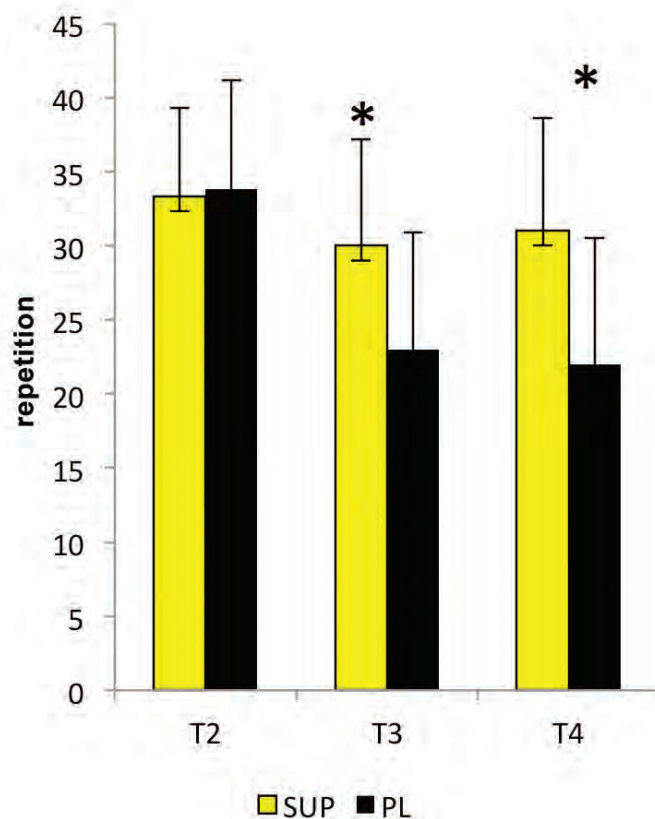


FIGURE NO. 2

COMPARISONS OF NUMBER OF REPETITIONS PERFORMED. * = SIGNIFICANT DIFFERENCE BETWEEN GROUPS. SUP = PROTEIN GROUP; PL = PLACEBO GROUP. DATA FROM HOFFMAN ET AL, 2010.



to the success of the research performed by the Human Performance Laboratory has been in the ability to rapidly delineate the results of these studies to the coaching staff and athletes. These lines of communication provide positive reinforcement for continued research and generate additional ideas for subsequent study. It also provides support for continued cooperation between coaches and applied scientists.

Sport nutrition is another area of study that is often examined by sport scientists that have immediate relevancy to coaches and athletes. One of the largest struggles seen in sport today is the understanding of the efficacy of various sport supplements that athletes are confronted with. There are many individuals that simply want to minimize the use of dietary supplements, ignoring the potential benefits that they may provide.

While others understand the potential benefits, but want the scientific evidence to make the appropriate decision regarding which supplements are efficacious and safe, and which supplements are not effective. An example of such research is the benefits of protein immediately following the workout that appears to enhance the recovery from the workout (see Figure 2) (7).

In this study a protein supplement provided pre and post a high intensity workout including the 4 sets of the 10 repetitions per set of the squat exercise was compared to a group of participants consuming a placebo.

The groups consuming the protein recovered faster from the exercise session, as reflected by a significant greater number of repetitions performed in the squat exercise 24- and 48-h following the initial workout. In addition,

creatine kinase concentrations, an enzymatic marker of muscle damage, began to decline in the protein group but continued to elevate in the placebo group at 48-h post-exercise. The message for coaches was the importance that protein intake surrounding the workout may have in enhancing recovery.

Interesting, the investigation surrounding the rhabdomyolysis incident at Iowa University discussed above revealed that none of the athletes that were hospitalized consumed any protein pre or post workout. However, no athlete that consumed a protein supplement surrounding the workout was hospitalized. This presents interesting anecdotal evidence, that sport science has provided scientific evidence to support the potential benefit of protein intake and recovery from exercise.

References

1. Casa DJ, Anderson SA, Baker L, Bennett S, Bergeron MF, Connolly D, Courson R, Drezner J, Eichner R, Epley B, Fleck S, Franks R, Guxkiewicz KM, KG Harmon, Hoffman JR, Holschen JC, Jost J, Kinniburgh A, Klossner D, Lopez RM, Martin G, McDermott BP, Mihalik JP, Myslinski T, Pagnotta K, Poddar S, Rodgers G, Russell A, Sales L, Sandler D, Stearns RL, Stiggins C, Thompson C. The inter-association task force for preventing sudden death in collegiate conditioning sessions: Best Practices Recommendations. *Journal of Athletic Training*. 47:477-480, 2012.
2. Drake DR, Herwaldt L, Hines NW, Kregel KC, Thoman D. Report of the special presidential committee to investigate the January 2011 hospitalization of university of Iowa football players. March 2011.
3. Gonzalez AM, Hoffman JR, Rogowski JP, Burgos W, Manalo E, Weise K, Fragala MS, and Stout JR. Effect of playing time on performance changes in NBA basketball players. *Journal of Strength and Conditioning Research*. 27:611-615, 2013.
4. Gonzalez A.M., Hoffman J.R., Scallin-Perez, J., Stout J.S., and Fragala M.S. Performance changes in NCAA Division I women basketball players during a competitive season: Starters vs. non-starters. *Journal of Strength and Conditioning Research*. 26: 3197-3203, 2012.
5. Hoffman JR and Kang J. Strength changes during an inseason resistance training program for football. *Journal of Strength and Conditioning Research*. 17:109-114, 2003.
6. Hoffman J.R., M. Wendell, J. Cooper, and J. Kang. Comparison between linear and nonlinear inseason training programs in freshman football players. *Journal of Strength and Conditioning Research* 17:561-565, 2003.
7. Hoffman JR, NA Ratamess, CP Tranchina, SL Rashti, J. Kang, and AD Faigenbaum. Effect of Protein Ingestion on Recovery Indices Following a Resistance Training Protocol in Strength/Power Athletes. *Amino Acids*. 38:771-778, 2010.
8. Jajtner AR, Hoffman JR, Scanlon TC, Wells AJ, Townsend JR, Beyer KS, Mangine GT, McCormack WP, Bohner JD, Fragala MS, Stout JR. Performance and Muscle Architecture Comparisons between Starters and Non-Starters in NCAA Division I Women's Soccer. *Journal of Strength and Conditioning Research*. 27:2355-2366, 2013.
9. Vanholder R, Sever MS, Ereik E, Lameire N. Rhabdomyolysis. *J Am Soc Nephrol*. 11:1553-1561, 2000.





DR. JAY HOFFMAN

HOLDS THE RANK OF FULL PROFESSOR IN THE SPORT AND EXERCISE SCIENCE PROGRAM AT THE UNIVERSITY OF CENTRAL FLORIDA. HE IS PRESENTLY THE DEPARTMENT CHAIR OF EDUCATION AND HUMAN SCIENCES AND DIRECTOR OF THE INSTITUTE OF EXERCISE PHYSIOLOGY AND WELLNESS.

DR. HOFFMAN IS A FELLOW OF THE AMERICAN COLLEGE OF SPORTS MEDICINE AND THE NATIONAL STRENGTH AND CONDITIONING ASSOCIATION (NSCA).

HE SERVED AS PRESIDENT OF THE NATIONAL STRENGTH AND CONDITIONING ASSOCIATION BOARD OF DIRECTORS FROM 2009-2012. DR. HOFFMAN ALSO SERVED ON THE BOARD OF DIRECTORS OF THE USA BOBSLED AND SKELETON FEDERATION. DR. HOFFMAN HOLDS A UNIQUE PERSPECTIVE IN HIS SPORT SCIENCE BACKGROUND. PRIOR TO HIS ACADEMIC CAREER HE SIGNED FREE AGENT CONTRACTS WITH THE NY JETS AND PHILADELPHIA EAGLES OF THE NFL AND THE TAMPA BAY BANDITS OF THE USFL. A DUAL NATIONAL OF THE USA AND ISRAEL, DR. HOFFMAN COMMANDED THE PHYSIOLOGICAL UNIT OF THE ISRAEL AIR FORCE AND SERVED AS A RESEARCH OFFICER IN THE COMBAT FITNESS UNIT OF THE IDF DURING HIS MILITARY SERVICE. DR. HOFFMAN HAS BEEN HONORED OR AWARDED THE 2007 OUTSTANDING SPORT SCIENTIST OF THE YEAR FROM THE NSCA, 2005 OUTSTANDING KINESIOLOGY PROFESSIONAL AWARD FROM THE NEAG SCHOOL OF EDUCATION ALUMNI SOCIETY OF THE UNIVERSITY OF CONNECTICUT, 2003 EDUCATOR OF THE YEAR NSCA, AND 2003 NEAG SCHOOL OF EDUCATION OUTSTANDING ALUMNI RESEARCH AWARD (UNIVERSITY OF CONNECTICUT).

DR. HOFFMAN'S PRIMARY AREA OF STUDY FOCUSES ON PHYSIOLOGICAL ADAPTATIONS RESULTING FROM NUTRITIONAL AND EXERCISE INTERVENTION. DR. HOFFMAN HAS PUBLISHED MORE THAN 200 ARTICLES AND CHAPTERS IN PEER-REVIEWED JOURNALS. HIS BOOKS PHYSIOLOGICAL ASPECTS OF SPORT TRAINING AND PERFORMANCE, NORMS FOR FITNESS, PERFORMANCE, AND HEALTH, AND PROGRAM DESIGN WERE PUBLISHED BY HUMAN KINETICS. A PRACTICAL GUIDE TO DESIGNING RESISTANCE TRAINING PROGRAMS AND TOTAL FITNESS FOR BASEBALL WERE PUBLISHED BY COACHES CHOICE. FURTHER SHARING HIS RESEARCH AND FINDINGS, DR. HOFFMAN HAS LECTURED AT MORE THAN 380 NATIONAL AND INTERNATIONAL CONFERENCES AND MEETINGS.

COACHING WEIGHT- LIFTING IN THE AGE OF SPORT TECHNOLOGY

What can technology do
for a weightlifter and coach?

BY ANNA SWISHER





The level of sophistication in training athletes, including weightlifters, has increased exponentially over the last few decades. An explosion of tech products, such as wireless accelerometers, fitness trackers, motion-capture systems, barbell trackers, and apps for seemingly everything, has given coaches and athletes the ability to measure and track virtually anything. Now that technology has opened up what is possible, the focus must shift towards learning what is worth tracking and how it can be integrated into decision making. Weightlifting coaches are well versed in weightlifting technique, training, and tactics, but are often less familiar with sport technology. As technology in sport becomes ubiquitous, coaches can benefit from learning more about what to consider when selecting and adopting devices.

WHAT CAN TECHNOLOGY DO FOR A WEIGHTLIFTER AND COACH?

Though it can be a powerful tool, technology cannot accurately predict sport performance, replace common sense, or give definitive answers about how to optimally train lifters.

Information from technology does not hand answers to a coach about training and performance, but rather allows a coach to ask better questions.

Technology expands what a coach can see and measure, effectively augmenting the coach's subjective observations and intuitions. The well-trained eye of a veteran

coach is a wonderful tool, but at the elite level, where razor-thin margins separate the top performers, using sport technology to aid in athlete monitoring can be a big advantage. Here are three questions to guide you as you consider adopting new technology.

IS THE TECHNOLOGY RELIABLE AND VALID?

Reliability can be thought of as repeatability, meaning that if you weigh someone on a scale once every ten seconds for two minutes, the scale should show the same mass at each reading.¹ If the scale fluctuates by nine pounds over the twelve readings, the data is not reliable and therefore is worthless to a coach. Both intra- and inter-session reliability are critical when using fitness trackers, force plates, calipers, accelerometers, or anything else that tracks data longitudinally over time to inform coaches and athletes about the training state of the athlete.^{1,2} Coaches can work to enhance reliability by using the average of multiple trials rather than a single effort, always testing under the same conditions (e.g., same time of day, same level of hydration, same tester), and using calibrated, quality equipment.^{1,2}

Validity means that the test or measurement is truly representative of the ability or trait being measured. For example, a one-rep max bench press may be a reliable test, but is not a valid measure of aerobic endurance. The validity of new technology is often assessed by looking at the degree of agree-



ment between gold-standard equipment and the device in question. Assessing validity is nearly impossible when companies create proprietary variables such as “remaining energy” and “total effort” as these are unknown amalgamations of multiple sources of input.

These metrics purport to help make the coach's analysis easier by collating information into “coach friendly” categories, but may lead the coach to erroneous conclusions.

Coaches should use directly measurable metrics such as peak barbell velocity or jump height rather than “reactive ability” or “remaining energy” to ensure that the data is valid. Coaches should also avoid comparing values between devices as the variance between devices can be very large.³ This can be due to methodological differences in how a variable is calculated and how the data is filtered and smoothed.^{3,4} Even if the device you select has some variance from the gold-standard measurement



technique, as long as the measurements have high reliability, it can be a helpful tool to use to track changes over time.

WHAT VARIABLES/METRICS SHOULD BE TRACKED?

As “big data” comes to sport, coaches must grapple with how to mine meaningful information out of the mountains of data collected from new devices. Collecting a lot of data is relatively easy, but analyzing data and turning it into actionable outputs for a group of lifters after each training session can be complex and incredibly time consuming. The human and financial resources required to run an athlete monitoring program are considerable and perhaps only widely feasible at the highest levels of sport.²

Specific variables to consider when monitoring weightlifters include peak barbell velocity, peak power output, peak rate of force development, barbell trajectory,

testosterone to cortisol ratio, anthropometrical measurements, and vertical jump; these may provide valuable information about an athlete’s trained state and training progress.^{2,3,5-9} This list is not exhaustive, and there are promising new findings each year, such as examining force asymmetry in the lower body, that might further assist coaches in training lifters.¹⁰

HOW DOES THE DATA INFLUENCE TRAINING DECISIONS AND FIT INTO THE ATHLETE MONITORING PLAN?

Some of the challenges with new devices are that we don’t yet know what information is valuable and how the detailed streams of information should inform training choices. When peak power drops unexpectedly but the lifter can still make the lifts/reps in a workout without problem, should the coach act to change training on account of the new info about power?

It is a good idea, when possible, to

collect several weeks or months of baseline data to get a sense of how a particular variable fluctuates in a lifter prior to using the data to inform training decisions. There are highly individual responses in many variables, such as heart rate and power output, so setting an arbitrary threshold for action is not recommended.^{11,12} Coaches should understand the trends and implications of the baseline data and continue to monitor the same lifter longitudinally rather than analyze group data for guidance.

Once baseline data has been collected, a coach should consider selecting a few key variables to augment the other existing athlete monitoring practices that influence athlete programming. A coach might collect weekly vertical jump data in weightlifters including jump height, peak force, impulse, peak power, and rate of force development to see if changes in any of these variables are reflective of fatigue levels. If jump height remains stable over several months of training with both high and low

training volumes, the coach learns that jump height lacks the sensitivity to reflect fatigue levels. However, if the coach sees that impulse and peak power data from the jumps is more sensitive to changes in training volume, that data may be valuable as part of a larger pool of information used to monitor a lifter's training.

CONCLUSION

An accelerometer would be hard pressed to identify when an athlete is burned out by training, coming down with a cold, or nervous about an upcoming contest. However, carefully chosen and implemented sport technology does have the potential to be a valuable supplemental source of information. Just as coaches must

know tactical and biomechanical aspects of weightlifting, the profession is evolving such that coaches must be competent in using sport technology.

To be most effective, coaches must first understand sport technology's strengths and limitations and how to incorporate it into decision making.



ANNA SWISHER, MA, CSCS

A DOCTORAL FELLOW IN SPORT PHYSIOLOGY AND PERFORMANCE AT EAST TENNESSEE STATE UNIVERSITY, ANNA TEACHES UNDERGRADUATE

COURSES AND CONDUCTS RESEARCH ON WEIGHTLIFTING, ATHLETE MONITORING, AND COACH EDUCATION UNDER DR. MIKE STONE, VETERAN WEIGHTLIFTING COACH AND SPORT SCIENTIST. SHE IS A FORMER WEIGHTLIFTER, A SPORT SCIENCE CONSULTANT, AND THE CO-CREATOR OF ELEIKO'S OLYMPIC WEIGHTLIFTING AND PROGRAM DESIGN FOR STRENGTH COACHES COURSE.

References

1. Vincent W.; Weir J. *Statistics in Kinesiology*. 4th ed. Champaign, IL: Human Kinetics; 2012.
2. Stone MH, Stone ME, Sands WA. *Principles and Practice of Resistance Training*. Champaign, IL: Human Kinetics; 2007.
3. McMaster DT, Gill N, Cronin J, McGuigan M. A brief review of strength and ballistic assessment methodologies in sport. *Sports medicine (Auckland, NZ)* 2014;44:603-23.
4. Cormie P, McCaulley GO, Triplett NT, McBride JM. Optimal loading for maximal power output during lower-body resistance exercises. *Medicine and science in sports and exercise* 2007;39:340-9.
5. Carlock JM, Smith SL, Hartman MJ, et al. The relationship between vertical jump power estimates and weightlifting ability: a field-test approach. *Journal of strength and conditioning research / National Strength & Conditioning Association* 2004;18:534-9.
6. Stone MH, Sands WA, Pierce KC, Carlock J, Cardinale M, Newton RU. Relationship of maximum strength to weightlifting performance. *Medicine and science in sports and exercise* 2005;37:1037-43.
7. Crewther B, Cronin J, Keogh J, Cook C. The salivary testosterone and cortisol response to three loading schemes. *Journal of strength and conditioning research / National Strength & Conditioning Association* 2008;22:250-5.
8. Garhammer J. Power production by Olympic weightlifters. *Medicine and science in sports and exercise* 1980;12:54-60.
9. Musser LJ, Garhammer J, Rozenek R, Crusemeyer JA, Vargas EM. Anthropometry and barbell trajectory in the snatch lift for elite women weightlifters. *Journal of strength and conditioning research / National Strength & Conditioning Association* 2014;28:1636-48.
10. Sato K, Heise GD. Influence of weight distribution asymmetry on the biomechanics of a barbell back squat. *Journal of strength and conditioning research / National Strength & Conditioning Association* 2012;26:342-9.
11. Argus CK, Gill ND, Keogh JW, Hopkins WG. Assessing the variation in the load that produces maximal upper-body power. *Journal of strength and conditioning research / National Strength & Conditioning Association* 2014;28:240-4.
12. Racinais S, Buchheit M, Bilsborough J, Bourdon PC, Cordy J, Coutts AJ. Physiological and performance responses to a training camp in the heat in professional Australian football players. *International journal of sports physiology and performance* 2014;9:598-603.

Suggested Reading

1. McMaster DT, Gill N, Cronin J, McGuigan M. A brief review of strength and ballistic assessment methodologies in sport. *Sports medicine (Auckland, NZ)* 2014;44:603-23.
2. Stone MH, Stone ME, Sands WA. *Principles and Practice of Resistance Training*. Champaign, IL: Human Kinetics; 2007.
3. Giroux C, Rabita G, Chollet D, Guilhem G. What is the Best Method for Assessing Lower Limb Force-Velocity Relationship? *International journal of sports medicine* 2015;36:143-9.
4. Turner, A, Brazier, J, Bishop, C, Chavda, S, Cree, J, Read, P. *Data Analysis for Strength and Conditioning Coaches: Using Excel to Analyze Reliability, Differences, and Relationships*. *Strength Cond. J.* 37(1):76-83, February 2015.

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.nisca-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 \pm 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.

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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 in-

structions 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 \pm 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:

Adobe Photoshop (.psd)

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PowerPoint (.ppt)

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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.

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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 ($^{\circ}$ 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);
- 1 J = 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

MÁS ALLÁ DEL ENTRENAMIENTO (PRIMERA PARTE) - 1. ENTRENAR LA FUNCIÓN ES ENTRENAR EL MOVIMIENTO

Alberto Andorlini

SM (ing), n.º 2, año I, mayo-agosto 2015, pp.4-17

“Entrenar la función es entrenar el movimiento” es la primera de una serie de “intervenciones multimetámicas”. El primer paso, con pies de plomo, para definir una nueva metodología de intervención que tenga como objeto el Entrenamiento del movimiento. Nuestra disertación nace con el presente artículo, que debe considerarse como una especie de incubadora de hipótesis conceptualizadas, o de conceptos hipotéticos, y como una interpretación libre del axioma “La forma sigue a la función”; pasará por un eje de referencia –desde el cuerpo, pasando por el movimiento, hasta el cuerpo en movimiento– que constituirá, en cambio, la brújula que orientará las consideraciones y alimentará la reflexión (segundo artículo); abordará una gramática elemental que tratará de proporcionar los instrumentos necesarios para descodificar cualquier composición motora (tercer artículo); hasta llegar a la definición de un modelo metodológico y operativo que permita el buen rendimiento del ejercicio (cuarto artículo). Dicho rendimiento (ordinario y extraordinario) no puede limitarse a un único instante, una única sesión de entrenamiento, un único momento o una única ejecución, sino que ha de extenderse a todos los movimientos y a todos los elementos que estos tienen en común.

LAS ESPECIALISTAS DEL LEVANTAMIENTO DE PESAS SE HAN LIBERADO DEL USO DE LA BARRA FEMENINA

Andrew “Bud” Charniga

SM (ing), n.º 2, año I, mayo-agosto 2015, pp.18-29

Son varios los factores que pueden influir en la oscilación de la moderna barra utilizada en la halterofilia, aumentándola, especialmente en la actividad femenina, que contempla la utilización de una barra especial. Entre dichos factores cabe mencionar, como muy importantes, la cantidad del peso cargado, la longitud de trabajo de la barra y la longitud del espacio entre las manos. No obstante, el actual (y en realidad imprevisto) aumento de fuerza de las levantadoras de pesas modernas ha conllevado, de hecho, que la barra concebida específicamente para las mujeres quedara obsoleta. Ello ha creado problemas importantes de seguridad y ejecución, que solo pueden subsanarse introduciendo cambios en el diseño de la barra para mujeres.

MODELO BIOMECÁNICO DE LAS BASES TÉCNICAS DE ARRANCADA

Donato Formicola

SM (ing), n.º 2, año I, mayo-agosto 2015, pp.30-41

Con los actuales estudios científicos sobre la técnica de arrancada, realizados con modelos biomecánicos antropomorfos, se trata de comprobar si la moderna técnica de levantamiento tiende a verticalizar cada vez más la trayectoria

de la barra, a fin de aumentar la eficiencia de la acción mecánica. El objetivo de este tipo de estudios es presentar un modelo biomecánico antropomórfico que respete las propiedades antropométricas y ergonómicas del cuerpo de un deportista de sexo masculino. El modelo, compuesto por seis segmentos anatómicos, se sitúa en un plano geométrico para ejecutar de forma unívoca 10 posiciones clave de la técnica de arrancada y recabar información útil sobre la realización de las fases fundamentales de dicha acción deportiva. El análisis biomecánico realizado permitió destacar dos estrategias motoras esenciales: el movimiento giratorio de la pelvis y la extensión vertical de las extremidades inferiores, cuya sinergia y forma de realización aumentan la eficiencia de todo el levantamiento.

DEFINIR EL ENTRENAMIENTO DEPORTIVO ¿VELEIDAD O NECESIDAD?

Pasquale Bellotti

SM (ing), n.º 2, año I, mayo-agosto 2015, pp.42-49

Tras haber destacado la importancia de definir un fenómeno con el fin de poder comprenderlo mejor (delimitándolo) y conocerlo a fondo (una definición ha de contener todos los elementos fundamentales de la acción concreta), el autor reconstruye la historia de la evolución en los años en que se acuñó la propia definición del entrenamiento, que es fruto de la experiencia y de la comprensión progresiva del verdadero significado y de la principal función de dicho proceso (el entrenamiento).

ANÁLISIS CINEMÁTICO EN TRES DIMENSIONES DE LA TÉCNICA DE ARRANCADA PARA EL LEVANTAMIENTO DE DISTINTOS PESAS

Hadi, G, Akkusx, H, y Harbili, E.

SM (ing), n.º 2, año I, mayo-agosto 2015, pp.50-61

El objetivo de este estudio era analizar los efectos de aumentar las cargas de la barra en el movimiento del cuerpo y de la propia barra en los levantamientos con la técnica de arrancada al 60, 80 y 100 % de una repetición máxima, y examinar la biomecánica de dicha técnica. El estudio se realizó en siete levantadores de pesas de élite de sexo masculino del equipo nacional de Turquía. Para grabar los levantamientos, se utilizaron cuatro cámaras que funcionaban a 50 campos por segundo. Para el análisis cinemático en 3D del centro de gravedad (CG) y el movimiento de la barra, se digitalizaron los puntos del cuerpo y de la barra con el programa informático Ariel Performance Analysis System. Se observaron diferencias significativas entre los valores de trabajo vertical ($p < 0,05$). Los valores de la potencia de los tres levantamientos con la técnica de arrancada también resultaron ser significativamente diferentes ($p < 0,05$). Se observó otra diferencia significativa ($p < 0,05$) entre el desplazamiento vertical máximo de la barra, la velocidad vertical máxima de la barra, el desplazamiento vertical máximo del CG y la velocidad vertical del CG durante la fase de encaje bajo la barra. Los resultados pusieron de

manifiesto que los movimientos vertical y horizontal de la barra y del cuerpo en la fase del tirón de la técnica de arrancada disminuían a medida que aumentaba la carga de la barra. La potencia durante el segundo tirón aumentó a pesar de que el trabajo no varió, mientras que el trabajo y la potencia aumentaron durante la fase del primer tirón a medida que aumentaba el peso de la barra. Los resultados de este estudio indican que los levantadores de pesas debían realizar más rápidamente el encaje bajo la barra y la fase de fijación, ya que cuando se aumentaba el peso de la barra en el levantamiento mediante arrancada, el movimiento vertical de la misma disminuía.

LA IMPORTANCIA DE LAS CIENCIAS APLICADAS EN EL DISEÑO DE LOS PROGRAMAS DE ENTRENAMIENTO

Jay R. Hoffman

SM (ing), n.º 2, año I, mayo-agosto 2015, pp.62-69

La colaboración entre el científico y el entrenador es una importante relación simbiótica que tiene la capacidad de aumentar al máximo el rendimiento deportivo. El uso apropiado de la ciencia del deporte brinda numerosas posibilidades, entre ellas, elaborar criterios de selección que ayuden a los entrenadores en la construcción del equipo, realizar evaluaciones fisiológicas encaminadas a supervisar el rendimiento deportivo y evitar el sobreentrenamiento, diferenciar entre varios paradigmas del entrenamiento y formular recomendaciones basadas en el estudio científico de los complementos alimenticios. Estos elementos pueden aportar beneficios importantes, que quizás no garanticen un campeonato, pero que pueden aumentar al máximo las posibilidades de lograr el potencial pleno.

EL ENTRENAMIENTO DE LA HALTEROFILIA EN LA ERA DE LA TECNOLOGÍA APLICADA AL DEPORTE

Anna Swisher

SM (ing), n.º 2, año I, mayo-agosto 2015, pp.70-75

El grado de complejidad alcanzado por el entrenamiento de los deportistas, comprendidos los levantadores de pesas, ha aumentado exponencialmente en los últimos decenios. La explosión de productos tecnológicos ha concedido a los entrenadores y los deportistas la capacidad de medir y registrar prácticamente todo. Teniendo en cuenta que hoy en día la tecnología se aplica a todos los ámbitos, ha de prestarse más atención a tratar de aprender qué vale la pena registrar y cómo puede incorporarse al proceso de toma de decisiones. Los entrenadores de halterofilia están formados en la técnica, el entrenamiento y la táctica de esta disciplina; sin embargo, a menudo tienen un menor conocimiento de la tecnología deportiva. A medida que la tecnología aplicada al deporte se torna omnipresente, los entrenadores pueden beneficiarse de tener una mayor cantidad de información relativa a los aspectos a tener en cuenta cuando se eligen y se adoptan determinados dispositivos.



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Russian

НЕ ТОЛЬКО ТРЕНИРОВКА (ПЕРВАЯ ЧАСТЬ) – ТРЕНИРОВАТЬ ФУНКЦИЮ ОЗНАЧАЕТ ТРЕНИРОВАТЬ ДВИЖЕНИЕ

Alberto Andorlini

«Тренировать функцию означает тренировать движение» это первая статья из серии «политематических публикаций». Первый и очень осторожный шаг в этом смысле заключается в определении новой методологии Тренировки Движения. Наша научная работа начинается с этой статьи, которая должна рассматриваться как определенный вид «инкубатора» концептуальной гипотезы... или гипотетических концепций и как свободная интерпретация аксиомы «форма следует за функцией»; потом переходит к основному стержню проблемы – тело, движение, и наконец движение тела – который представляет собой компас с помощью которого можно ориентировать размышления и углублять исследование (вторая статья); в дальнейшем затронет так называемую «элементарную грамматику», идея которой заключается в разработке инструментов для декодификации любой двигательной композиции (третья статья); и наконец подойдет к определению методологической и оперативной модели, которая приводит в действие «performance» (четвертая статья). Эта «performance» (ординарная и straordinaria), которая не может быть сведена только к одному моменту или только к одному тренировочному занятию, или к только к одному выполнению движения или упражнения, должна быть распространена на все движения и... на все элементы общие для любого движения.

ОПРЕДЕЛИТЬ ЧТО ОЗНАЧАЕТ ТЕРМИН «СПОРТИВНАЯ ТРЕНИРОВКА». АМБИЦИЯ ИЛИ НЕОБХОДИМОСТЬ.

Pasquale Bellotti

Автор подчеркнул роль процесса определения явлений с целью их лучшего определения (обозначая их границы) и использования (любое определение должно включать в себя основы конкретной акции), прослеживает историю эволюции дефиниции «спортивная тренировка» в период самого становления тренировки как результата опыта и постепенной реализации смысла первичной роли этого процесса (тренировки, чтобы быть точными).

БИОМЕХАНИЧЕСКАЯ МОДЕЛЬ ТЕХНИЧЕСКОЙ БАЗЫ УПРАЖНЕНИЯ «РЫВОК»

Donato Formicola

Цель современного научного анализа упражнения «рывок», реализованного используя биомеханические антропоморфные модели, заключается в проверке того, что современная техника подъема штанги имеет тенденцию к всё большей вертикализации траектории штанги с целью повышения эффективности механического действия. Цель данного исследования заключалась в презентации биомеханической антропоморфной модели соблюдающей антропометрические и эргономические характеристики тела спортсмена (мужского пола). Модель, включа-

ющая шесть анатомических сегментов, была установлена на геометрической поверхности с целью однозначной реализации десяти ключевых позиций техники рывка и получения полезной информации о реализации основных фаз этого спортивного действия. Биомеханический анализ позволил определить две основные двигательные стратегии: вращательное движение таза и вертикальное разгибание нижних конечностей, синергия действия и способ выполнения которых повышают эффективность всего подъема штанги.

РОЛЬ ПРИКЛАДНОЙ НАУКИ В ПРОГРАММИРОВАНИИ ТРЕНИРОВКИ

Jay R. Hoffman

Сотрудничество между ученым и тренером является важным симбиозом, представляющим собой большой потенциал для достижения максимальных спортивных результатов. Правильное использование результатов спортивной науки представляет собой большие потенциальные возможности. Это сотрудничество включает: разработку критериев отбора для помощи тренеру в формировании и организации команды, физиологическую оценку и мониторинг спортивных результатов (performance) с целью избежания синдрома перетренированности (overtraining), дифференциацию между различными тренировочными парадигмами, разработку важных рекомендаций основанных на научном анализе пищевых добавок. Все это может обеспечить существенные преимущества, которые не гарантируют победу, но максимизируют шансы полной реализации потенциала.

ТРЕХМЕРНЫЙ КИНЕМАТИЧЕСКИЙ АНАЛИЗ ТЕХНИКИ РЫВКА ШТАНГИ РАЗЛИЧНОГО ВЕСА

Hadi, G, Akkux, H, and Harbili, E.

Целью данного исследования было изучение влияния повышения веса штанги на кинематику штанги и тела спортсмена в упражнении «рывок» (60%-80%-100% от максимального повторения (1RM)) и оценка биомеханики техники рывка. Исследование было проведено на семи тяжелоатлетах (мужского пола) национальной сборной Турции. Для регистрации подъёмов использовались четыре телекамеры работающие с частотой 50 изображений в секунду. Для трехмерного кинематического анализа центра тяжести (CG) и движения штанги, точки на теле спортсмена и на штанге были зафиксированы с помощью «Ariel Performance Analysis System». Были отмечены существенные различия ($p < 0.05$) значений вертикальной работы. Были также отмечены значительные различия ($p < 0.05$) показателей мощности в трёх рывках.

Отмечалось также существенное различие ($p < 0.05$) между показателями максимального вертикального перемещения штанги, максимальной вертикальной скорости штанги, максимального вертикального перемещения центра тяжести (CG), вертикальной скорости центра тяжести (CG) во время «оборота» под штангой.

Результаты показали что при увеличении веса штанги, вертикальные и горизонтальные кинематические показатели штанги и тела снижались во время первой фазы (1° pull) рывка.

Проявленная мощность повышалась во время второй фазы (2° pull), хотя показатели работы не изменялись, в то время как работа и мощность увеличивались во время первой фазы (1° pull) с повышением веса штанги.

Результаты исследования предполагают, что когда повышался вес штанги в рывке показатели вертикальной кинематики штанги снижались.

О ТОМ КАК СПЕЦИАЛИСТКИ ТЯЖЁЛОЙ АТЛЕТИКИ «ОСВОБОДИЛИСЬ» ОТ «ШТАНГИ ДЛЯ ЛЕДИ»

Andrew “Bud” Charniga

Существует много факторов которые в состоянии влиять на повышение колебания современной штанги, особенно в женской тяжёлой атлетике в которой предусматривается использование специальной штанги. Среди этих факторов можем процитировать как очень влиятельные: нагруженный вес, рабочая длина стержня штанги, ширина хвата. Тем не менее, рост силы современных спортсменок (который не был принят во внимание) привёл к тому что стержень, специально спроектированный для тяжелоатлетов, устарел. Все это создало большие проблемы в области безопасности и производительности, которые могут быть решены только благодаря соответствующим изменениям в конструкции штанги для женщин.

ТРЕНИРОВКА В ТЯЖЁЛОЙ АТЛЕТИКЕ В ЭПОХУ РАЗВИТИЯ ПРИКЛАДНОЙ ТЕХНОЛОГИИ В СПОРТЕ

Anna Swisher

В последние десятилетия экспоненциально вырос уровень сложности спортивной тренировки спортсменов, в том числе и тяжелоатлетов. Бум технологических продуктов предоставил тренерам и спортсменам возможности измерять и регистрировать практически все. Сегодня, когда технология практически внедрилась во все сферы, внимание должно сконцентрироваться на выборе того, что стоит действительно регистрировать и каким образом результаты этой регистрации могут быть использованы в процессе принятия решений. Тренеры по тяжёлой атлетике хорошо подготовлены в области методологии тренировки, техники и тактике этой дисциплины, однако менее знакомы со спортивной технологией. Постепенно прикладная спортивная технология внедряется во все области деятельности и тренеры могут извлекать выгоду от получения большого количества информации о том что необходимо учитывать при выборе и использовании определенных устройств.

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**SCIENTIFIC
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**THE OFFICIAL JOURNAL OF THE EUROPEAN
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