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Editor-in-Chief: Prof. (Dr.) S.K. Verma

It is a matter of great pleasure in bringing to you the second issue of **Journal of Exercise Science and Physiotherapy** ***(JESP)***. *JESP* is the official journal of the ***Exercise Fitness and Health Alliance*** (**EFHA**). *JESP* is an international peer reviewed journal intended to cover the latest advances in clinical practice and research related to all aspects of exercise sciences, such as the management of sports injury, exercise physiology, sports psychology, physical education, physiotherapy and the epidemiology of exercise and health. By virtue of open exposure of the journal to almost all aspects of exercise and sports related research, *JESP* is destined to serve the interest of readers that includes sports physicians, primary care physicians, exercise scientists, physical educationists, physiotherapists, trainers, medical advisors to sporting organisations, kinesiologists, orthopaedic consultants/surgeons, osteopaths, consultants in emergency medicine, paediatricians, growth development specialists, cardiologists, occupational therapists, chiropodists and podiatrists, pain specialists, behavioural psychologists, dieticians and obesity specialists, exercise immunologists, rheumatologists, rehabilitation specialists and public health specialists.

The current issue of *JESP* contains two review articles namely "The biomechanics of stretching" by Duane Knudson from California State University, Chico, USA and "Heat shock proteins in exercise: A review" by Lars Mc Naughton, & Co-workers from U.K. The Journal also contains research contributions in the form of original articles from leading researchers working in the area of exercise physiology, health related fitness, training, physiotherapy, obesity and nutrition from India. In addition to this, the recent issue of *JESP* also includes short communications and case reports from eminent health professionals. Over and above the research reports, the journal also presents the review report on a book entitled "Nutrition Exercise and Weight Reduction".

Suggestions for further improvement are welcome. In the end I take this opportunity to congratulate the editorial team in bringing out this issue of *JESP*.

S.K. Verma

The Biomechanics of Stretching

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Abstract

This narrative review examined the biomechanical effect of stretching exercises on skeletal muscles. While there is a long history of clinical research on the effect of stretching on flexibility, there have only been a few years of research on the acute and chronic effects of stretching on the biomechanical parameters of muscle function. The acute effect of stretching appears to be a significant increase in range of motion primarily due to increased stretch tolerance and significant reductions in most all forms of muscular performance. Stretching also creates significant acute reductions in passive tension (stress-relaxation) in the muscle, but does not appear to affect its stiffness/elasticity. Stretch training significantly increases range of motion, but it also tends to increase the passive tension and stiffness of the musculature. Future research of human muscle *in vivo* during stretching and normal movement using ultrasound promises to help clarify the effects of stretching on the active and passive components of muscle and the many biomechanical variables of muscular performance.

Key Words: **Elasticity, Flexibility, Muscle, Stiffness, Tendon, Viscoelastic**

Introduction

Stretching is an important therapeutic and exercise training modality for increasing joint range of motion. There has been extensive research on the effects of various stretching programs that have documented the clinical effectiveness of these techniques in modifying flexibility *(Knudson et al. 2000; Harvey et al., 2002; Shrier, 2004; Decoster et al., 2005).* Improvements in soft tissue imaging and force measurement technology have only recently begun to allow biomechanical studies to document the mechanisms of the effect of stretching on the muscle-tendon unit and muscular performance. This review will summarize the biomechanical research on the effects of stretching on the muscle-tendon unit. These studies provide important basic science evidence that compliments clinical studies to help guide professionals in prescribing stretching exercises.

Biomechanics of Muscle Tension

The tension created by skeletal muscle can be classified as originating from two mechanical sources, active and passive. Active tension represents the contractile effects or the force generated by the interaction of actin and myosin filaments. Passive tension arises from the connective tissue components of skeletal muscle when elongated beyond their resting length. Active and passive tension cannot be considered separate structural elements of muscle because the connective tissue matrix of muscle is quite complex (within muscle and between muscles in anatomical compartments) and actin cross-bridges have elastic properties *(Proske and Morgan, 1999).* Many readers will be familiar with the electro-mechanical delay and hyperbolic force-velocity properties of muscle (*Hill, 1938)* that also complicate the production of muscle force. Most biomechanical models of muscle use a Hill model that includes a series-elastic component to account for passive tension interacting with active tension. This review will focus on the muscle length-dependent properties of muscle since this is the mechanical property most strongly related to stretching exercises. The force and moment of force about a joint axis created by a particular muscle or muscle group is a result of both active and passive components of muscle tension.

Biomechanics has typically described the active and passive components of muscle as the length-tension relationship of muscle. The active tension of skeletal muscle is said to have three regions or limbs (ascending, plateau, and descending), while passive tension increases in an exponential fashion (Figure 1). While most of these studies have been based on tissue preparations from animal models *(e.g. Taylor et al. 1997; Davis et al., 2003),* several in vivo studies of human muscle groups have recently reported similar patterns of active and passive tensile resistance, especially in the plantar flexors *(Maganaris, 2001; Gajdosik, 2002; Hoang et al., 2005).* There is considerable normative data on the rise in passive torque provide by passive tension of the plantar flexors *(Gajdosik et al., 1999; Moseley et al., 2001).*

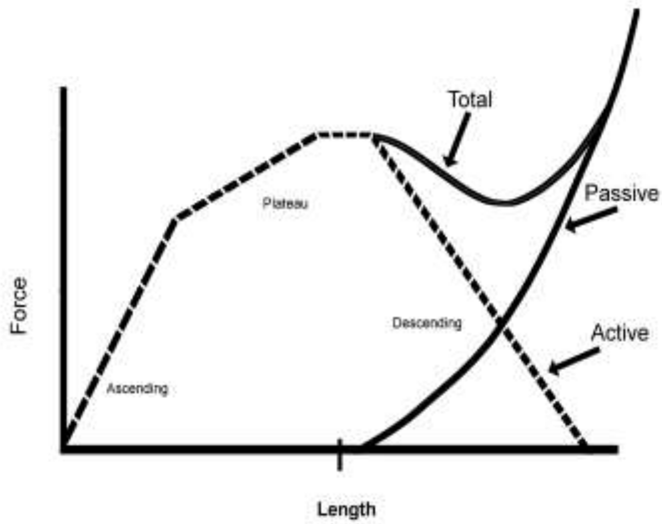

Figure1. The force-length relationship of muscle reflects the sum of the active (—— —) and passive tension (———) sources of force. The active tension curve is typically classified as having an ascending, plateau, and descending limbs. Adapted with permission from Knudson (2003).

When connective tissues like ligament and tendon samples are stretched to failure in materials testing machines, a variety of variables can be calculated documenting their mechanical response. Variables like peak forces, energy absorbed, elongation, and stiffness (elasticity) have all been measured for a variety of these tissues. For example, whole rabbit muscle preparations have been stretched to failure to document the effect of warm-up *(Safran et al., 1988)* or cadaver tissues tested to document the mechanical strength of the various bundles of the human medial collateral ligament *(Robinson et al., 2005).*

While the tension of muscle can be easily understood as arising from active of passive sources, the interaction of these two sources is very complex. The interaction of these two components of tension implies that exercise interventions, like stretching, may have complex effects on skeletal muscle depending on the interaction of the tissues and the nature of the training stimulus.

Acute Effects of Stretching

When a muscle or muscle group is passively stretched using techniques like in static, dynamic, or proprioceptive-neuromuscular facilitation (PNF) stretching there may be some short-term changes in the muscle. Acute or short-term effects of stretching on muscle relate to the initial performance changes in the first few hours after stretching. This section will look at factors affecting the acute response of muscle to stretching. The acute effect following stretching then depends on the biomechanical performance variable of interest. Some biomechanical variables (like range of motion) have been shown to improve following stretching, while some appear to be unaffected (stiffness) and others are significantly reduced (strength).

An important factor in the acute effect of stretching is that the passive tension in a muscle depends on the rate of stretch. This rate dependency means that the tensile resistance in a muscle strongly depends on the timing of the stretch. This property is called viscoelasticity. The faster the stretch the higher will be the stiffness of the muscle (Figure 2). Stiffness is the measure of elasticity of a material and is defined as the slope of the stress/strain or load/deformation curve in the elastic region of the curve. The load-deformation curves of viscoelastic materials (like Figure 2) are complex and have several regions. The "toe" region is the initial quick elongation with minimal force rise). There is a highly nonlinear region followed the "elastic" region where the curve begins to approximate a straight line. If these tissues were pulled to failure the curve would show a "plastic" region where the curve flattens out as permanent damage is done to the tissue. During normal activities most ligament and tendon strain is typically between 2 and 5 percent strain so they occur in the toe and just before the elastic regions of the curve *(Carlstedt and Nordin, 1989).* The viscoelastic response of muscles, tendons, and ligaments means that a slow stretch will create less passive tension than a faster stretch to the same length.

The acute effect of stretching on flexibility is pretty clear. Stretching creates an acute increase in joint range of motion that tends to persist for 60 to 90 minutes *(Moeller et al., 1985; Kirsch et al., 1995; Zito et al., 1997).* Much of this short-term increase in static flexibility is related to an increase in stretch tolerance *(Wiemann and Hahn, 1997; Magnusson, 1998).* In other words, the increased range of motion may be related to an analgesic effect that allows the person to tolerate higher levels of passive tension required to stretch the muscle farther than it was before. Stretch tolerance has also been observed to be higher in flexible persons than "tight" persons, so greater range of motion in most persons is achieved with higher passive tensions *(Magnusson et al., 2000a).*

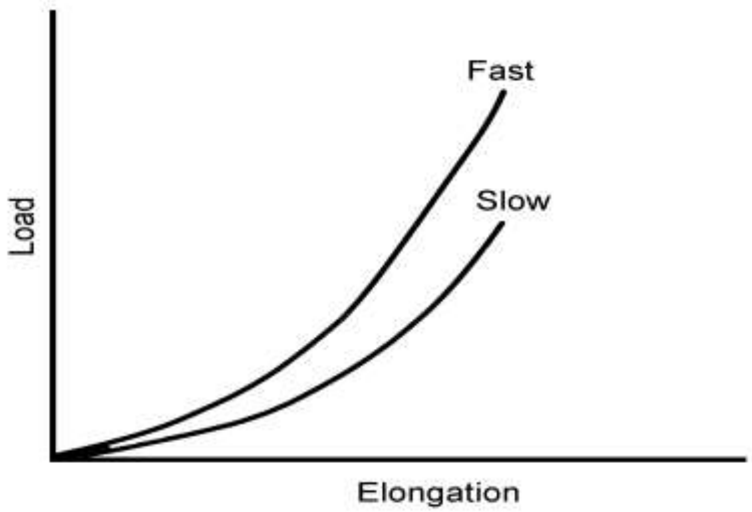

Figure 2. Typical force-elongation curves for slow and fast stretches of a muscle, tendon, or ligament. The visocoelastic response of these tissues means that faster stretches make the tissue stiffer, resulting in greater force for a given elongation. Adapted with permission from Knudson (2003).

Another related factor is that stretching decreases the passive tension in the muscle at a given length. This decrease in passive tension in the muscle at a particular joint angle is due to stress relaxation (Figure 3). Stress relaxation is the decrease in stress (force per unit area) in a material elongated and held at a constant length. Holding stretches for 20 to 30 seconds is a good standard because most of the stress relaxation in passive stretches occurs in the first 20 seconds *(McHugh et al., 1992; Magnusson, 1998; McNair et al., 2000; Duong et al., 2001).* Patients can feel this decrease in muscle tension when they hold a static stretch. Stress relaxation following stretching provides an acute 10 – 30% decrease in passive tension *(Magnusson et al., 1995; Magnusson et al., 2000b; McNair et al., 2000),* but this stress relaxation lasts only about one hour *(Magnusson et al., 1996b).*

This lower tension early in range of motion should not be confused with the stiffness or elasticity of the muscle. While a patient might feel stretching makes their muscles feel less “stiff” *(Reisman et al. 2005),* this is not correct in the true sense of the word. What patients are often feeling following stretching or mild movement following inactivity are “thixotropic” or history dependent (length and contraction) effects *(Hutton, 1993; Magnusson et al., 1995).* An everyday example would be when a person is sitting in a constrained position for a long time; they will find their back muscles feel inextensible or ‘stiff’ until they move around for a few seconds. This change in passive tension very early in the toe region of a muscle has been called “short-range stiffness,” but is not the true stiffness of the tissue if it were to be stretched near injury-producing levels.

Many studies have measured the torque/angle curves immediately following stretching as estimates of the load/elongation behavior and passive stiffness of stretched muscle groups *(e.g.*

Rosenbaum and Hennig, 1995; Halbertsma et al. 1996, 1999; Magnusson, 1998; Magnusson et al., 1996b; 1998; 2000,). These studies are conducted at very slow speeds (1 to 5 degrees per second) for ethical (safety) and neuromuscular (minimal reflex activation) reasons. There are many problems in accurately measuring muscle group/joint stiffness *(Latash and Zatsiorsky, 1993)* and comparisons are difficult. There are conflicting results from these studies, different experimental protocols (dynamometers, set-ups, test speeds) and incorrect definitions of stiffness (slope not calculated in the elastic region of the torque/angle curve). This latter issue is a problem because the torque/angle slopes in various regions of the curve are not strongly correlated to each other *(Gadjosik & Williams, 2002).* Other studies estimate muscle group stiffness from damped vibration during activation, but there also is a very low correlation between passive and active muscle stiffness *(Blackburn et al., 2004).* Most strong studies of passive stiffness observe results like in Figure 3, where the slope of the torque/angle curve does not change following multiple bouts of stretching. The only conclusion is that there is no clear evidence that stretching creates an acute decrease in muscle stiffness.

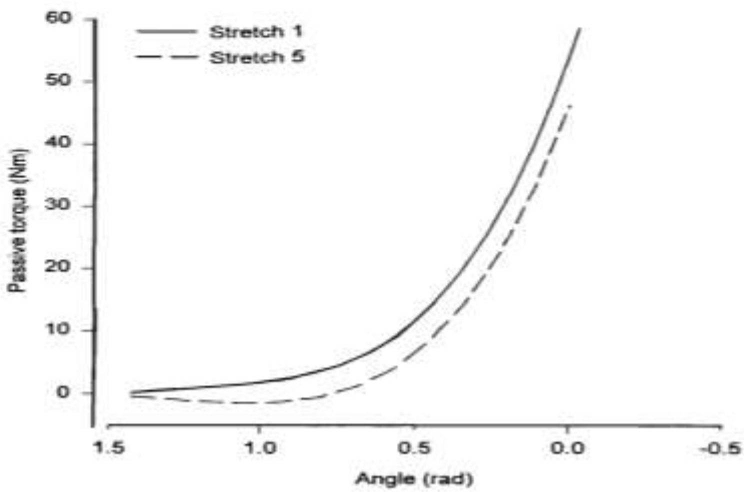

Figure 3. Torque/angle curves for the hamstring muscles for the first and fifth stretches. Note the lower resistance at each joint angle from stress relaxation, but also notice the slope of the curve in the elastic (linear) region does not change so the stiffness of the muscle group is similar. Reproduced with permission from Magnusson et al., (1996a).

It is likely that the stiffness of a muscle group is more dependent on warm-up than stretching. One of the most effective methods to decrease muscle stiffness is to increase muscle temperature with warm-up activities, this also increases the maximum strain and stress the muscle can endure before injury *(Safran et al., 1989; Noonan et al., 1994).* Studies in humans that have examined both stretching and active warm-up in combination have shown that the decrease in muscle stiffness is mainly a result of increased temperature from warm-up and not the effects of stretching (*Rosenbaum & Hennig, 1995; McNair & Stanley, 1996).* One study found that continuous passive motion significantly reduced the stiffness of the plantar flexors while stretching did not *(McNair et al., 2000).*

One of the latest areas of research on the acute effects of stretching uses bright mode ultrasound to examine the responses of the various components of muscle (fibers, aponeurosis, and tendon). *Kubo et al. (2002b)* studied the acute effect of stretching and contractions on the stiffness of the human Achilles tendon. The acute effect of stretching was to significantly decrease tendon stiffness (8%), but the largest effect of stretching was a 29% reduction in hysteresis. Hysteresis is the energy lost when a viscoelastic material is stretched and returns to its normal length. This is a promising area of research since ultrasound studies have also begun to document the interaction of length changes of fibers, aponeurosis, and tendons during a variety of contractions of human skeletal muscle *(e.g. Fukunaga et al., 1997; Kubo et al., 2000).*

Another factor in the acute effect of stretching involves the changes in muscle force following stretching. Stretching of muscle results in an exponential rise in passive tension in the muscle and research on animal models has shown that the force which can damage (weaken) muscle can be as low as 16 to 30% of maximum failure force or at lengthening as small as 16 to 25% (*Noonan et al., 1994; Sun et al., 1998; Tsuang et al., 1998).* Research in the last decade on humans has conclusively confirmed that an acute effect of stretching is a decrease in the static and dynamic expressions of muscular strength *(for reviews see: Knudson et al., 2000; Shrier, 2004; Weerapong et al., 2004).* A decrease between 4 and 30 percent has been observed in maximal strength tests *(e.g. Kokkonen et al., 1998; Avela et al., 1999; Nelson and Kokkonen, 2001; Marek et al., 2005),* jumping *(Church et al., 2001; Cornwell et al., 2001; McNeal and Sands, 2003: Young and Behm, 2003),* sprinting *(Fletcher and Jones, 2004; Nelson et al. 2005a),* muscular endurance *(Nelson et al., 2005b),* and throwing *(Noffal et al., 2004).* Stretch-induced decrements in muscular performance seem to be about equally related to neuromuscular inhibition and decreased contractile force *(Avela et al., 1999)* and can last up an hour *(Fowles et al., 2000).* The effect is similar in males and females, with a curvilinear dose-response and 20 to 40 seconds of static stretching resulting in significant reductions in isometric strength *(Knudson and Noffal, 2005).*

It is clear that from the standpoint of maximizing muscular performance, stretching creates an acute decrease in performance, therefore stretching should not normally be recommended prior to exercise with apparently healthy individuals, but be programmed during the cool-down after exercise training *(Knudson, 1999; Knudson et al., 2000).* The other line of evidence that supports this conclusion is that the largest, prospective studies of stretching show no effect of stretching on injury rates *(Pope et al., 1998, 2000; Amako et al., 2003).*

Chronic Effects of Stretching

The chronic or training effects of stretching have also been studied extensively, but surprisingly these effects have often differed from the acute effects of stretching. Reviews of research on stretching a variety of muscle groups report significant improvements (5 – 31% or 6 to

12 degrees) in range of motion with 3 to 6 weeks of training *(Knudson et al., 2000; Harvey et al. 2002; Guissard and Duchateau, 2004; Decoster et al. 2005).* The long-term extensibility of muscles due to stretching or physical activity are believed to be due to a myogenic response of sarcomeres and its clinical implications fairly well understood *(DeDeyne, 2001; Gajdosik, 2001).* The effects of stretch training on muscular strength and the mechanical properties of the muscle-tendon unit, however, are less clear.

A common belief in many circles is that stretch training will decrease muscle stiffness, possibly even decrease the increases in muscular stiffness that results from strength training. Like the acute effects of stretching, this belief about the chronic effect of stretching is not likely correct. The combination of stretching with isometric training does not prevent the increase in muscle group stiffness *(Klinge et al., 1997).* Other studies of stretch training alone show no effect on stiffness *(Halbertsma and Goeken, 1994; Magnusson et al. 1996b&c)* or increases in muscle stiffness *(Reid and McNair, 2004). Kubo et al. (2002a)* found no change in the stiffness of the Achilles tendon following three weeks of stretch training. When studies report decreases in passive muscle stiffness following stretch training it is often because they do not use correct definitions of stiffness, taking torque/angle slopes at standardized points in the range of motion before the linear region *(e.g. Guissard and Duchateau, 2004).* The research is fairly consistent that stretch training will not likely significantly decrease muscle stiffness, rather it may have no effect or increase muscle stiffness.

If future research were to confirm that stretching has a chronic effect of increasing muscle stiffness, it is unclear if this would be beneficial. The predominant hypothesis is that a stiff muscle may be better adapted for force transmission in concentric muscle actions, while a more compliant muscle may be better for shock absorption, stretch-shortening cycle muscle actions, and reducing risk of injury *(Wilson et al., 1991, 1994; Walshe et al., 1996).* There is very little training or basic science research to confirm or refute these hypotheses *(Owen et al. 2005).* It is unknown if a more compliant tendon that absorbs small, rapid stretches allowing the muscle fibers to remain in concentric or an isometric state would be better or worse than a stiff muscle that can absorb more energy but may force the fibers into eccentric action. The complexity of the active and passive components of muscle tension mentioned earlier and the variety of movements makes it difficult to predict what changes in stiffness in what muscle-tendon components would do to muscular performance.

It is likely that the addition of stretching following strength training bouts is effective not only in maintaining normal range of motion, but also as an additional overload stimulus that tends to increase strength adaptations *(Shrier, 2004).* The research does not support the belief that stretch training decreases muscle stiffness, but there is preliminary evidence that it may increase stiffness and decrease energy lost in recovery from stretch *(Kubo et al. 2002a).* The relationship between any muscle mechanical adaptations to stretch training and muscular performance is likely to be complex. This will be a fertile area for future research on stretching.

Conclusion

Recent research with dynamometers and ultrasound imaging has cast new light on the biomechanical mechanisms and effects of stretching. The acute effect of stretching appears to be a significant increase in range of motion mostly due to increased stretch tolerance and a significant reduction in most all forms of muscular performance. Stretching also results in significant acute stress-relaxation in the muscle, but does not appear to affect muscle stiffness/elasticity. Stretch training has a chronic effect of increasing range of motion, but also tends to increase the passive tension and stiffness of the musculature at the limits of motion. Future research of human muscle during stretching and contraction using ultrasound *in vivo* promises to help clarify the effects of stretching on active and passive components of muscle and on the many biomechanical variables of muscular performance.

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Heat Shock Proteins in Exercise: A Review

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Abstract

This review has attempted to highlight some of the most recent and original studies involving the stress response. It is clear that, especially regarding *in vivo* human studies, there is a paucity of research regarding the SPR stimulus, it's signalling system, measurement concepts, chronic adaptations, and it's practical use in both the health and elite sporting performance fields. In addition, the differences in exercise intensity, mode duration, subjects, training status etc. contribute to disparity in findings from previous studies.

Key Words: **% Body Fat, Flexibility, Cardiovascular Endurance, VO_2 max**

Introduction

Contemporary exercise physiology research has termed changes in the homeostatic balance within the whole organism as stress. Stress is defined as 'the process by which environmental events threaten or challenge the organism's well being and by which that organism responds to this threat' *(Turner, 1994).* Stressors of any nature act initially at the cellular level and are manifested as protein damage or impairment, which compromises the function and integrity of the cell. Without intervention, stressors would develop throughout cell lines and eventually affect tissues, organs and perhaps in time, the whole organism. However, a set of highly conserved proteins have been shown to accumulate at such instances and have thus been termed stress proteins (SP). It has been postulated that expression of these proteins convey a response initiated to maintain cellular homeostasis after exposure to stress. The response has been denoted in all types of cells investigated to date, and although the precise function of these proteins remains unclear, their expression in the cell allows it to survive normally lethal stresses.

The most commonly cited SP is the heat shock protein (HSP), so called because the original stressor that elicited the SP response was hyperthermia *(Ritossa, 1962).* Yet, to date, investigators have been unable to directly ascertain the stimulus and mechanism by which SP are synthesised, and further, their role is asserting stasis. Nonetheless, HSP's have been associated with a number of cytoprotective functions, including the protection of stable proteins *(Dobson and Ellis, 1998),* chaperoning and folding of nascent polypeptides *(Beckman et al., 1990),* and degradation of aggregated proteins *(Chiang et al., 1989).*

A number of conditions, including hyperthermia, ischemia, pH alterations, energy depletion, calcium variations, abnormal protein generation and oxidative phosphorylation uncoupling are known to induce the cellular stress protein response (SPR). The majority of these stressors that are met with the SPR accompany exercise and therefore exercise physiologists have experienced difficulties in drawing firm conclusions from their findings *in vivo*. A cellular stress protein response to endurance exercise for instance, may be derived from one or more of the conditions outlined above, such as hyperthermia, energy depletion and abnormal protein generation. High-intensity activity is accompanied by pH and calcium alterations and oxidative phosphorylation uncoupling. Therefore the stimulus for the SPR has proven difficult to ascertain, as has the magnitude of the SPR to individual stressors. Gaining an understanding of the way in which the SPR protects cells after exposure will aid researchers in ascertaining how exercise may provide protection to cells and tissues either for health and occupational reasons, or for elite athletes in extreme environments.

Location and Type

Heat shock proteins have a number of different forms and isoforms, which are distinguished by their molecular weight and have enabled researchers to categorise them into families. This, coupled with different sampling methodologies and species examined, makes comparisons between studies very difficult.

The 70-KiloDalton (kDa) family of HSP's are the most highly conserved (Hunt and Morimoto, 1985), and considered to be the most stress inducible of all of the HSPs. Although the precise role of this family remains unknown, it is thought that HSP70 is involved in protein synthesis *(Beckman et al., 1990),* transport *(Chiang et al., 1989),* protection from protein denaturation and aggregation, and restoring the function of damaged proteins subsequent to a stress exposure *(Zietara and Skorkowski, 1995).* The two most extensively studied proteins of the HSP70 family are the cognate (HSC73 = HSC70), and inducible (HSP72 = HSP70) isoforms. The constitutive isoform is only slightly stress-inducible *(Locke, 1997),* whereas HSP70 is highly inducible, both are situated in and around the nucleus, endoplasmic reticulum, cytosol, and mitochondria, although the locations vary depending on the particular protein. During stress episodes, the HSP72 and HSC73 isoforms migrate from the cytoplasm to the nucleus *(Welch and Feramisco, 1984),* presumably to protect protein synthesis processes. In recovery, HSP70 and HSC70 return to the cytoplasm and become associated with proteins *(Welch and Mizzen, 1988),* perhaps to repair aggregated and denatured proteins vital in normal cell functioning to restore cellular homeostasis.

Signalling

Although a number of afferent stimuli have been proposed for HSP synthesis, such as hyperthermia and reactive oxygen species generation, the efferent signal responsible for this stress response is relatively unclear. It has been postulated that the regulation of HSP synthesis is controlled via a feedback system involving heat shock transcription factors (HSF). In unstressed cells, HSF exists as a monomer in the cytoplasm and the nucleus *(Locke, 1998),* perhaps bound to HSP. Following an exposure to physiochemical stress, HSF is converted to a trimetric state and thereby acquires DNA binding activity *(Baler et al., 1993),* a process known as HSF activation. The activation of HSF has indeed been identified within minutes of heat shock *(Locke et al., 1995; Kim et al., 1995),* ATP depletion *(Benjamin et al., 1992),* hypoxia *(Giaccia et al., 1992),* exercise *(Locke et al., 1995)* and changes in pH *(Petronini et al., 1995).* During such stressors HSP interact with denatured proteins thus allowing HSF to interact with heat shock elements (HSE) on the promoter region of the HSP gene, therefore promoting their transcription *(Fehrenbach and Niess, 1999; Locke and Noble, 1995; Noble and Aubrey, 1999).* When HSP levels subsequently rise, they again bind to HSF, thereby self-regulating their own synthesis *(Noble and Aubrey, 1999).*

The binding activity of HSE was investigated during cold (6º) and heat (38ºC) exposure, and in response to α-adrenergic receptor agonist administration, in brown adipose tissue of adult male mice *(Matz et al., 1995, 1996a).* Both cold and heat exposure resulted in amplified HSE binding, with heat stressed tissue eliciting the greater response *(Matz et al., 1995, 1996a).* Yet, although HSP70 mRNA expression evoked from α-adrenergic receptor agonist treatment was similar if not greater to that induced by heat stress, minimal HSE binding was evident *(Matz et al., 1996a).* These results demonstrated that HSE-binding was not necessarily associated with the induction of HSP70 mRNA from α-adrenergic receptor agonist treatment, suggesting that different transcriptional regulatory pathways exist. Furthermore, HSP70 transcript accumulation was different in magnitude to heat and cold stressors, indicating three different induction mechanisms, these findings were also independent of changes in body temperature *(Matz et al., 1995, 1996a).*

The discovery of attenuated increases in HSP70 expression to cold stress with administration of α-adrenergic receptor antagonists, and amplified HSP70 levels with α-adrenergic receptor agonist treatment in the absence of cold stress, suggests autonomic activity may to some extent mediate HSP70 expression. Specifically, augmented sympathetic outflow through, for instance, noradrenalin, initiate HSP transcription through unknown complex signal transduction pathways *(Matz et al., 1995, 1996a, 1996b).*

This area of SPR has received very little attention in the available literature. Knowledge of the HSP expression efferent signal would enable researchers to determine the stress stimuli. In turn, this information would allow the manipulation of training regimens and acclamatory protocols to derive the optimal benefits.

Muscle Damage

The expression of HSP's after exercise may be interpreted as a marker of muscular damage. *Thompson and colleagues (2001, 2002, and 2003)* completed a series of studies, which aimed to determine the influence of muscle damage on the SPR. In their first study the researchers subjected 8 non-weight trained volunteers to two sets of 25 maximal eccentric contractions *(Thompson et al., 2001).* Muscle biopsies of the biceps brachii (BB) pre and 48 hours post exercise. The HSP70 increased by 1064% 48 hours post exercise, but these were not accompanied by changes in actin protein expression. Thus, the HSP70 response was not a result of bulk or systemic protein adaptations. The magnitude of the HSP70 expression was also large with the type of damaging exercise employed in this study, with respect to that associated with non-damaging endurance activity (e.g. *Liu et al., 1999; Vogt et al., 2001).* The authors concluded that the large calcium and protein alterations associated with damaging repetitive contractions of this nature be responsible for SP synthesis, thus Inferring a possible role of proteolysis for SP's.

A subsequent study was undertaken by ten untrained subjects whom performed two sets of 25 maximal voluntary contractions (MVC) on two separate occasions, four weeks apart *(Thompson et al., 2002).* The investigators used the eccentric component of the bicep curl (lowering portion) to induce damage to the BB, from which muscle biopsies were extracted pre and post each exercise session (i.e. B1 & B2). Indicators of muscle damage were apparent after B1, but showed smaller changes after B2; however these changes were not paralleled by HSP expression post exercise. Although the magnitude of the HSP response was the same after both bouts of exercise, the basal level prior to B2 was lower. The authors concluded that the lower basal expression of the cellular responses mediated the attenuation of damage associated with B2.

In their final study, *Thompson and co-workers (2003)* added to their earlier work by supplementing a downhill running protocol to the bicep eccentric loading utilised in their previous research. Muscle biopsies from the vastus lateralis (VL) demonstrated an increase in HSP70, though this was not as pronounced as the HSP70 accumulation derived from the BB. The elevated SPR to both forms of damaging eccentric exercise strengthened the argument for a HSP role for protein remodelling caused by mechanical rather than metabolic stress.

Despite the clarity of Thompson's findings, a number of concerns are apparent. First, both forms of eccentric activity undertaken in their methodologies would have been accompanied by both oxidative phosphorylation uncoupling, and a level of hyperthermia within the muscle. Thus, it is difficult to suggest that the elevations in HSP expression were simply due to mechanical stress alone. Although, there is a strong case for the postulation that the SPR has a role for proteolysis, this process would also be required during, and in recovery from endurance exercise, in which energy depletion, pH alterations and ROS generation would all result in protein unfolding and/or denaturation. Moreover, the results of a decreased basal HSP expression to the second exercise bout is in direct contrast to other studies that investigated stress responses to endurance activities *(Liu et al., 1999; Vogt et al., 2001; Brickman et al., 1996; Ecochard et al., 2000).*

Human Exercise Studies

In terms of studies investigating exercise, his majority of investigations have focused upon the SPR's to different modes of exercise under a number of experimental controls. Invariably these studies have focused upon the responses either during exercise, recovery and/or a second bout to identify possible adaptations.

Liu and colleagues attempted to investigate the influence of training volume *(Liu et al., 1999 & 2000)* and intensity *(Liu et al., 1999 & 2000)* upon the long-term SPR. The experimenters withdrew muscle biopsies from the VL of national level rowers whom were undertaking preparation for international competition. The rowers were prescribed a four-week training program, which progressively increased intensity up to week three, whereas the volume peaked at week two and was reduced thereafter. HSP70 expression increased five-fold and peaked at week three. This was despite a reduced training volume between weeks two and three, suggesting a possible time-delay between HSP70 translation and accumulation. *Liu et al., (1999)* also discovered a reduced creatine kinase (CK) level in the blood with training, inferring that HSP70 may possibly provide some protection. The major finding of this investigation however was that HSP70 accumulated despite the reduced training volume between weeks two and three, the intensity between these two sampling points did increase, thus implying that training intensity is the predominant stimulus for the SPR.

The subsequent article by *Liu et al., (2000)* supported their earlier findings. In this experiment well trained rowers were divided into two training groups, A and B. Group A performed higher intensity training during phase one, whereas group B performed higher intensity training during the training phase two. Both training intensity and volume were reduced in the final phase. The HSP70 accumulation was related to the intensity of the training i.e. greater in group A during phase one and greater in group B after phase two. Furthermore, HSP70 expression was reduced in both groups as a result of the reduced phase three training load.

These two investigations appear to demonstrate the occurrence of an acute response to the training stimulus. However, as the participants involved in *Liu and co-worker's studies (1999, 2000)* were highly endurance trained, and were therefore frequently exposed to the stressors known to evoke a SPR (i.e. hyperthermia, hypoxia, and pH alterations.). This work did not allow an analysis of the chronic SPR profile, thus it is unclear how long-term exercise regimens adopting a sustained training volume and intensity would adapt the HSP response of whole organism.

The acute response to exercise induced stress is commonly denoted by an immediate expression of HSP mRNA, which indicates enhanced HSP transcription rates *(Febbraio and Koukoulas, 2000; Ferenbach et al., 2000b),* and a greater HSP expression later in the post exercise (PX) period *(Khassaf et al., 2001; Ferenbach et al., 2000a, 2000b). Febbraio and Koukoulas (2000)* exercised five healthy, yet untrained individuals at 63% of peak oxygen uptake (VO_2peak) to fatigue. Muscle biopsies were taken from the VL at rest, 10 minutes, approximately 40-minutes before fatigue (F-40), and at fatigue (F). The HSP72 mRNA did not statistically increase by 10-min, although, significant elevations of 2.2 ± 0.5 and 2.6 ± 0.9 fold were noted at F-40 and F respectively. Therefore HSP72 mRNA increased progressively during acute concentric cycling exercise. Interestingly, blood lactate (BLa) and muscle temperature increased at the 10 min sample period, but these were not paralleled by HSP72 mRNA accumulation. Thus, the authors speculated that heat and Bla were not independently responsible for the SPR. However, it is more likely that a time lag between the stressor and gene transcription exists.

Fehrenbach and colleagues (2000b) also found that HSP transcription in leukocytes was apparent immediately after athletes ran a half-marathon. Furthermore HSP72 expression was elevated above resting levels at both three and 24 hours post exercise *(Ferenbach et al., 2000a, 2000b).* In contrast, however, eleven moderately trained males and females did not display increased HSP70 levels at either 15 or 24 hours after a 60-minute run at 70% VO2max *(Shastry et al., 2002).* It is possible that the contradicting results were caused by the different cellular locations investigated.

A longer time-course of HSP expression was profiled by *Khassaf and co-authors (2001).* Muscle biopsies were taken from the VL at rest, and one, two, three and six days after one-legged cycling at 70% VO_2peak for 45 minutes. The concentric nature of the bout did not elicit muscular damage, denoted no-increase in CK activity at any of the sampling times over the six days. The results from this study were however, somewhat clouded by a high level of inter-individual variability. Thus HSP70 levels were only statistically increased after six days post exercise, although a steady progression was observed throughout.

The elevated HSP levels six days PX presented by *Khassaf et al. (2001)* were supported by findings from another study *(Vogt et al., 2001).* Here, untrained participants undertook five 30-minute cycling bouts at varying intensities, which were mediated by BLa responses every week for six weeks *(Vogt et al., 2001).* High-intensity (~4-6mmol/l BLa) activity elevated the constitutive HSP70, although muscle biopsies were taken just 24 hours post exercise, which may be indicative of an acute response rather than a cellular adaptation. Nevertheless, the accumulation of constitutive HSP70 has been shown after 4 weeks of intense endurance activity *(Liu et al., 1999).*

Another method of estimating the SPR to chronic exercise regimens involves comparing cellular responses of trained (TR) and untrained (UT) subjects. Only three studies to date have made this comparison *(Ferenbach et al., 2000a, 2000b; Shastry et al., 2002),* and each discovered that basal HSP70 expression was reduced in TR individuals, therefore HSP70 expression is down regulated with endurance training. In addition, *Fehrenbach et al. (2000b)* demonstrated that TR subjects displayed a greater number of HSP70 transcripts with respect to their UT counterparts. Taken together, these studies suggest that endurance activity provides protection by reducing the threshold for HSP70 transcription. The down-regulation in basal HSP70 expression in these studies is likely to be due to the higher oxidant stress threshold encompassed in the TR. It remains to be investigated whether a chronic non-damaging exercise program will derive similar SPRs.

The differences in stress response to acute and chronic stress are depicted in the literature as thermotolerance and acclimatization respectively *(Moseley et al., 1994).* Thermotolerance is the cellular adaptation to an acute stress exposure that allows the organism to survive a subsequent lethal exposure, with the severity of the initial stressor exposure positively related to the magnitude and duration of thermotolerance *(Kregel, 2002).* Contrastingly, acclimatization is the ability to perform greater work in a given stressful environment, for example in the heat due to heat dissipation improvements caused by repeated mild elevations in core temperature *(Moseley, 1997).* It was previously considered that thermotolerance had a short life-span of just several hours, denoted by HSP induction and decay associated with HSP70 induction and degradation *(Moseley, 1997; Kregel, 2002).* Recently, it has been established that thermotolerance may last up to 3-5 days in duration *(Kregel, 2002; Khassaf et al., 2001).* Acclimatization unlike thermotolerance allows an equilibrium to be maintained at a given work-rate in stress-prolonged periods. Unfortunately, as the full time-course of HSP expression following different stressors is still to be elucidated, a clear distinction between acquired thermotolerance and acclimatization remains elusive.

Thus far the attempt to determine the specific stimulus for the SPR associated with exercise has proved difficult, and human *in vivo* investigations are rare due to their highly invasive nature. *Vogt and co-*

workers (2001), attempted to manipulate the oxidative stress during exercise by using different exercise intensities and simulating various levels of oxygen availability. After a six-week training intervention the authors discovered that their previously untrained participants increased their basal HSP70 mRNA levels after high intensity bouts under conditions of both normoxia (146.5%) and simulated hypoxia (137.7%) at 3850m above sea level. Low intensity training below the lactate threshold did not evoke a HSP70 mRNA expression regardless of the O2 availability. These results led the authors to conclude that metabolic stress caused by the high-intensity activity, rather than simulated hypoxia, is the primary influence upon HSP70 transcription. *Vogt et al. (2001)* suggest that the accumulation of lactate and pH alterations may be the primary stimuli for HSP expression from exercise. However, this study design was not able to control the effects of heat gain during exercise. The high-intensity exercise would have generated a greater local heat load and perhaps consequently elevated HSP transcription. Moreover, the biopsies were taken just 24 hours post exercise, and the acute response may also have been responsible for elevated constitutive HSP70.

Animal Exercise Studies

In vivo animal studies have enabled researchers to control erroneous variables and have administered more invasive but accurate measurement techniques. Furthermore, higher sampling frequencies can be employed with animal studies, and therefore investigations of this nature have provided more research regarding the time-course profile of HSP levels and their adaptation to a chronic exercise regime. Human studies have inferred that exercise training may dampen the volume of HSP70 expression in the muscle or blood cells, but this stimulus elevates the HSP70 mRNA levels. This has been postulated to be the result of a lowered threshold for HSP production at the onset of stress *(Fehrenbach et al., 2000b; Maloyan et al., 1999).* However, the basal levels and acute response to exercise have still to be determined from a chronic training study, as to date such inferences have been made from TR Vs UT cross-sectional comparisons. Animal studies have been able to investigate these responses. *Ecochard and co-workers (2000)* found that after just two weeks of training, male rat basal HSP72 levels were elevated, yet these levels were not further increased after eight weeks of chronic exercise. *Brickman et al (1996)* found that only after 63 days of training, was the basal HSP content amplified. In addition, the acute response to exercise demonstrated an augmented HSP level in the TR compared with UT controls. Interestingly, repeated electrically stimulated muscle contractions evoked a peak HSP70 response at 18-24 hours PX *(McArdle et al., 2001).* Despite the wide variation in the time-to-peak HSP response derived from animal studies, these responses are markedly quicker than those displayed by human subjects *(e.g. Khassaf et al., 2001).* Yet, many human studies have utilised sampling frequencies that may have been insensitive to determine the peak SPR.

Reasons for the large variation in the time profile of the HSP response include the nature, intensity and duration of the stress imposed. *Demirel et al., (1999)* ran female rats at 70-75% VO2max for either 30, 60 or 90 minutes per day for 10 weeks. After the final exercise bout, 24 hours later, HSP72 concentrations were identified from the adrenal glands. All durations of exercise elicited increased HSP72 levels compared to a sedentary control group. Moreover, HSP72 levels elevated with increasing daily exercise duration, demonstrating a role for training volume in the SPR, directly contrasting with the results from human studies *(Liu et al., 1999, 2000).*

Another factor, which may have equal relevance, is the site from which the HSP has been extracted. Even if muscle samples were utilised universally, the variation in muscle fibre typology may profoundly influence the SPR manifested. Although this hypothesis is yet to be justified in human subjects, a number of animal studies have extracted biopsies from different muscles. Acute stress exposures to electrical muscle stimulation and hot water immersion of the rodent hindlimb, produced a more rapid response in the soleus muscle (< 2 hours), which is known to have a larger proportion of type I muscle fibres *(Oishi et al., 2002; McArdle et al., 2001).* These slow muscles also demonstrated a larger basal level of HSP72 and thus an innate ability to synthesise HSP72 *rapidly (Oishi et al., 2002; McArdle et al., 2001; Kelly et al., 1996; Ecochard et al., 2000).* Muscles composed predominantly of type II fibres such as the plantaris and the extensor digitorum longus (EDL) produced an elevated HSP72 expression which peaked at 48 and 24 hours post exercise respectively *(Oishi et al., 2002; McArdle et al., 2001).* The muscle specific chronic SPR has shown that the greatest increases in basal HSP expression have transpired in faster muscles *(Kelly et al., 1996),* such that no differences between the muscle types were denoted.

The cause of the elevated HSP expression after training in predominantly type I muscle has been attributed to myosin heavy chain production and protein resynthesis. However, recent studies have negated this postulation, by discovering that HSP72 was only correlated to myosin heavy chain in sedentary populations *(Kelly et al., 1996),* and consequently muscle fibre typology did not change with chronic stress exposure *(Ecochard et al., 2000).* The latter study manipulated the oxidative stress caused during chronic exercise training by occluding the iliac artery in male rats *(Ecochard et al., 2000).* HSP72 accumulation was greater in the ischemic hindlimb by 40% when superimposed on exercise training; however, this adaptation was not apparent in UT and one-week TR rats. Furthermore, the SPR was not associated with mitochondrial oxidative capacity of the occluded limb, as although cytochrome oxidase and citrate synthase activities increased with training, these changes were prevented by arterial insufficiency.

Kelly and co-investigators (1996) also exposed rats to an elevated oxidative stress by restricting vitamin E supplementation. Vitamin E is the primary intramembrane antioxidant and membrane stabiliser, thus depletion disrupts organelle membrane function. In addition, vitamin E depletes oxyradicals and disrupts the chain reaction of phospholipids peroxidation initiated by reactive radicals *(Halliwell & Gutteridge, 1989).* Taken together these processes were hypothesised to enhance the oxidative stress experienced by exercising muscles and thus evoke a HSP response. The results of this study indicated that the HSP expression was not increased in vitamin E deprived rats with aerobic exercise training when compared to the exercised control group (vitamin E supplemented). The authors speculated that their methodology was not sufficient to generate oxidative stress.

The role of hyperthermia in the HSP response, independently of exercise, has not been investigated in great detail. Muscle biopsies from rat hindlimbs immersed in 42˚C water for one hour, manifested an immediate HSP72 response, and these amplified levels were sustained for four hours in the soleus muscle before returning to basal levels *(Oishi et al., 2002).* In contrast, HSP72 concentration in the plantaris was unaffected until 12-hours post heat exposure, yet the HSP72 accumulation remained higher than basal levels at 24, 36, 48 and 60 hours post exposure. Again, these differences were attributed to higher protein turnover in slow muscle, coupled with their innate ability to synthesise HSP72 more rapidly. The magnitude of the HSP response in both muscle types was lower than that produced after exercise stress, inferring that oxidative stress may be the primary stimulus for the SPR. *Salo et al., (1991)* discovered that HSP70 transcripts and the protein itself were increased subsequent to both exercise to exhaustion and *in vitro* heat shock (~42˚C) of isolated tissues for 2 hours. Induction was greater in active muscle and liver tissue samples after exercise in comparison to an acute heat exposure.

Nonetheless, to date, studies have not measured local temperature of the cell extraction site, either during or post exercise, thus the role of hyperthermia should not be underestimated. Indeed, *Walters (1998)* found that although HSP70 increased similarly with both active and passive heat stress in male rats, HSP70 in various regions of the brain was correlated with hypothalamic temperature. In addition, active heating in moderate ambient temperatures (~24˚C) did not evoke a central HSP70 response. More conclusively, exercise *per se* did not increase HSP70 in the brain without hyperthermia. Yet again though, the SPR was investigated from a different tissue, in this case from the brain, therefore making comparisons between studies extremely complex.

Studies have not yet been able to delineate the effects of hyperthermia and exercise on the heat shock response. *Skidmore et al., (1995)* however, attempted to achieve this by exposing male adult rats to passive and active heating protocols in different ambient temperatures (36-42 Vs ~14˚C). Although, passive heating increased HSP70 expression in soleus, gastrocnemius and left ventricle tissues, HSP70 increases were greater in the active heating trials and exercise in the cold. These findings suggest that factors associated with exercise have a greater effect on the SPR than the independent influence of heat. However, sufficient intensity of heat shock (≥ 41 ºC) independently stimulates a stress response *(Skidmore et al., 1995; Salo et al., 1991; Oishi et al., 2002; Flanagan et al., 1995). Flanagan et al., (1995)* studied the effects of heating rates of male rats *in vivo*. The rodents were exposed to low (0.045˚C/min) and high (0.166˚C/min) heating rates until colonic temperature reached 42˚C, at which point they were cooled passively in ambient temperatures of 22-24˚C for four hours before tissue samples were withdrawn. Both heating protocols induced HSP72 expression in the small intestine, liver and kidney, with the greatest response denoted in the liver tissue samples, where HSP72 increased 21-fold compared to baseline concentrations. Despite experiencing a lower thermal load (time colonic temperature was maintained ≥ 40.4˚C), the animals exposed to the higher heating rate showed greater concentrations of HSP72. The results presented by *Flanagan et al., (1995)* infer that the rate of heating is very important in respect to HSP72 synthesis. However, these results should be interpreted with caution, as heat induced vasoconstriction may result in ischemia of the gut and liver, which subsequently may amplify the stress experienced *(Kregel et al., 1988; Kregel and Gisolfi, 1989).*

Very little work has been undertaken concerning heat exposure *per se* in human subjects. *Fehrenbach et al., (2000b)* exposed resting human leukocytes to an *in vitro* acute heat shock (42˚C) for two hours. The heat stimulus was sufficient to induce a HSP70 mRNA increase, showing higher increases in trained individuals compared to their sedentary counterparts *(Fehrenbach et al., 2000b).* Unfortunately, the time-course and the magnitude of the HSP70 protein expression were not examined here. *Schneider et al., (2002)* reported that one hour of heat shock at 42.5˚C induced HSP70 accumulation in peripheral blood mononuclear cells three hours post exposure. The up-regulation of HSP70 was sustained until 12 hours, but declined after 24 hours of incubation at control temperatures (37˚C).

Maloyan et al., (1999), performed the most comprehensive study undertaken to date to determine the HSP response to chronic and acute stress. The authors exposed 3-wk-old rats to short (1-2 days) or long-term (30 days) periods of heat acclimation at 34˚C. The acute response was measured immediately after a two hour exposure to either a 41 or 43˚C environment in both acclimated (AC) and control groups. After 30 days of heat acclimation, peak HSP72 mRNA level was attained earlier after an acute heat shock, and the resting stock of inducible HSP72 was increased with respect to the control group. Whereas the short-term heat acclimated rats did not manifest altered HSP levels. The acute response to heat strain trials indicated that HSP72 accumulation was faster with augmentation of the stress and that the time-to-peak HSP response was four-times quicker in AC than in the control group (1 Vs 4 hours respectively). These results supported the notion of an altered threshold for the mobilisation of HSP's with acclimation. However, *Moloyan et al. (1999)* used direct heat exposure as their stressor, whereas other studies have used exercise to generate a SPR in both *animals (e.g. Brickman et al., 1996; Echochard et al., 2000; McArdle et al., 2001; Samelman and Always, 1996; Kelly et al., 1996)* and humans *(Liu et al., 1999, 2000; Khassaf et al., 2001; Ferenbach et al., 2000a, 2000b; Febbraio and Koukoulas, 2000; Shastry et al., 2002; Vogt et al., 2001).* Moreover, *Maloyan et al. (1999)* extracted a sample from cardiac tissue, other studies have utilised blood or muscle samples.

The time-to-peak HSP response from an acute stress exposure has varied. Rats exposed to a similar heat (42˚C) to that administered by *Maloyan et al (1999)* displayed a more prolonged response, peaking at 48 hours post exercise *(Oishi et al., 2002),* although wet heating rather than dry was used in the more recent study, which is known to transfer a greater thermal load at a quicker rate *(Armstrong, 2000).* Also, the HSP response was identified within a muscle sample in the Oishi et al. (2002) study, which is more likely to be affected by a thermal stress than the more centrally located cardiac tissue extracted by *Maloyan and colleagues (1999).*

Implications

Although the specific function of HSP's have not yet fully been comprehended, it is clear that their expression confers some form of protective response to stress. Therefore, a greater understanding of the SPR's stimuli and signal would enable coaches and athletes to design appropriate and effective training schedules. If HSP's are expressed in this manner, their content may also provide a marker of the stress experienced in both physical and occupational tasks. The altered threshold for HSP accumulation may also provide us with new information regarding acclimation, helping scientists to devise optimal exposure protocols. Finally, if HSP's are produced in response to heat shock, then their content may also provide an index of the heat strain exposed during a particular activity.

Future Directions

The literature reviewed in this article is diverse, in terms of its sample population, site, frequency and methodology. Many of these articles require further support work to collaborate their findings. The main areas for further research centre around the stimulus for the HSP response. Various human and animal studies have attempted to manipulate one of the many factors thought to induce a SPR, such as hyperthermia *(Mizzen and Welch, 1988; Li et al., 1995), ischemia (Emami et al., 1991; Gray et al., 1999),* pH alterations *(Weitzel et al., 1985; Gapen and Moseley, 1995),* energy depletion *(Febbraio and Koukoulas, 2000; Febbraio et al., 2004),* calcium accumulation *(Kiang et al., 1994)* and abnormal protein generation *(Chiang et al., 1989).* However, many of these studies have utilised exercise as the primary stressor, yet it is known that many of the factors listed above are associated with exercise. The few investigations that have attempted to isolate a specific stimulus have lacked the appropriate controls, and there are still more factors that remain to be investigated.

One of the major fields of study within the discipline of stress response is the time-profile of the response and it's adaptation in the acute response from chronic stress exposure References. Past research detailed earlier has studied the acute response over either-short or long sampling periods, which are often insensitive to the peak and time-to peak HSP accumulation. However, the variation of sample populations such as human, animal, trained and untrained; and different sampling sites (muscle, liver, brain, leukocytes etc.) makes firm conclusions extremely difficult. To date, there is no study that has investigated the acute response to a stressor after chronic exposure in sufficient detail. The few studies that have, did not control various factors associated with exercise, moreover, chronic exposure to heat, hypoxia and high intensity activity are still to be analysed.

One area of interest is the role of hyperthermia in the HSP response. This area has been under-researched in the human population. Many have reported the SPR, yet no studies have simultaneously monitored the local temperature at the sampling site i.e. muscle, blood, cardiac and cerebral temperature, thus associations between temperature and the HSP response have been indirect thus far. It may be possible to control the local temperature of muscles by water immersion or by wearing a water perfused suit, such strategies would allow a subject to exercise at a given intensity without affecting the local body temperature. An investigation of this nature would aid researchers to determine the magnitudes of the stress response to various stimuli. Similarly, active versus passive heating protocols have yet to be utilised in human subjects. This procedure may enable investigators to delineate the effects of heat and exercise on the HSP70 response.

The signalling system for HSP transcription is also still to be elucidated. It is possible that the rate of reduced parasympathetic withdrawal is associated with the SPR *(Maloyan et al., 1999).* Certainly this area requires further research, and with the contemporary non-invasive measurement of cardiac autonomic activity via heart rate variability, such research is feasible.

One major area for future research involves the measurement site of the SPR. The available literature has so far sampled from muscle, blood, cardiac tissue and cerebral regions. Although, the various areas will derived different results to different stressors, these sample site variations have yet to be quantified. Can HSP expression from the blood accurately measure the stress response from a daily training regimen? Does sampling form the blood accurately monitor the acute response? If yes, then daily blood letting will allow optimal training strategies to be implemented and overtraining symptoms can be avoided.

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A Comparison of a Vegetarian and Non-Vegetarian Diet in Indian Female Athletes in Relation to Exercise Performance

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Abstract

The study was conducted to explore the prevalence of vegetarianism and non-vegetarianism amongst the Indian female athletes and its effects on nutritional status and exercise performance of the subjects. Sixty four women national athletes attending national camps in preparation of international competition in the age group of 16-25 yrs participated in the present study. Anthropometric measurements viz; height, weight, body fat and lean body mass were taken and dietary intake pattern was assessed through 24 hour recall method. Performance was assessed by graded exercise till exhaustion. Blood samples were taken prior to exercise for assessment of haemoglobin. Results showed prevalence of non-vegetarianism was high amongst Indian sports women (61.9%) than lacto (22.2%) and ovolacto vegetarians (15.9%). None of them were pure vegetarians. Body fat was significantly higher among lacto vegetarians (27.2 $\pm$ 4.2%) than non- vegetarians (24.3 $\pm$4.0%) and ovolacto vegetarians (23.1$\pm$1.92%). No significant difference was found for energy and carbohydrate intake between the three groups. Protein intake was significantly higher in non – vegetarians as compared to ovolacto vegetarian and lacto vegetarian group ($p<0.01$) and fat intake was higher in lacto vegetarians as compared to ovolacto vegetarian and non vegetarian group ($p<0.01$). B-complex vitamins, iron intake, haemoglobin concentration ($p<0.05$) were high in non-vegetarians. Calcium and fibre intake was high in lacto-vegetarians ($p<0.05$). Endurance time and recovery was better in non-vegetarians than other groups ($p<0.05$). The present study shows prevalence of non-vegetarianism was high in Indian National sports women than lacto, ovolacto vegetarianism. Some nutrients intake, haemoglobin level and endurance time was better in non-vegetarians than lacto or ovolacto vegetarians.

Key Words: **Prevalence, Dietary Intake, Nutritional Status, Endurance Time, Indian Sports Women**

Introduction

In India due to the various socio-economic and religious beliefs, the dietary habits vary amongst different populations. An increasing number of athletes are adopting vegetarian diets for ecological, economic & religious reasons *(Nieman, 1999).* A well-planned and varied vegetarian diet is perfectly consistent with good health and can potentially reduce the risk of many chronic diseases *(White & Frank, 1994).* Physical activity, athletic performance, and recovery from exercise are enhanced by optimal nutrition *(Joint Position Statement, 2000).* Multiple benefits of vegetarian dietary practices that extend to enhanced physical fitness and performance have been explored since the early 20th century *(Nieman, 1988).* Athletes who were practicing meatless dietary regimen most frequently reported low energy intake, along with low levels of vitamins and minerals *(Lukaski, 1995)* particularly B-complex, calcium, iron, and zinc *(Grandjean, 1987, Seiler, 1989).* However vegetarian diets can meet the nutritional requirements of athletes with appropriate selection of foods *(Joint Position Statement, 2000).* Many studies have been conducted to compare the athletic ability of vegetarian vs. non-vegetarian subjects, but, no difference has been reported *(Cotes et al., 1970, Williams, 1985, Hanne et al., 1986).* Few recent investigations relating vegetarian diet to performance have been published but the prevalence of vegetarianism among athletes has not been well researched *(Bachrach et al., 1990).*

The present study investigates the prevalence of vegetarianism among Indian sports women and possible differences between non-vegetarian, ovolacto and ovovegetarian diets in relation to performance of the sports women preparing for high-level competition.

Materials and Methods

Subjects: 64 women national athletes attending national camps in preparation of international competition in the age group of 16-25 yrs participated in the present study. Subjects were divided into 3 groups according to their dietary patterns-

a) Non-vegetarians
b) Lacto vegetarians
c) Ovolacto vegetarians

Subjects were classified as non-vegetarians if foods of plant and animal origin, including meat, fowl, eggs, milk and other dairy products, and fish were included in their diet; lacto vegetarians if foods of plant and dairy products were included in their diet; ovolacto vegetarian if foods of plant origin, with milk and other dairy products and eggs were included in their diets.

Anthropometry and body composition

Body mass was measured with accurately calibrated electronic scales (Seca Alpha 770) to the nearest 0.1kg, and stature with stadiometer (Seca 220) recorded to the nearest 0.5 cm. Body density was estimated from the sum of the skin folds sites viz; biceps, triceps, subscapular and suprailiac *(Durnin and Womersely, 1974).* Percentage of body fat was calculated using equation of *Siri (1956).* Lean body mass was calculated by subtracting fat mass from total body mass.

Nutrient intake

To collect the dietary information, 24 hour recall and weighment method was used. Nutrients like Calorie, carbohydrate, protein, fat, calcium, phosphorous, iron, zinc, vitamin A, vitamin B_1, vitamin B_2, vitamin B_3, vitamin C and fibre were calculated by using table of food composition, ICMR, 2000 *(Gopalan et al., 1974).* Nutrient intake was compared with recommended dietary allowance, which was given by ICMR.

Exercise Testing

Participants were advised not to engage in strenuous activities two days before an exercise test and not to exercise on the day of the test. Individuals were requested to maintain their normal diet. There after a treadmill test was performed to determine the heart rate responses to graded exercise so as to find out the sub maximal responses in cardiovascular system. The time taken till exhaustion was recorded to determine the maximal endurance performance. The test protocol started with 6 km/h speed and there after increased by 2km/h after every 2min.This protocol was continued until the subject got exhausted. Venous blood was taken to assess the haemoglobin concentration of the subjects

Statistical analysis

Statistical Package (SPSS 11.00) was used for analysis of data. Values were presented as Mean and Standard Deviation. Percent distribution was computed to determine the prevalence of vegetarianism among subjects. One way analysis of variance followed by Scheffe's test was used to find out whether the difference of means in each parameter between the groups was significant. Differences were considered significant at p<0.05 level and p<0.01 level.

Results and Discussion

Prevalence of non-vegetarianism was highest among sports persons. Among subjects none of them were vegetarians.61.9 % of subjects were non-vegetarians, 22.2% were lacto vegetarians and 15.9 % were ovolacto vegetarians (Table.1).

Table 1. Prevalence of non-vegetarianism and vegetarianism among subjects

Dietary pattern	Total (64)	Prévalence (%)
Non vegetarians (NV)	39	61.9
Lacto vegetarians (LV)	14	22.2
Ovo lacto vegetarians (OLV)	11	15.9

Table 2. Morphological characteristics of the subjects

Parameters	NV	LV	OLV	'F' Value
Age (yrs)	19.30 ±2.79	18.40 ±2.13	17.60 ±1.34	2.27NS
Height (cm)	167.21 ±8.60	164.64 ±7.13	169.65 ±9.26	1.04 NS
Weight (Kg)	60.47 ±8.36	60.35 ±7.06	63.2 ± 6.78	0.55 NS
Body fat %	21.1 ±1.9	27.2 ±4.2	24.3 ±4.0	4.14*
Lean body mass (kg)	45.52 ±5.67	43.41 ±5.87	45.19 ±5.45	1.06NS

*Significant at p<0.05, NS- Not significant

Morphological characteristics of the subjects are presented in *Table 2*. No significant differences were found amongst the groups for height, weight and lean body mass. However, body fat was significantly higher among lacto vegetarians (p<0.05) than non -vegetarians and ovolacto vegetarians.

Table 3. Macronutrient intake of the subjects

Macro Nutrients	NV	LV	OLV	'F' Value
Energy (kcal)	3133 ±484	3449 ±425	3030 ±692	2.55NS
Carbo-hydrate (g)	408.6 ±72.5	424.7 ±58.3	398.3 ±115.8	0.36NS
Protein (g)	151.9 ±24.5	106.7 ±15.4	111.7 ±16.7	29.11*
Fat (g)	96.28 ±13.99	148.6 ±26.7	131.4 ±26.8	41.41**

*Significant at P<0.05, ** Significant at p<0.01, NS Not significant

Further, a look at their macro nutrient intake (Table.3) shows that intake of carbohydrate and energy was not significantly different in any group. Protein intake was higher in non-vegetarians as compared to other groups (p<0.01) and fat intake was higher in lacto vegetarians as compared to non-vegetarians and ovolacto vegetarians (p<0.01).

Calcium intake was found to be significantly higher among lacto vegetarians (p<0.01) than other groups (Table.4). Iron intake was found to be higher in non-vegetarians as compared to the other two groups (p<0.05). No significant differences were found for zinc intake amongst groups. Riboflavin and Niacin intake was higher in non-vegetarians (p<0.01) as compared to lacto and ovolacto vegetarians. No significant difference was found amongst groups for thiamine and vitamin-C intake. A significant difference (p<0.05) was found for and *B*- carotene amongst the groups. *B*- carotene intake was found to be higher in non-vegetarians as compared to the other two groups. Fibre intake was more among lacto and ovolacto vegetarians as compared to non-vegetarians

Table 4. Micronutrient intake of the subjects

Micro nutrients	NV	LV	OLV	'F' Value
Calcium (mg)	1428.1 ±255.2	2693.3 ±594.4	1932.2 ±605.1	48.45**
Iron (mg)	22.7 ±1.88	21.8 ±1.67	20.8 ±2.33	4.39*
Zinc (mg)	6.08 ±0.91	6.13 ±0.76	5.89 ±1.13	0.24 NS
Vitamin-A (µg)	2496.5 ±276.6	2411.2 ±307.56	2162.7 ±590.1	3.67*
Vitamin-B1 (mg)	2.05 ±0.33	2.02 ±0.55	2.00 ±0.84	0.06 NS
Vitamin-B2 (mg)	1.91 ±0.30	1.45 ±0.22	1.77 ±0.48	10.46**
Vitamin-B3 (mg)	11.04 ±1.26	9.23 ±1.50	7.96 ±1.36	25.62**
Vitamin-C (mg)	61.42 ±22.8	77.1 ±35.7	72.17 ±15.5	2.25 NS
Fibre (gm)	8.71 ±2.82	11.94 ±3.59	10.67 ±2.43	6.12**

*Significant at p<0.05, **Significant at p<0.01, NS Not significant

Total exercise time was noted to find out the exercise performance. Non-vegetarians were able to carry on the exercise for a longer time than lacto vegetarian and ovolacto vegetarians (p<0.01). Ovolacto vegetarians performed better than lacto vegetarians. Heart rate responses during rest, sub maximal, maximal exercise and recovery were noted and the presented in figure.1.No significant differences were found among subjects for resting heart rate, sub maximal and maximum heart rate. A significant difference (p<0.05) was found among groups for the 2nd and 3rd min recovery heart rates. Recovery was faster among lacto vegetarians as compared to non-vegetarians and ovolacto vegetarians (table.5).

Table 5. Physiological and Biochemical parameters of the subjects

PARAMETER	NV	LV	OLV	F Value
Endurance time (min)	15.77 ±3.59	12.18 ±2.62	14.63 ±2.34	6.34**
RHR (b/min)	80.41 ±10.84	85.92 ±8.87	82.8 ±10.5	3.04NS
12th min HR(b/min)	169.9 ±27.26	178.72 ±7.87	180.2 ±9.17	1.26NS
14th min HR (b/min)	179.1 ±10.59	180 ±1.00	187.2 ±4.78	1.15NS
16th min HR (b/min)	186.0 ±7.74	189± 1.00	191.3± 6.42	0676NS
Max HR (b/min)	184.0 ±9.39	189.0 ±8.59	188.0 ±8.67	1.84 NS
1 min Rec HR (b/min)	121.7 ±15.17	118.1 ±19.5	134.8 ±22.9	2.89 NS
2 min Rec HR (b/min)	104.6 ±14.8	93.0 ±16.4	112.9 ±16.4	5.2*
3 min Rec HR (b/min)	96.8 ±12.9	88.8 ±14.0	103.7 ±15.3	3.6*
Hemoglobin (gm/dl)	13.2 ±1.20	12.3 ±0.74	12.5 ±1.25	3.8*

*Significant at p<0.05, ** Significant at p<0.01, NS Not significant

Hemoglobin concentration was found to be significantly different amongst groups (p<0.05). Non-vegetarians were found to have higher hemoglobin concentration than ovolacto and lacto vegetarians.

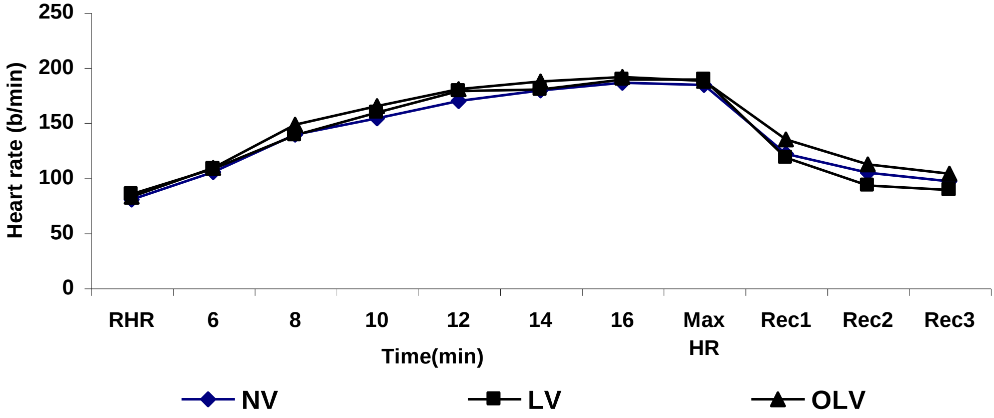

Figure 1. Heart rate responses of the subjects during rest, sub maximal, maximal and recovery period.

Prevalence of vegetarianism is high among Indian population *(Majumdar, 1974),* but the present study shows that among Indian sports women prevalence of non-vegetarianism is high**.** This may be because of Indian diets, which are essentially high carbohydrate diets; their staple being cereal and leguminous products with an inclusion of 3-4 exchanges of vegetables and fruits each. To this, the non-vegetarian adds 2-3 portions of meat and eggs where as ovolacto vegetarians and lacto vegetarians add eggs and/or milk products. Such diets are adequately high in carbohydrate as recommended in sports nutrition guidelines *(NIN/ICMR, 1985).*

In the present study there was a significant difference for body fat ($p<0.05$). Among subjects' lacto vegetarian and ovolacto vegetarian body fat was higher than non-vegetarians. Vegetarians have less body weight and low skin folds *(Eisinger, 1994).* In Indian context lacto and ovolacto vegetarians were consuming more dairy products and high fat foods. Higher body fat in lacto and ovolacto vegetarians may be due to consumption of dairy products such as whole milk, ghee, paneer and high fat foods. This was also evident from their fat intake which was higher than >30% in lacto and ovolacto vegetarians.

No significant difference was found between groups for energy intake in the present study for Indian sports women but mean intake was higher in lacto vegetarians than other groups. Some studies showed that Vegetarians, especially vegans, have lower energy intakes and more difficulty meeting energy requirements than non-vegetarians due to the low caloric density of their diets *(Nathan et al., 1996).* Energy intake of Indian female athletes ranges between 3030 Cal to 3449.3 Cal. The major source of energy from their diet was from carbohydrate >fat >protein.

Sports nutrition guidelines recommend that 60- 65 % of total energy should come from Carbohydrates.50-55% of these should be from complex carbohydrates, and only about 10% from simple sugars. High Carbohydrate diets optimise muscle and liver glycogen stores

(Bergstrom et al., 1967, Nilsson & Hultman, 1973) and optimise performance during prolonged, moderate intensity exercise *(Hargreaves et al., 1984)* and short duration high intensity exercise *(Maughan & Poole, 1981, Widrick et al., 1993, Larson et al., 1994 and Pizza et al., 1995).* In this study there is no significant difference between three groups for Carbohydrate intake and all the groups' intakes could not meet the recommended dietary allowances. Carbohydrate intake of Indian sports women was only 50% from total calories, which could not meet the RDA. This shows their low intake of carbohydrate from the diet. Carbohydrate intakes are inadequate it is difficult to replenish glycogen stores used during exercise *(Bergstrom et al., 1967).*

Protein requirements are not different for the vegetarian athlete: 1.2 to 2 gm protein per kg of body weight is practiced depending on sport and duration *(Millward et al., 1994, Lemon, 1995).* Studies showed that vegetarians and lacto, ovolacto vegetarians can meet or exceed the requirements *(Janelle & Barr, 1995).* In this study non-vegetarians and ovolacto vegetarians could meet their recommended protein (15-20% from total calories) but lacto vegetarians' intake was less than 15% from total calories and could not meet the RDA.

Dietary fat should make up the reminder of energy intake after Carbohydrate and protein needs are met. The American, Canadian and Indian Dietetic Associations recommend that <30 % of total energy intake should come from fat *(ADA, 1993).* In Indian context non-vegetarian fat intake could meet the RDA (27.65%) but lacto (38.8%) and ovolacto vegetarian (39%) intake was much higher than RDA >30%. This could be due to higher intake of dairy products and fat rich foods such as paneer, sweets, ghee, whole milk etc.

There was no shortage of calcium, vitamin –C and B carotene in all three groups but shortage of iron, zinc, thiamine, riboflavin and niacin vitamins amongst all the subjects than recommended allowances. A lactovegetarian and ovovegetarian diet may have shortage of iron, calcium, iodine, selenium, zinc, riboflavin, vitamin D and vitamin B_{12} *(Belko, 1987, Soares et al., 1993, Eisinger, 1994 Gibson, 1994).* Non-vegetarians intake of iron and B–complex vitamins was high than other groups. Lacto vegetarians fibre intake (11.94g) was high than other groups but according to ICMR, all the groups fibre intake was less than RDA.

Haemoglobin concentration of non-vegetarians was significantly higher ($p>0.05$) than other groups. This could be consumption of iron rich foods such as poultry, pulses, fruits and dried fruits etc. Non-heme iron absorption may be improved by vitamin-C or an acid diet but not by and alkaline diet or high fibre diet, both of which exist in vegetarian diets *(Deuster et al., 1986).*

In the present study endurance time was longer and recovery was fast in non-vegetarian, which could be a result of nutrient intake and high haemoglobin concentration than other groups. Good nutrition is important for maintaining a high level of performance. *(Manore et al., 1993, Clarkson & Haymes, 1994, Fogelholm, 1995).* Higher the concentrations of haemoglobin in blood, greater will the capacity of the system to carry oxygen to cells and tissues. If higher amount of oxygen is available then one can sustain exercise for longer time and nutrients may also helped to exercise for longer period and faster recovery *(Pate, 1983).*

Conclusion

The present study shows prevalence of non-vegetarianism was high in Indian sports women than lacto, ovolacto vegetarianism. Nutrient intake, haemoglobin level, endurance time was better in non-vegetarians than lacto, ovolacto vegetarians.

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Effect of Weight Reduction on Selected Physiological Parameters in Male Junior National Boxing Campers

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Abstract

The study was conducted on a total of 24 junior national boxing campers to assess pattern of change in body weight (BW) during the camp and effect of weight reduction on selected physiological parameters. On the day of joining the camp, BW, standing height, grip strength, grip endurance, resting pulse rate, resting blood pressure, body fat percent (BF%) and fat free mass percent (FFM%) were measured using standard techniques. However, BW was measured thrice during 20 days' camp; firstly on the day of joining and subsequently on 10th and 19th (one day before competition) days of camp. Change in BW (as measured on 1st and 19th day) was calculated. Campers who reduced their BW by >1% during the camp were selected and studied further for relative changes in selected parameters. Out of 24 subjects only 10 reduced BW by 4.68% during the camp and weight reduction indicated a gradual pattern. Comparison before and after weight reduction revealed increase in resting pulse rate, resting blood pressure (systolic and diastolic) and BF%. However, only resting diastolic blood pressure indicated significant ($p<0.05$) increase. A non-significant decline in grip strength, grip endurance and FFM was observed after weight reduction. Thus, gradual weight reduction up to 5% of BW to compete on the top of lower weight category may not affect grip strength and endurance.

Key Words: **Weight-Reduction, Boxers, Grip Strength, Grip Endurance, Body Composition, Blood Pressure**

Introduction

In today's world of neck to neck competition, an athlete cannot afford to take a chance as minute fraction of time can deprive him of fame and fortune. In never ending quest for winning, athletes try to use all possible means, which promise to improve their performance. They do not want to leave any stone unturned in getting the extra edge over their counterparts. It has been seen that making weight is common problem in combative sports like judo, wrestling, boxing etc, where athletes are divided into weight categories *(Widerman and Hagon, 1982; Webster, 1990; Hall and Lane, 2001).* In such events, athletes generally intend to compete on top of the lower category, as chances of winning become more. For this purpose they try to reduce weight rapidly by any means. Ideally, weight should be reduced systematically and gradually through a well planned scientific method so that weight is lost mainly through fat. It has a beneficial effect on performance, because it gives extra strength to the player.

It is seen that some boxers gain weight during the off-season. So they reduce weight rapidly only a few days before the competition. As weight reduction cannot be done by diet and exercise planning in few days, athletes depend upon total food and fluid restriction. If desired weight is not achieved by total restriction of food and liquid alone, they use various dehydration techniques to lose weight *(Webster et al., 1990).* State of hypo-hydration and continuous feeling of hunger and thirst may affect the working capacity and psychological condition of athletes *(Horswill et al., 1990; Hall and Lane, 2001).* Dehydration may decrease blood volume, plasma volume, stroke volume and increase the heart rate which can lead to circulatory distress and *hypotension (Dill and Costill, 1974).* Unplanned weight reduction might further reduce weight through muscles. It decreases the muscular strength and muscular endurance, which in turn, may affect performance during the competition *(Webster et al., 1990; Armstrong, 1992; Oopik et al., 1996).* However, *Widerman and Hagon (1982)* found that planned weight loss of 8% through continuous training and restricted diet did not affect the maximal aerobic power and muscular strength in a wrestler. Similarly, *Kraemer et al (1999)* also indicated that benefits could be gained through well- planned weight reduction programme.

The present study was undertaken to see whether our boxers attending national camp adjust their weights to change their weight categories. Further, effect of weight reduction on some physiological parameters was assessed.

Materials and Methods

Study was carried out on twenty four male junior boxers in the age range of 16-18 years, who came to attend the National junior boxing camp held from 14th January 2003 to 3rd February 2003 in Jawaharlal Nehru Stadium, Delhi. The training camp was held to prepare the boxers for International competition 'ONGC YMCA VIII International Boxing Championship'.

Out of twenty four boxers included in the study, three were from light fly weight, two from fly weight, one from bantam weight, two from feather weight, three from light weight, two from light welter weight, four from welter weight, two from middle weight, three from heavy weight and two were from super heavy weight category.

From the twenty-four subjects included in the study, eleven reduced their weight during the camp and those eleven were selected for the assessment of effect of weight reduction on physiological parameters. However, one boxer left the camp in between due to some injury and was later excluded from the study leaving a total of 10 subjects for further study.

Step 1

The general information including previous level of participation and weight category etc. from all the subjects was collected on the day of joining the camp. Then following measurements were recorded:

Body weight (BW): Body weight was taken with minimum clothing when the boxer was standing erect on the electronic weighing machine of sensitivity of 0.1 kg.

Standing height: Height was taken using standard technique with anthropometric rod with an accuracy of 0.1cm.

Grip strength: **T**he grip strength was taken with the help of grip dynamometer. The subject was asked to hold it with right hand while keeping the arm straight in front of the body in horizontal position. He was instructed to stand erect and press it with maximum force without moving the hand in any direction or touching the body.

Muscular grip endurance: Grip endurance was measured with the help of grip dynamometer and stopwatch. The 2/3rd of the subject's grip strength was calculated and the subject was instructed to hold the dynamometer at this level for the maximum possible time duration in a single stretch. Time was recorded to minimum of 0.01 sec.

Resting pulse rate: The subject was asked to sit in a comfortable position. After giving five minutes rest, the resting pulse rate was counted from radial artery.

Resting blood pressure: The subject was asked to sit in resting position. The systolic and diastolic blood pressure was recorded from the right arm using sphygmomanometer. The blood pressure was recorded to minimum of 2mmHg.

Body composition: Body fat percentage (BF %) and fat free mass percentage (FFM %) was measured using skin fold method. Biceps, triceps, subscapular and suprailiac skin folds were measured using Lafayette skin fold calliper. BF% and FFM % were calculated using the equations given by *Durnin and Wormeslay (1974)* and *Siri (1961).*

Step 2

All the subjects were weighed thrice in all during 20 days' camp; once on the day of joining, then on 10th and 19th (one day prior to competition) days of camp.

Step 3

Percent change in their body-weight during the camp was calculated. Those subjects who reduced their body weight by more than one percent during the camp were taken for further study and following measurements were taken again:

1 Grip strength
2 Muscular grip endurance
3 Resting pulse rate
4 Resting blood pressure
5 Biceps skin fold
6 Triceps skin fold
7 Subscapular skin fold
8 Suprailiac skin fold

Step 4

Changes in all the parameters listed above were calculated before and after weight reduction.

Data analysis: Mean and S.D. values of all physiological parameters of the campers recorded on the day of joining the camp were calculated. Dependent 't' test was computed to check the significance of difference wherever required. The level of significance was set at 0.05 level of confidence.

Results

The male junior national boxing campers included in the study belonged to the age group of 16 to 18 years. Range of their body weight (BW) was from 46 Kg to 116 Kg (n=24), as these campers belonged to different weight categories.

Table 1. Distribution of subjects according to percentage change in their body weight during the camp (n=24)

S. NO	CHANGE IN BODY WEIGHT	N
1.	Lost weight (>1%)	10
2.	Gained weight (>1%)	2
3.	Maintained weight (<1% change)	10
4.	Left the camp in between	2

Table1 shows the distribution of subjects according to change in their body weight during the camp. Change in weight was calculated from the values on 1st and 19th day of joining the camp. Out of twenty-four subjects included in the study, ten subjects reduced their weight by >1% during the camp. Reduction in body weight (4.68%) was statistically significant ($p < 0.05$) (Table 2). Ten subjects maintained their weight, while two gained >1% and two campers left the camp in between.

Table 2. Percent difference between the means of parameters studied before and after weight reduction (mean ± S.D) (n=10)

S.No.	Parameters	On the day of joining (before weight reduction) A	On 19th Day of Camp (A day before competition) (after weight reduction) B	Difference B-A	Percent change (%)	t-values
1.	Body weight (Kg)	60.23±7.9	57.41±7.4	-2.82	-4.68	6.07*
2.	Grip strength (Kg)	38.56±5.3	38.33±7.2	-0.23	-0.59	0.64
3.	Muscular grip endurance (secs)	7.15±4.7	6.18±4.0	-0.97	-13.56	0.52
4.	Resting pulse rate (pulse/min)	64.9±13.1	67.1±16.8	+2.2	+3.38	1.23
5.	Resting systolic BP (mmHg)	133.4±19.8	136.4±10.6	+3.0	+2.24	1.37
6.	Resting diastolic BP (mmHg)	81.0±8.9	90.4±4.8	+9.4	+11.60	3.88*
7.	Body fat (%)	16.03±3.9	16.34±3.4	+0.32	+0.32	0.30
8.	Fat free mass (%)	83.97±3.8	83.66±3.4	-0.32	-0.32	1.95

All physiological parameters further studied in the subjects who reduced weight during the camp are given in table 2. Values of these parameters as taken on the first day of the camp (before weight reduction), one day prior to competition (after weight reduction) and percent differences have also been presented (Table 2). After reducing mean weight of 4.68%, resting pulse rate, resting blood pressure (systolic and diastolic) and fat percentage showed an increase. While grip strength, grip endurance and fat free mass percentage decreased after weight reduction. The difference was observed to be statistically significant only for body-weight and resting diastolic blood pressure ($p<0.05$). However, the difference was non-significant for rest of the variables.

Discussion

Out of the total number of boxers studied (n=24), ten reduced weight during the camp. The mean weight loss was 2.82 Kg (4.68%; Table 2) over a period of 20 days, which is quite within the acceptable range.

The methods and techniques used by campers to reduce weight were beyond the scope of this study. But their weight was measured three times during the camp at regular intervals to assess the rate/consistency of weight loss. The rapid weight reduction pattern that is generally practiced by wrestlers and boxers did not seem to be followed by the subjects in the present study. Generally it is the practice to reduce weight rapidly through dehydration in the last few days before competition. But in this study, trend of weight change was spread over a period of 20 days indicating gradual weight loss (Table 3).

High BF% and low FFM% besides having long-term health implications, also affect variables related to performance particularly in strength dominating sports. In the present study, although boxers reduced body weight but no significant change was seen in parameters of body composition (BF% and FFM %). However, the initial BF% (16.03%) values of these campers were already much higher than the suggested normal values of BF% for wrestlers (5-7%) *(Kelly et al., 1978).* The BF% of the subjects was even towards the higher limit of the range of BF% for sedentary males (11-17%) as suggested by *Verma and Mokha (1994).* Various other studies have also reported BF% of male boxers as 10-15% *(Bhardwaj et al., 1990, Guidetti et al., 2002).*

Table 3. Pattern of change in body weight (%) during the camp (n=10)

S.No.	Weight on the day of joining (Kg)	Weight on 10th Day of Camp (Kg)	Percentage change (%)	Weight on 19th Day of Camp (Kg)	Percentage Change (%)
1	51.20	47.6	-7.03	48.05	+0.94
2	52.30	50.4	-3.63	51.00	+1.19
3	52.40	50.6	-3.43	51.05	+0.88
4	60.40	57.6	-4.63	57.02	-1.00
5	62.00	59.0	-4.83	60.00	+1.69
6	65.00	64.2	-1.23	62.00	-3.42
7	76.50	75.1	-1.83	74.00	-1.46
8	66.00	61.5	-6.81	60.00	-2.43
9	55.40	53.7	-3.06	54.00	+0.54
10	61.00	60.0	-1.63	57.00	-5.00

+ refers to Gain, - refers to Loss

Grip strength has been well correlated with boxing ranking. In the present study, mean grip strength was 38.56 ± 5.3 Kg which is much lower as compared to the reported value of 58.2 Kg for elite boxers *(Guditti et al., 2002).* The low grip strength of junior boxers may be attributed to their high fat percentage and low fat free mass. However, when compared before and after weight reduction, a non-significant decline of 0.59 percent and 3.56 percent in muscular strength and endurance respectively was observed in the present study. This may be attributed to their slow and gradual pattern of weight reduction. Boxers already possessed high fat percentage, which did not decrease with the reduction in body weight.

All 24 junior boxers in the present study exhibited the normal resting pulse rate. However, their resting blood pressure (systolic as well as diastolic) was observed to be high normal with mean values of 142.84 and 89.21mmHg for systolic and diastolic blood pressure respectively. While studying blood pressure of the individual subjects, eight subjects were found to be hypertensive with diastolic blood pressure of more than 90mmHg. The systolic blood pressure was also noticed to be more than the normal upper limit (140mmHg) in case of twelve subjects.

Due to hypertension, the heart has to expel blood from the left ventricle against a greater resistance. Further, hypertension places great strain on the systemic arteries and arterioles. All the subjects in the present study were less than 18 years old. If the blood pressure remains high, as they grow old, the stress due to hypertension can cause the heart to enlarge and the arteries to become scarred, hardened and less elastic. Eventually, it can lead to arthrosclerosis, heart attacks, stroke and kidney failure. The blood pressure increases during exercise and during competition due to anxiety. This increase can further enhance risks during the competition.

Those 10 subjects who reduced weight during camp also reported 133.4 and 81mmHg before weight reduction, which increased to 136.4 and 90.4 mmHg for systolic and diastolic pressure respectively. The 11.6% rise in diastolic blood pressure was significant ($p<0.005$). A non-significant increase of 3.38% was noticed in the resting pulse rate as a result of weight reduction.

As the weight reduction was gradual in the present study, pulse rate increase does not seem to be the result of decrease in blood volume. Therefore, the increase in resting pulse rate as well as blood pressure was probably due to the psychological factors like excitement and anxiety related to participation in the International level competition. Anxiety may also be linked with the weight maintenance to participate in the lower weight category. *Hall and Lane (2001)* also established positive relationship between rapid weight loss and increased anger, fatigue and tension. As pulse rate and blood pressure are highly affected by emotional state, above changes in emotional level may be attributed to the increase in these parameters. *Fleck (1988)* observed an increase in the blood pressure with resistance training. Therefore, increase in blood pressure during the camp may also be due to the resistance training given to them.

To avoid risks of hypertension and higher body fat percentage, the boxers need to improve diet pattern and life style. Proper exercise, sleep and rest need to be encouraged and smoking, alcohol and drugs should be restricted. There is a dire need of diet counselling and positive life style changes for these boxers to avoid risk in future life.

The weight, if reduced gradually, to compete on the top of lower weight category does not affect grip strength and endurance which are directly associated with boxing performance. However, to gain benefits with respect to strength and endurance, the boxers should reduce weight from fat. Weight management both during season and off-season should be taken care of by judicious diet and continuos training to avoid long term debilitating effects on health.

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Effect of Training on Morphological, Physiological and Biochemical Variables of Young Indian Soccer Players

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Abstract

The present study aims to find out the training induced changes on different physiological and biochemical parameters in young Indian soccer players. A total of 30 Indian male soccer players (age range 14-16 yrs) regularly playing competitive soccer were selected, a training programme consist of 6 wks and 12 wks of training was employed, and the effects were studied on different morphological, physiological and biochemical variables. Results showed a significant decrease ($P<0.05$) in body fat, and a significant increase ($P<0.05$) in LBM following the training programme. Strength of back and hand grip muscles were also increased significantly ($P<0.05$) after the training. Moreover, significant reduction in heart rates during rest, sub-maximal exercise, maximal exercise and recovery were noted following the training. Further, significant increase ($P<0.05$) in aerobic capacity and anaerobic power were observed after the training. Significant reduction ($P<0.05$) in haemoglobin, total cholesterol, triglyceride and LDLC were noted after the training. A significant increase in serum urea, uric acid and HDLC were noted after training. Since the data on the soccer players are limited in India therefore, the present study may provide useful information to the coaches to develop their training programme.

Key Words: **Body Fat, Strength, VO_2max, Anaerobic Power, Lipid Profile**

Introduction

Soccer is unarguably the most popular sport world wide. The common aspect of the game is the necessity of teamwork to complement individual skills. Since soccer is a physical contact sport and lots of movements and skills are involved. A high level of physical demand is required for match play, which involves kicking, short sprinting, throwing, catching, trapping etc. The activities of the game include short sprinting as well as casual recovery movements. As the players have to cover a big area in the ground during attack and defense therefore, the game demands for aerobic as well as anaerobic fitness *(Reilly, 1996; Reilly et al., 2000a).* Identification and selection of players at the young age are essential; this helps the selectors and the coaches to produce a successful player of top level *(Manna et al., 2002; Reilly et al., 2000b).* Training helps to develop the strength, endurance as well as skills, and become more effective when given to young players *(Bell and Rhodes, 1975; Berg et al., 1985; Jung et al., 2000; Reilly et al., 2000b; Strudwick et al., 2002).*

Monitoring of training through different laboratory and field tests are performed to observe the training induced changes in different morphological, physiological and biochemical variables among the players. Apart from the skills and teamwork required for game play body composition, strength, aerobic capacity and anaerobic power as well as heart rate during exercise and recovery have significant impact *(Aziz et al., 2000; Carraro et al., 1993; Chin et al., 1994; Urhausen and Kindermann, 2002).* Moreover, biochemical profiles like hemoglobin, urea, uric acid, lipids and lipoproteins are also good indicators for monitoring of training and physical fitness *(Berg et al., 1994; Casoni et al., 1985; Cerny 1975; Fry et al., 1991; Manna et al., 2004).*

Studies on young soccer players are scanty. Moreover, studies on effect of training have not been observed on young soccer players in India. Therefore, the aim of the present study was to find out the effect of training on different morphological, physiological and biochemical parameters in young Indian soccer players.

Materials and Methods

Subjects and training

A total of 30 male (age range 14 - 16 years), regularly playing competitive soccer athletes were selected after medical check up from the National training camps at Sports Authority of India. An average of 2 hours of training in morning sessions was generally completed by the players. The training involves both aerobic and anaerobic training. The evening hours were similar however technical training (skill developments) sessions were completed. The training sessions were divided into three phases (i) transition phase (TP= 0 weeks); (ii) preparatory phase (PP= 6 weeks); (iii) competitive phase (CP= 12 weeks) and were followed 5 days per week. Morphological, physiological and biochemical variables were measured in the laboratory. Each test was scheduled at the same time of day (± 1 hour) in order to minimize the effect of diurnal variation. The study was conducted at Sports Authority of India and was approved by the ethical committee of the institute.

Measurement of morphological parameters

Body mass was measured with the accurately calibrated electronic scale (Seca Alpha 770, UK) to the nearest 0.1 kg and stature with a stadiometer (Seca 220, UK) recorded to the nearest 0.1 cm. Body density was estimated from the sum of the skin-fold sites *(Durnin and Womersley, 1974).* Estimated percentage body fat was calculated from a standard equation *(Siri, 1956).* Lean body mass (LBM) was calculated by subtracting fat mass from total body mass. Grip and back strength were measured by dynamometers (India Medico Instruments, India) *(Jonson and Nelson, 1996).*

Measurement of physiological parameters

Treadmill (Jaeger LE 500; Jaeger, Germany) tests were performed at 0% gradient to determine the cardiovascular status of the players during sub-maximal and maximal exercise. Heart rate responses during rest, exercise and recovery were noted in every 5 sec using a heart rate monitor (Polar, Finland). The maximum oxygen consumption (VO_{2max}) was measured following standard methodology using computerized respiratory gas analyser (Oxycon Champion, Germany) *(Astrand and Rodhal, 1970).* The subject was asked to run on the treadmill at a speed of 6 km/h for 2 min thereafter, the workload was increased by 2 km/h for every 2 min until volitional exhaustion. Expired gases were sampled breadth-by-breadth and measured from a mixing chamber using computerized respiratory gas analyser (Oxycon Champion, Jaeger, Germany).

Anaerobic power was measured using a cycle ergometer (Jaeger LE 900; Jaeger, Germany) *(Inbar et al., 1996).* After a 10 min warm up the subject was asked to pedal as fast as possible with out resistance. Within 3 sec a fixed resistance of 0.075 kg per kg body mass was applied to the flywheel and the subject continuous to pedal "all out" for 30 sec. A computerized counter continuously recorded the flywheel revolutions in 5 sec intervals. Anaerobic power was measured using the software supplied by Jaeger, Germany.

Measurement of biochemical parameters

A 5 ml of venous blood was drawn from an antecubital vein after a 12 hour fast and 24 hours after the last bout of exercise. Hemoglobin (Hb), urea and uric acid were measured following standard methodology *(Mukharjee, 1997).* Total cholesterol (TC), triglyceride (TG) and high-density lipoprotein cholesterol (HDLC) were determined by enzymatic method using Boehringer Mannhein kit (USA) *(Mukharjee, 1997).* Low-density lipoprotein cholesterol (LDLC) was calculated from a standard equation *(Friedewald et al., 1972).*

Statistical analysis

Data were presented as mean and standard deviation (SD). Analysis of variance (ANOVA) followed by multiple two-tail t-test with Bonferroni modification was used to determine whether the differences of means in each parameter between the groups were significant. Differences were considered significant when P<0.05 *(Das and Das, 1998).* Accordingly, a statistical software package (SPSS-10) was used.

Results

In the present study effects of different phases of training (preparatory phase-6 wks and competitive phase-12 wks) have been observed on different morphological, physiological and biochemical variables of young Indian soccer players. Significant decrease (P<0.05) in percentage body fat was noted after 12 wks of training. On the other hand significant increase (P<0.05) in LBM was noted after both 6 wks and 12 wks of training. Strength of backs and grip muscles were measured and the results showed a significant increase (P<0.05) in back strength after 12 wks and grip strength of right and left hands after both 6wks and 12 wks of training. Further, significant increase in body mass was noted after 12 wks of training among the players. However, no significant change was noted in stature following the training program (Table 1).

Table 1. Effect of training on body composition and strength on young India soccer players

Groups		Stature (cms)	Body Mass	LBM (kg)	Body Fat (%)	BST (kg)	GSTR (kg)	GSTL (kg)
TP	Mean	168.5	52.0	41.8	19.6	105.8	30.9	29.7
	SD	± 5.2	±1.3	±1.8	±4.0	±12.2	±3.3	±2.9
PP	Mean	168.5	52.8	43.3*	18.0	110.1	34.0*	31.3*
	SD	± 5.2	±1.7	±2.4	±4.7	±13.2	±4.0	±3.2
CP	Mean	168.6	53.7*#	45.8*#	14.6*#	114.8*	35.9*	34.5*#
	SD	±5.3	±1.7	±2.8	±5.1	±14.3	±4.7	±4.2

Data were presented as mean ± SD, N=30. ANOVA followed by multiple two-tail t-tests with Bonferroni adjustment. Data were significantly different from each other *P<0.05, when compared with TP, #P<0.05, when compared with PP. LBM= lean body mass, BST= back strength, GSTR= grip strength right hand, GSTL= grip strength left hand.

Effect of training was noted on heart rate during sub-maximal exercise, maximal exercise as well as recovery. Heart rate recorded during sub-maximal exercise decreased significantly (P<0.05) after both 6 wks and 12 wks of training. Significant reduction (P<0.05) in heart rate during rest and maximal exercise were also noted after 12 wks following the training. Significant reduction (P<0.05) in heart rate was also noted during 2nd and 3rd min of recovery period following the 12 wks of training. However, no significant change was noted in heart rate recorded during 1st min of recovery after an exhaustive exercise on treadmill following the training (Table 2).

Table 2. Effect of training on heart rate responses during sub-maximal exercise, maximal exercise and recoveries on young Indian soccer players

Groups		RHR (beats/min)	HR1 (beats/min)	HR2 (beats/min)	HRM (beats/min)	HRR1 (beats/min)	HRR2 (beats/min)	HRR3(kg) (beats/min)
TP	**Mean**	69.0	129.0	141.7	185.8	162.7	139.1	123.7
	SD	± 2.7	±12.4	±10.6	±3.7	±7.8	±9.1	±9.9
PP	**Mean**	68.5	125.5*	144.1**	186.9	161.3	137.3	120.4
	SD	± 2.3	±13.0	±11.1	±5.6	±9.0	±10.1	±11.1
CP	**Mean**	66.0*	120.6*	138.7*	183.3*#	158.3	133.0*	117.7*
	SD	±2.7	±13.6	±11.2	±5.1	±9.9	±12.3	±11.5

Data were presented as mean ± SD, N=30. ANOVA followed by multiple two-tail t-tests with Bonferroni adjustment. Data were significantly different from each other *P<0.05, when compared with TP, #P<0.05, when compared with PP. RHR= resting heart rate, HR1= sub-maximal heart rate 1st min, HR2= sub-maximal heart rate 2nd min, HR_{max}= maximal heart rate, HRR1= recovery heart rate 1st min, HRR2= recovery heart rate 2nd min, HRR3= recovery heart rate 3rd min

Further, significant increase (P<0.05) in aerobic capacity (VO_{2max}) was noted after 12 wks of training. In addition, anaerobic power was also increased significantly (P<0.05) after 6 wks and 12 wks of training among the players (Fig 1).

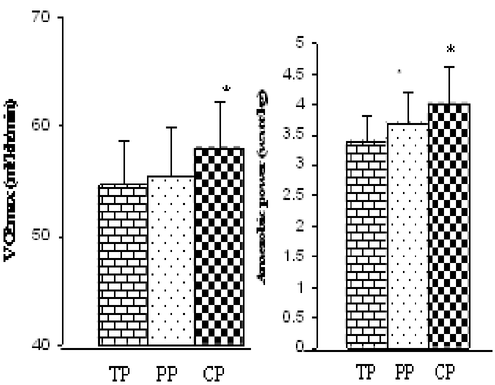

Figure 1. Effect of training on maximal aerobic capacity and anaerobic power of young Indian soccer players.

Data were presented as mean ± SD, N=30. ANOVA followed by multiple two-tail t-tests with Bonferroni adjustment. Data were significantly different from each other *P<0.05 when compared to TP, #P<0.05 when compared to PP, TP= transition phase, PP= preparatory phase, CP= competitive phase.

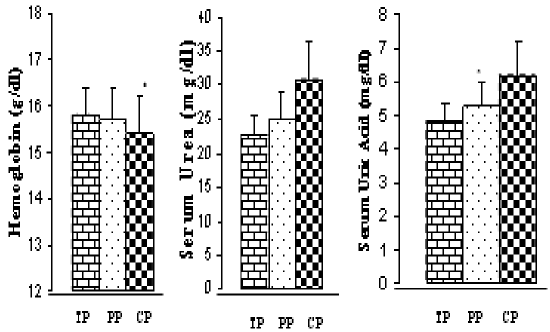

Figure 2. Effect of training on hemoglobin, serum urea and uric acid on young soccer players.
Data were presented as mean ± SD, N=30. ANOVA followed by multiple two-tail t-tests with Bonferroni adjustment. Data were significantly different from each other *P<0.05 when compared to TP, #P<0.05 when compared to PP. TP= transition phase, PP= preparatory phase, CP= competitive phase

Biochemical parameters including haemoglobin, urea, uric acid, total cholesterol, triglyceride, HDLC and LDLC were noted. Results showed a significant reduction (P<0.05) in haemoglobin concentration following 12 wks of training. On the other hand a significant increase (P<0.05) in blood urea and uric acid were noted after both 6 wks and 12 wks of training (Fig 2). Further, significant elevation (P<0.05) was noted in blood level of HDLC after the training. Moreover, significantly lower level (P<0.05) of triglyceride was also noted after 12 wks of training On the contrary, significant reduction (P<0.05) in total cholesterol, LDLC, the ratio of TC/HDLC and LDLC/HDLC were noted after both the 6wks and 12 wks of training (Table 3).

Table 3. Effect of training on lipids and lipoproteins profile of young Indian soccer players.

Groups		TC(mg/dl)	TG(mg/dl)	HDLC(mg/dl)	LDLC(mg/dl)	TC/HDLC	LDLC/HDLC
TP	**Mean**	167.3	93.5	38.7	113.3	4.4	3.0
	SD	± 26.5	±19.3	±5.3	±25.8	±1.0	±0.9
PP	**Mean**	154.7*	85.8	46.5*	91.1*	3.4*	2.1*
	SD	± 15.8	±23.3	±8.9	±15.2	±0.7	±0.6
CP	**Mean**	147.8*#	76.8*	48.5*	80.7*#	3.1*#	1.7*#
	SD	±10.1	±25.3	±7.2	±10.8	±0.4	±0.4

Data were presented as mean ± SD, N=30. ANOVA followed by multiple two-tail t-tests with Bonferroni adjustment. Data were significantly different from each other *P<0.05, when compared with TP, #P<0.05, when compared with PP. TC= total cholesterol, TG= triglyceride, HDLC= high density lipoprotein cholesterol, LDLC= low density lipoprotein cholesterol.

Discussion

Since the ancient times, it has been believed that suitable physique has an importance to achieve success in particular sports. The measurement of height and weight has some importance in selecting sports personal *(Beunen and Malina, 1988; Beunen et al., 1997).* The estimation of body composition permits the quantification of gross size of an individual into two major structural components namely fat mass and lean body mass. This appraisal provides an important baseline to develop an effective training programme. The body composition especially in sports persons is a better guide for determining the desirable weight rather than using the standard height-weight-age tables of normal population, because of the presence of high proportion of muscular content in their total body composition *(Franks et al., 1999).* Stature and body mass have significant impact on elite soccer teams *(Reilly et al., 2000a).* Tall players have an advantage in playing positions such as goalkeeper, forward and defense. Body mass come into play since soccer is a body contact game. Heavy weight (not over weight) players get an advantage in defense. However, a standard body mass is required for every playing positions. The present study showed no significant change in stature among the players after the training. This may be due to short duration of training. However, significant increase in body mass was noted after 12 weeks of training. The percentage of body fat plays an important role for the assessment of physical fitness of the players *(Sergej, 2003).* Increase in body fat can reduce the aerobic and anaerobic fitness *(Powers and Howley, 1997).* Present study showed a decrease in body fat in the young players. Aerobic training increases the fat utilisation during exercise, which may be the cause of the reduced fat level after training. Therefore, a low level of body fat as well as an increase in fat free body mass plays a key role in keeping physical fitness.

Many activities in soccer are forceful and explosive (e. g. tackling, jumping, kicking, turning and changing pace). The power output during such activities is related to the strength of the muscles involved in the movements. Thus, it might be beneficial for a soccer player to have a high muscular strength, which also diminishes the risk of injury *(Fleck and Falkel, 1986; Grace, 1985).* The results of the present study showed an increase in back and grip strength after the training. The muscular strength of soccer players appears to be related to the position in the team. In a study of top-class Danish players, muscular strength was lowest for the midfield players than fullbacks, goalkeepers, forwards and central defenders *(Reilly et al., 2000a).* Strength of the back muscles plays a key role of fitness among the soccer players, as kicking and passing the ball are part of the game *(Malina et al., 2000; Manna et al., 2002; Wisloff et al., 1998).* Therefore, the game demands for high level of back strength. Moreover, strength of grips also has significant impact on the performance of the soccer players, which is needed for throwing, catching or fisting the ball (goal keeping). Responses to strength training are also thought to be small in the prepubescent child *(Bangsbo, 1994).* Until testosterone increases in boys at the time of the adolescent growth spurt, muscle mass remains below the percentage of total body weight observed in adults. Strength gains pre-puberty are mainly due to improved neuromuscular coordination. The percentage muscle mass increases after sexual maturation as muscle development are stimulated by androgenic hormones. Increasing strength gains also accompany the rise in testosterone *(Round et al., 1999).*

Heart rate increases with an increase in work intensity and shows linear relationship with work rate *(Astrand and Rodhal, 1970).* In the present study significant reductions in heart rates during rest, sub maximal and maximal exercise was noted with the advancement of training. It has been observed that training reduces the rise in heart rate during exercise and fasten the fall in heart rate during recovery. During the match play the activities are not continuous; instead it is intermittent that means it involves short sprinting and casual recovery. Some times running with the ball and some times without the ball. Thus less increase in heart rate during exercise and rapid fall in heart rate during casual recovery may help the player to perform better. Heart rate becomes the only factor in increasing cardiac out put after stroke volume reaches its maximum level at about 40% of maximal work *(Powers and Howley, 1997).* Since heart rate can increase from 50-190 beats per min (300-400 %) in well-trained sports persons, with an increasing stroke volume of about 50-75%, heat rate plays a key role in increased cardiac out put during exercise *(Astrand and Rodhal, 1970).*

Present study showed an increase in VO_{2max} after the training. In the young players increase in VO_{2max} with training are quite noticeable *(Reilly, 1996).* The maximum aerobic capacity for elite male players has been determined in several studies, with mean values between 56 and 69 ml/kg/min having been reported *(Reilly, 1996).* Based on results obtained from elite Danish players, full backs and midfield players had the highest values and goalkeepers and central defenders the lowest. Players in a top Norwegian team had higher VO_{2max} values than that player from lower ranked team playing in the same league (67.6 vs. 59.9 ml/kg/min) *(Withers et al., 1977).* On the other hand, in a study of top-class Danish players, no difference in VO_{2max} was observed between regular and non-regular first-team players *(Bar-Or, 1988).* Nevertheless, the consistent observation of mean VO_{2max} values exceeding 60 ml/kg/min in elite teams suggests the existence of a threshold below which an individual player is unlikely to perform successfully in top-class soccer *(Reilly, 1990).* An earlier study reported that the VO_{2max} of young elite Danish players was as high as that of older professionals when expressed relative to body mass *(Bar-Or, 1988).*

In the present study significant increase in anaerobic power was noted after the training. It has been seen that post pubertal increase in physical and physiological parameters are related to increasing level of testosterone *(Round et al., 1999).* Anaerobic power represents the highest rate of anaerobic energy released, where as anaerobic capacity reflects the maximal anaerobic energy production an individual can obtain in any exercise bout performed to exhaustion. Although mean power output over 30s on a cycle-ergometer has been used to evaluate the maximal performance of soccer players during short term exercise and thus, indirectly, their anaerobic power *(Care et al., 1970; Inbar et al., 1996; Reilly et al., 2000a).* Another study reported that soccer players had values about 20% higher than basketball players, walkers and runners *(Witters et al., 1977).* Similarly, it has been observed that elite Hungarian soccer players had a 16-30% higher anaerobic power than an age-matched control group. It would appear, therefore, that a high anaerobic power is desirable for success in top-class soccer *(Apor, 1988).* This capability is reflected in the higher values for anaerobic capacity among goalkeepers, central defenders and strikers observed in English League players *(Reilly et al., 1990).* In children, anaerobic power is less well developed than adults *(Bar-Or and Unnithan, 1994).* Anaerobic power increases progressively during maturation until reaching that of adults after the teenage years.

Hemoglobin concentration in blood which is mainly used for the transport of oxygen from blood vessels to exercising muscles, and transport of carbon dioxide from working muscles to blood vessels. Moreover, hemoglobin represents the iron status of the body *(Beard and Tobin, 2000).* Present study has shown a decrease in hemoglobin concentration with the advancement of training among the players, which may be due to heamolysis of the red blood cells. This can be substantiated by nutritional manipulation *(Bar-Or and Unnithithan, 1994).* Dill and associates (1974) found hemoglobin concentration to be 4% lower in highly trained runners than in controls. Another study showed that the total amount of hemoglobin rather than its concentration in the blood is the determining factor for reaching a maximal VO_2 *(Kanstrup and Ekblom, 1984).*

The present study has shown increased level of urea and uric acid after both 6 weeks and 12 weeks of training. It may be suggested that increased level of urea and uric acid may be due to increased intensity of training *(Urhausen and*

Kindermann, 2002). The main end product of protein metabolism is urea. Prolonged exercises have been shown to cause increased urea concentration in the blood, liver, skeletal muscles, urine, and sweat *(Carraro et al., 1993; Cerny, 1975)* Determination of serum urea and uric acid used as indicators of over training *(Urhausen and Kindermann, 2002).* Therefore, monitoring of exercise stress through different biochemical parameters including serum urea and uric acid become common practice *(Fry et al., 1991).* The results of the present study indicated that the higher intensity of training in the players.

In the present study a significantly decreased level of total cholesterol, triglyceride and LDLC were noted with the advancement of training. Further, significantly higher level of HDLC was observed after the training among the players. Regular participation in physical activity is associated with lower plasma level of cholesterol, triglyceride and LDLC *(Durstine and Haskell, 1994).* Level of fitness influences the lipid profile as physically fit and active person tend to have lower level of lipids than unfit or less active person. Lipoproteins are vehicles for transporting lipids to the sites of their metabolism in various tissues. The uptake of LDLC by cells is part of a homeostatic mechanism regulating the intracellular cholesterol metabolism and providing cholesterol for plasma membrane as an essential structural component. However, a high blood plasma concentration of cholesterol in the form of LDLC is the most important factor causing arteriosclerosis LDLC *(Berg et al., 1994; Durstine and Haskell, 1994).* A high ratio of HDLC to LDLC, is reduced the likelihood of the development of arteriosclerosis *(Berg et al., 1994; Durstine and Haskell, 1994).* Evidence has been collected that endurance training results in a decrease of total cholesterol and LDLC levels and an increase of HDLC concentration *(Berg et al., 1994; Durstine and Haskell, 1994).* Similar observation was noted in the present study.

Conclusion

It may be concluded that these changes are due to participating in an increasing number of competitions, advancement in training and awareness in the players. It may be stated that training induced changes in different physical and physiological parameters after puberty are androgen dependent. Nutritional manipulation from the young age may help the growth and development of the players. Since, the data on young soccer players in India are limited; therefore, the present study may provide a useful database to the coaches to develop their training program.

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Anthropometric Profile and Development of Facial Hair in Male Athletes

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Abstract

The present investigation has been carried out to study the anthropometric profile and development of facial hair in male athletes. The data for the present study consists of 697 subjects including 347 athlete and 350 control boys ranging in age from 10 to 18 years. The athletes, who actively participated in various activities including running, jumping and throwing have been included in the present study. Sixteen anthropometric measurements viz. weight, stature, diameters, circumferences and skinfolds have been taken on each subject. The development of facial hair has been studied by five point maturity scale. There is a regular increase in all anthropometric measurements from 10 to 18 years in both athlete and control boys. The adolescent spurt has occurred earlier in athlete boys in most of the anthropometric measurements. The athlete boys are lighter in weight up to 14 years and shorter in stature up to 16 years than control boys followed by more weight and stature in athlete in the subsequent age groups. The athlete boys possess broader shoulders, hips and larger bony diameter of the extremities. The chest and calf circumferences are larger in athletes whereas the head and upper arm circumferences and all skinfolds are more in control boys. The development of facial hair is earlier in athletic boys with significant differences in stage II and III as compared to control boys.

Key words: Anthropometric Measurements, Development, Facial Hair, Athletes

Introduction

It has been established that physical or sports activity during childhood and youth results in persistently favourable influence in the physiological maturity. *Malina (1977)* reported that adolescent athletes have been found to be advanced in maturity. *Oppliger et al. (1986)* studied swimmers of 7-12 years and found them to be significantly taller, heavier and with greater lean body mass than controls. *Sidhu et al. (1998)* found athletes to be early maturer as compared to non-athletes.

Although much data have been accumulating about the effect of physical activity on the morphological profile but only few reports are available about the effect of physical activity on sexual maturation. So in the present investigation an attempt has been made to study if athletic activity has any influence on anthropometric profile and development of facial hair in male athletes ranging in age from 10 to 18 years.

Materials and Methods:

The data for the present study consist of 697 subjects including 347 athlete and 350 control boys ranging in age from 10 to 18 years. The athletes who actively participated in various activities including running (100 meter to 1500 meter), jumping (long and high) and throwing (short put, javelin and discs) have been included in the present study. The data on athletes have been mainly collected from National Institute of Sports (NIS), Punjabi University, Polo ground, Patiala and Guru Nanak Stadium, Ludhiana. The data on controls have been collected from various educational institutions of Patiala, Ludhiana, Mansa, Jalandhar, Hoshiarpur and Ropar. To study physical growth sixteen anthropometric measurements viz. weight, stature, diameters (biacromial, bicristal, humerus bicondylar, wrist, femur bicondylar, ankle), circumferences (head, chest, upper arm, calf) and skinfolds (triceps, suprailiac, subscapular, calf) have been taken on each subject by following standard technique given by *Tanner et al. (1969).*

The data collected have been grouped into nine age groups, each of one year duration i.e. 9.500 – 10.499 up to 17.500 – 18.499 for both athlete and control boys separately. The data have been subjected to various statistical tests viz. mean, standard deviation, standard error or mean. 't' test has been applied to compare the athlete with control for all anthropometric measurements.

The development of facial hair has been studied by adopting a 5 point maturity scale as suggested by *Reynolds (1951)* on the following basis:

Stage-I : Pigmentation of hair at the corners of the upper lips.

Stage-II : Hair spread medially to complete the moustaches.

Stage-III : Hair appear on the upper part of the cheek and in the midline just below the lower lip.

Stage-IV : Hair spread along the sides and lower border of the chin.

Stage-V : Thickening of hair on moustaches and beard.

All the subjects were classified into various stages of development of facial hair and percentage of each stage was calculated in each age group. On the basis of these percentages, median age of appearance of each stage has been calculated through Probit analysis *(Finney, 1952).*

Results and Discussion

1. *Anthropometric measurements:*

Table 1. Age changes in weight and stature of athlete and control group boys.

	AGE (YRS)	N	WEIGHT (KG)		STATURE (CM)	
			M	SD	M	SD
ATHLETES	10	40	27.66	2.63	140.92	3.50
	11	42	29.39	4.11	144.70	5.97
	12	43	31.40	6.43	148.72	6.40
	13	38	37.58	6.48	151.87	7.53
	14	37	42.11	8.73	158.50	9.02
	15	44	47.65	9.02	162.70	8.85
	16	40	50.69	8.85	165.62	8.97
	17	35	52.65	9.70	167.72	6.04
	18	28	55.36	9.84	168.87	9.24
CONTROL	10	44	29.41	4.96	144.73	7.25
	11	38	32.30	4.52	146.63	8.53
	12	39	35.56	5.83	147.93	9.87
	13	40	37.98	7.72	150.43	8.31
	14	41	43.15	8.65	156.30	7.37
	15	38	46.38	7.62	163.95	6.32
	16	40	49.52	8.46	166.81	5.84
	17	42	52.37	8.81	166.29	6.61
	18	28	54.50	6.28	168.20	6.46

Weight: The weight has shown a continuous trend of increase from 10 to 18 years in both athlete and control boys (Table 1). The athletes are lighter in weight than controls up to 14 years with significant differences from 10 to 12 years. From 15 to 18 years of age athletes are heavier although the differences are not statistically significant. The adolescent spurt in weight is earlier in athletes i.e. from 12 to 13 years and of greater magnitude (6.18 kg) than control group boys in whom the spurt has occurred from 13 to 14 years with a magnitude of 5.17 kg. *Singal et al. (1994)* studied intersportive differences in anthropometric measurements of hockey, boxing, judo, gymnastic athlete and control group boys and also reported lesser weight for athletes as compared to controls and other sports except gymnasts. *Mokha et al. (1988)* also suggested that lesser weight is advantageous to runners as they have to carry their bodies while running. *Sethi and Sidhu (1990)* and *Sidhu et al. (1996)* have reported more weight for sport boys as compared to control group from 11 to 19 years.

Stature: Like weight, the stature has also increased continuously from 10 to 18 years in both athlete and control boys (Table 1). The control boys are taller than athletes up to 16 years followed by slightly more stature in athlete boys from 17 to 18 years with statistically non-significant differences. The adolescent spurt is earlier in athletes i.e. from 13 to 14 years and in controls from 14 to 15 years. Earlier adolescent spurt in athlete boys reveal that they are advanced biologically and are ahead in the path of maturation leading to slightly more stature at 17 and 18 years of age *Shuck (1962)* reported greater height in junior high school athletes as compared to non-athlete boys. *Clark (1968)* reported that track athletes did not differ in size at upper elementary level (9-12 years) but at junior high level (12-15 year) the track athletes were significantly advanced in height and strength as compared to controls. *Singal et al. (1994)* studied intersportive differences in stature of players ranging in age from 18 to 30 years and reported lesser stature for athletes as compared to boxers, hockey, judo as well as control group and were taller than gymnasts. *Sethi and Sidhu (1990)* and *Sidhu et al. (1996)* reported more stature for sports boys as compared to controls even during growing years.

Table 2. Age changes in diameters of athlete and control group boys.

			BIACROMIAL DIAMETER		**BICRISTAL DIAMETER**		**HUMERUS BICONDYLAR**		**WRIST DIAMETER**		**FEMUR BICONDYLAR**		**ANKLE DIAMETER**	
	Age	**N**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
ATHLETES	10	40	29.95	1.64	21.87	1.37	4.62	0.49	4.47	0.45	7.32	0.39	5.96	0.26
	11	42	30.73	2.12	22.04	1.49	5.28	0.62	4.61	0.48	7.43	0.52	5.98	0.44
	12	43	31.41	2.39	22.48	1.81	5.96	0.48	4.80	0.47	7.73	0.66	6.14	0.50
	13	38	32.11	2.57	23.05	2.02	5.90	0.68	4.82	0.45	8.13	0.59	6.29	0.52
	14	37	33.53	3.05	24.99	2.22	6.35	0.52	5.09	0.41	8.37	0.65	6.45	0.54
	15	44	35.15	2.57	25.30	2.10	6.48	0.46	5.25	0.45	8.50	0.64	6.58	0.47
	16	40	35.07	2.74	26.06	2.50	6.50	0.42	5.28	0.42	8.52	0.84	6.69	0.45
	17	35	35.86	2.79	26.79	2.85	6.65	0.47	5.49	0.32	8.79	0.53	6.76	0.53
	18	28	36.02	1.84	26.47	1.56	6.71	0.59	5.52	0.44	8.94	0.86	6.85	0.37
CONTROL	10	44	29.62	3.09	20.37	2.13	5.27	0.95	4.51	0.85	7.14	0.82	5.86	0.81
	11	38	30.52	1.79	21.87	1.57	5.57	0.48	4.67	0.53	7.34	0.58	5.90	0.57
	12	39	30.84	3.35	21.70	2.75	5.55	0.59	4.56	0.50	7.38	0.96	5.78	0.52
	13	40	30.64	2.37	21.65	1.64	5.89	0.54	4.79	0.44	7.84	0.52	5.89	0.46
	14	41	37.73	2.91	23.12	2.29	6.12	0.58	5.05	0.48	8.34	0.61	6.27	0.58
	15	38	32.74	1.97	24.94	1.77	6.33	0.60	5.15	0.59	8.50	0.57	6.35	0.60
	16	40	34.01	2.27	24.98	1.64	6.47	0.66	5.17	0.50	8.61	0.73	6.37	0.52
	17	42	34.68	2.38	24.67	2.02	6.38	0.91	5.42	0.77	8.54	0.97	6.53	0.80
	18	28	34.98	1.89	25.13	1.67	6.56	0.97	5.47	0.70	8.77	0.85	6.63	0.80

Diameters: All the diameters– biacromial, bicristal, humerus bicondylar, wrist, femur bicondylar and ankle have shown a trend of increase from 10 to 18 years in both athlete and control boys (Table 2). The athletes possess broader shoulders than controls at all ages with significant differences at 13, 15, 17 and 18 years. The bicristal diameter is also larger in athletes in all age groups with significant differences at 10, 13 and from 16 to 18 years (Table 4). *De Garry et al. (1974)* also reported that male thrower, sprinters and runners possess broader shoulder than controls. *Sodhi and Sidhu (1984)* also found Indian discus, hammer and shot put throwers for having broader shoulders. *Sethi and Sidhu (1990)* reported broader shoulders and wider hips in boys from 13 to 18 years and have mentioned that these differences increase during 14 to 16 years. *Sidhu et al. (1996)* also reported that sports boys possess broader shoulders and wider hips than controls with significant differences in some age groups from 11 to 19 years.

Humerus bicondylar wrist, femur bicondylar and ankle diameters are also larger in athletes with significant differences in some age groups (Table 2, 4). *Singh et al. (1992)* reported that sports boys of age range 11-19 years are also ahead in humerus bicondylar and wrist diameters as compared to control boys.

Table 3. Age changes in circumferences and skinfolds of athlete and control group boys.

AGE (YRS)	N	CIRCUMFERENCES (CM)								SKINFOLDS (MM)							
		Head		Chest		Upper arm		Calf		Triceps		Suprailiac		Subscapular		Calf	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
								Athletes									
10	40	51.78	1.77	58.65	4.34	16.94	1.09	24.66	2.30	6.09	1.05	4.95	0.93	7.09	1.08	6.89	0.93
11	42	51.93	1.86	60.98	4.17	17.81	2.12	26.78	2.96	5.98	1.09	5.05	1.00	6.30	1.07	7.13	1.00
12	43	52.35	1.71	63.08	5.07	19.10	2.34	27.13	2.83	5.90	1.48	4.97	1.15	6.28	0.82	6.83	2.16
13	38	53.06	1.59	67.68	6.14	19.86	2.70	27.99	2.95	6.63	1.74	5.13	1.85	6.80	1.81	7.03	2.00
14	37	53.65	1.65	70.86	5.73	21.26	2.56	29.84	3.91	6.95	1.83	5.88	1.72	7.28	1.94	7.40	2.26
15	44	53.59	2.09	74.26	6.07	22.49	3.08	31.03	3.60	5.95	1.43	5.73	2.14	7.60	1.80	7.64	2.57
16	40	53.89	2.10	76.43	5.41	23.27	3.13	30.62	3.38	6.30	1.59	5.38	1.32	7.60	1.05	8.03	1.32
17	35	54.11	1.85	78.70	4.98	23.93	3.12	31.15	4.93	5.63	1.94	5.88	1.21	7.83	1.59	7.93	1.21
18	28	54.30	1.93	80.26	5.56	23.96	3.13	32.86	3.30	5.87	1.80	5.67	1.36	7.93	1.80	7.50	1.36
								Controls									
10	44	51.98	2.33	61.60	2.42	17.91	1.57	24.87	3.05	6.00	1.97	4.75	1.59	6.36	1.06	6.80	2.02
11	38	52.19	2.02	62.52	4.71	18.35	2.10	24.98	2.69	6.25	1.84	5.13	1.55	6.33	0.92	7.13	1.87
12	39	52.76	2.08	62.31	4.49	19.43	4.81	26.83	2.76	6.48	1.76	5.08	2.02	6.30	1.66	7.28	1.86
13	40	52.98	1.91	63.81	5.41	19.98	1.92	26.21	3.91	6.35	2.30	5.23	2.13	6.93	1.82	7.18	2.40
14	41	53.45	2.99	67.80	5.37	22.24	3.86	27.93	3.55	7.13	2.91	6.50	2.22	7.85	2.17	8.05	2.61
15	38	53.96	3.22	68.98	5.02	22.97	2.76	30.29	4.58	6.53	1.76	6.39	1.66	8.28	1.82	8.17	2.17
16	40	54.06	3.80	74.16	5.24	24.20	2.18	30.06	3.19	6.95	2.42	5.80	1.98	8.03	1.06	7.92	2.34
17	42	54.19	1.81	78.68	7.54	25.38	2.72	31.09	2.60	6.48	1.34	5.46	1.26	7.73	1.76	8.07	1.86
18	28	54.18	2.19	79.09	6.36	25.16	2.02	32.33	3.50	7.01	1.82	6.03	1.41	8.08	2.01	8.67	1.41

Circumferences: All the circumferences (head, chest, upper arm and calf) have shown a trend of increase from 10 to 18 years in both athlete and control boys (Table 3). The adolescent spurt has occurred earlier in athletes in all the circumferences except head circumference. The head circumference is slightly more in control boys with insignificant differences whereas the chest circumference is larger in athlete boys from 12 to 18 years with significant differences from 13 to 15 years. The upper arm circumference is larger in control boys with significant differences at age 10 and 17 years. The calf circumference is larger in athletes from 12 to 18 years with significant differences at 13 and 14 years. The large circumference of calf in athletes is due to more development of lean tissue because the calf skinfold values are larger in control group. *Singh (1992)* reported larger chest and calf circumference in sports boys from age 11 to 19 years than control boys.

Skinfolds: All the skinfolds (triceps, suprailiac, subscapular and calf) have also shown a trend of increase from 10 to 18 years of age in both athlete and control group (Table 3). The athlete boys have lesser value of skinfolds than control boys with significant differences in some age groups (Table 4). The adolescent spurt has occurred earlier in athletes in all skinfolds but the magnitude of increase is more in control boys. *Bhardwaj et al. (1990)* reported that sports persons possess small value of skinfold thickness as compared to controls. *Singh (1992)* also reported in the same direction while working on sports and control boys of 11 to 19 years of age. *Sethi and Sidhu (1995)* studied body composition and skinfold changes in sports boys and controls from 13 to 18 years and reported that the skinfolds become thicker with age and sports boys have shown lesser value of skinfolds at all ages and differences become more at 17 and 18 years.

Table 4. Comparison of athlete and control group boys – Test of significance ('t' test)

					DIAMETERS			
Age	**Weight**	**Stature**	**Biacromial**	**Bicristal**	**Humerus bicondylar**	**Wrist**	**Femur bicondylar**	**Ankle**
10	-2.04*	-3.17*	0.62	3.87*	-4.00*	-0.27	1.30	0.77
11	-3.00*	-1.16	0.48	0.50	-2.34*	-0.53	0.73	0.70
12	-3.00*	-0.43	0.88	1.50	3.44*	2.23*	1.90	3.19*
13	-0.49	0.80	2.62*	3.35*	0.07	0.30	2.37*	3.59*
14	-0.53	-1.17	1.18	3.66*	1.87	0.39	0.21	1.41
15	1.78	-0.25	5.44*	0.84	1.26	0.85	0.00	1.91
16	0.60	-0.70	1.88	2.29*	0.24	1.06	-0.51	2.95*
17	0.13	0.99	1.97*	3.69*	1.68	0.53	1.43	1.51
18	0.39	0.32	2.09*	3.10*	1.17	0.30	0.74	1.32

- sign indicates more value in control group, * Statistically significant at 5% level.

	CIRCUMFERENCES			SKINFOLDS			
Age	**Chest**	**Upper arm**	**Calf**	**Triceps**	**Supra-iliac**	**Subsc-apular**	**Calf**
10	-3.80*	-3.31*	-0.61	0.26	-0.71	3.12*	0.27
11	-1.54	-1.14	-2.87*	-0.89	-0.27	-0.13	0.00
12	0.73	-0.32	0.49	-1.60	-0.30	-0.07	-1.01
13	3.18*	-0.23	2.28*	0.61	-0.22	-0.32	-0.30
14	3.19*	-1.33	2.25*	-0.33	-1.38	-1.22	-1.17
15	4.31*	-0.74	0.80	-1.62	-2.07*	-0.169	-2.92*
16	1.91	-1.54	0.76	-1.42	-1.12	-1.82	0.26
17	0.01	-2.15*	0.06	-2.19*	1.49	0.26	-0.40
18	0.73	-1.70	0.58	-2.35*	-0.97	-0.68	-3.16*

Table 5. Comparison of median ages of development of different stages of facial hair in athlete and control group boys.

STAGE	ATHLETES		CONTROLS		TEST OF SIGNIFICANCE 'T' VALUE
	Median age	± S.E. of Median age	Median age	± S.E. of Median age	
I	11.66	0.88	12.49	0.26	-0.91
II	13.52	0.38	14.51	0.30	-2.04*
III	15.49	0.34	16.43	0.19	-2.40*
IV	16.69	0.93	16.73	1.36	-0.02

- sign indicates, early appearance of facial hair in athletes. * Statistically significant at 5% level.

2. *Development of Facial Hair:*

Table 5 presents the median age and standard error of median age of all the four stages of development of facial hair. It is evident from the table that all the stages of facial hair development have shown earlier appearance in athletes with significant differences in stage II and III as compared to control boys (Table 5). The athlete boys when compared with Jat Sikh boys studied by *Bhatnagar et al. (2000)* have shown delayed appearance of all stages except I[st] stage but have shown earlier appearance of all stages than Khatri boys reported by *Bajaj (1991).*

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Comparison of Caudal and Antero-Posterior Glide Mobilisation for the Improvement of Abduction Range of Motion

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Abstract

The study was conducted on twenty patients of age between 40-65 year of adhesive capsulitis to compare caudal and antero-posterior glide mobilisation technique for the improvement of abduction range of motion, pain relief, and improvement in ADL'S. Significant improvement in abduction active ROM & passive ROM as well as alleviation in pain and disability was observed, when end range mobilisation was administered for three weeks. It was further observed that caudal glide was more effective than the antero-posterior glide.

Key Words: Caudal Glide, Antero-posterior Glide, End Range Mobilisation

Introduction

Adhesive Capsulitis is one of the most common and disabling Orthopaedic disorder characterized by painful restriction of shoulder motion for which patients seeks treatment *(Codman, 1934)* Adhesive Capsulitis is characterized by an insidious and progressive loss of active and passive mobility in glenohumeral joint presumably due to capsular contracture. Despite research in the last century its etiology and pathology remains enigmatic *(Howel et al., 1988).*

This painful, debilitating disorder reportedly affects 2-5% of the general adult population *(Neer et al., 1989)* and 10-20% of people with diabetes *(Kevin et al., 1997).* Incidence is slightly higher in women than in men and is somewhat more common in the non dominant arm *(Dan et al., 1987).* This condition most frequently affects persons aged 40-60 years *(Uitvlugt et al., 1993).*

Primary frozen shoulder is classically described as having three stages, "Freezing", "Frozen" and "Thawing" *(Richard et al., 1986).* Pain particularly in the 1st phase often keeps patients from performing activities of daily living (ADL). In the second phase pain appears to be less pronounced but the restriction in active motion appears to limit the patient in personal care, ADL, and occupational activities. In the third stage there is increase in mobility, which leads to full or almost full recovery *(Richard et al., 1986).*

Inspite of various approaches there remains a lack of evidence that treatment speeds up recovery Joint mobilisation has become a widely employed physical therapy procedure for treating patients with joint hypomobility *(Maitland, 1983).* It is accomplished by performing gliding movements in the direction of limited joint glide *(Henricus & Obesmann, 2000).* Antero-posterior Glide and Caudal Glide mobilisations are frequently employed by physical therapists to mobilise the shoulder joint to decrease pain, improve mobility and regain normal joint function *(Goldstein, 2004).*

This study is conducted to investigate if Antero-posterior Glide mobilisation is effective in increasing abduction range of motion when given at the end of available range of motion. It is also to compare Antero-posterior Glide with Caudal Glide so as to analyse which of the two is more effective. These glides are given along with lateral distraction, capsular stretching, hot fomentation and exercises. This study done on patients of Adhesive Capsulitis is also to know about the effect of treatment on pain and functional recovery by evaluating through Shoulder Pain and Disability Index.

Materials and Methods

Subjects: Patients of Adhesive Capsulitis (n=20) in between the age of 40-65 years were included in the study. They were taken from out patient department of Prayas Physiotherapy Center, Dehradun and SBSPGI, Balawala. The sample studied includes 11 males and 9 female subjects with a mean age of 57.2. Thirteen subjects had left arm involvement and 7 had right arm involvement. They were instructed not to do any other exercises.

Inclusion Criteria

1. Case of pure Adhesive Capsulitis
2. Painful restriction of more then 50% of active & passive range of motion of the shoulder.
3. Capsular pattern of motion restriction.
4. An absence of radiological evidence of glenohumeral joint arthritis.
5. Symptoms present for at least 3 months.

Exclusion Criteria

- Local corticosteroid injection to the affected shoulder within the last 3 months or current corticosteroid therapy.
- Neuromuscular diseases.
- Shoulder symptoms due to other causes
- Pregnancy
- History of metastatic cancer or diagnosis of cancer within 12 months.
- Unstable angina
- Insulin dependent diabetes
- Prior shoulder surgery
- Arthritis of shoulder

Variables of the Study

Independent Variable

1. Joint Mobilisation (Caudal glide, Antero-posterior glide & Lateral distraction)
2. Hot pack
3. Capsular stretching (Posterior & Anterior)
4. Codman's exercise

Dependent Variable

1. Abduction range of Motion (Active and Passive)
2. Pain and functional ability through Shoulder Pain and Disability index *(Warren et al., 1984).*

Study Protocol

Group A (n=10) (Caudal Glide + Lateral Distraction + Conventional treatment)

Lateral distraction was given with Shoulder in neutral position followed by caudal glide, given at the shoulder joint line after the end of available abduction range was achieved. Grade 3 and 4 of Maitland Mobilisation was given for 10-15 repetitions for 5-6 times. Total duration lasted for 20 minutes. This was followed by conventional treatment.

Group B (n=10) (Antero-Posterior Glide + Lateral Distraction + Conventional Treatment)

Lateral distraction was given with shoulder in neutral position followed by Antero-posterior glide given at the shoulder joint line after the end of available abduction range was achieved. Grade 3 & 4 of Maitland mobilisation was given for 10-15 repetitions for 5-6 times for 20 minutes. This was followed by conventional treatment.

Procedure

With the initiations of each treatment session the subjects' abduction range of motion was measured actively and passively using standard goniometer according to the method as described by *Lippman (1943) and Norkin and White (1995).* The level of pain and disability was measured with the help of Shoulder Pain and Disability Index. Once measurements were recorded the patients were then treated according to the assigned groups. Intervention started with hot fomentation for 10 minutes followed by few minutes of warm up consisting of rhythmic mid range mobilisation. This was done with patient in supine position; the joint was taken through full range of available range of motion 3 times. After the patient were given capsular stretching for the posterior and anterior part of the capsule with 20 seconds hold in order to maintain the stretched position. This was repeated for 4 times. Thereafter the joint mobilisation was given according to the group the patients were assigned to. For all the glides 10-15 repetitions were made of grade 3 and 4 for Maitland Mobilisation technique, which were performed at the end of available range. Intermittently the shoulder was moved once or twice through full range of available ROM to obtain muscle relaxation. Total duration of end range mobilisation technique lasted for 30 minutes.

Codman's Exercise was first started with 10-15 repetitions without any weights. All other exercises were also performed for 10-15 repetitions in a particular session. All these exercises were first demonstrated to the patient and then were asked to repeat the same. They were instructed that while performing these exercises at home, they should avoid causing pain of greater than 5 out of 10 on pain scale (10 being the worst).

After the completion of intervention the measurement of abduction range of motion and values for pain and disability through SPADI was again taken. This protocol was given for total 9 sessions, which was completed in duration of 3 weeks.

Data Analysis

Unrelated and Paired t test was used to compare AROM, PROM, pain and disability. The significance (probability – P) has been selected as 0.05.

Results

Ten subjects were taken in each group with the mean age of 56.1 ± 4.95 and 58.3± 4.37 respectively (table 1)

Table 1. Subject Information

Serial No.	Group	N	Age Mean ± S.D.
1	A	10	56.1 ± 4.95
2	B	10	58.3 ± 4.37

Student t test was used for the comparison of mean of AROM between group A & B. At zero session calculated t value was 1.36 which is less than the tabulated value at significance level 0.05. This indicates that there was no much disparity amongst the subject of the two groups, before starting the intervention. The mean value of AROM was 43.7±10.44, 52.6±15.77 and that of PROM was 53.4±0.16, 62±17.08 respectively of the groups. (Tables 2 & 3).

Table 2. Comparison of mean of AROM between Group A &Group B

SESSIONS	GROUP A $\bar{X} \pm$ S.D.	GROUP B $\bar{X} \pm$ S.D.	T	S/NS
0	43.7 ± 10.44	52.6±15.77	1.36	NS
3	67.3 ±11.31	66.7 ± 19.8	0.1	NS
6	99.7 ±7.16	88 ± 17.37	1.89	NS
9	126.5 ± 10.9	104.3 ±17.63	3.58	S

P < 0.05

Table 3. Comparison of mean of PROM between Group A & Group B

SESSIONS	GROUP A $\bar{X} \pm$ S.D.	GROUP B $\bar{X} \pm$ S.D.	T	S/NS
0	53.4 ± 0.16	62 ± 17.08	1.61	NS
3	77.5 ± 9.4	77.2 ± 20.5	0.04	NS
6	110.8± 7.08	98.1± 17.47	2.27	S
9	137.7± 9.28	115.6±15.99	4.02	S

P<0.05

Student t test was done to compare the means of AROM group A & B at 0, 3rd, 6th and 9th sessions. The result of 0, 3rd and 6th session were found to be insignificant whereas that of 9th session were significant with the means of AROM being 126.5±10.9, 104.3 ±17.63 respectively of the groups (Table 2).

While comparing the means of PROM between groups A & B at 0, 3rd, 6th & 9thsessions the results of 3rd session were insignificant .The 6th and 9th sessions showed significant improvement with the t values of 2.27 and 4.02 respectively of the sessions (table 3).

Paired t test was used to compare AROM within the group A between 0 and 9th sessions. The mean difference of the session was 82.8 and the t value was 43.13 thus showing a significant improvement. Similarly of the group B the mean difference was 51.7 and the t value was 36.35 which was also significant (table 4).

Table 4. Comparison of Improvement in Mean of ROM within Group A&B between 0-9 sessions.

G	SESSION 0	SESSION 9	MEAN DIFFERENCE	T	S/NS
A	43.7±10.44	126.5±10.90	82.8	43.12	S
B	52.6 ±15.77	104.3±17.63	51.7	36.35	S

G stands for Group

When comparison of PROM was done within group A between 0 and 9th sessions the mean difference was found to be 84.3 and the t value was 67.6 which was significant .Similarly of group B the mean difference was 53.6 and the t value was 37.06 which was significant (Table 5).

Table 5. Comparison of Improvement in Mean of PROM within Group A & B between 0-9 sessions.

G	SESSION0	SESSION 9	MEAN DIFFERENCE	T	S/NS
A	53.4±10.16	137.7±9.28	84.3	67.6	S
B	62.0±17.08	115.6±15.99	53.6	37.06	S

G stands for Group, P<0.05

Evaluation of pain and disability was carried out through SPADI and student t test was used to compare the means of 0, 3rd, 6th and 9th sessions. At 0 session, the t value was significant whereas at 3rd, 6th and 9th sessions it was found to be insignificant (Table 6).

Table 6: Comparison of mean SPADI between groups A & B

SESSIONS	GROUP A $\bar{X} \pm$ S.D.	GROUP B $\bar{X} \pm$ S.D.	T	S/NS
0	80.98±6.78	69.77±14.4	2.39	S
3	73.83±6.61	64.27±14.35	2.03	NS

6	65.13±6.67	58.97±14.78	1.28	NS
9	58.04±6.78	52.96±14.5	1.06	NS

When paired t test was used to compare 0 and 9th sessions of group A, the t value was found to be 40.16 which was significant. Similarly of the group B was 22.72 which was significant (table 7).

Table 7. Comparison of Improvement in Mean of SPADI within Group A&B between 0-9 sessions

G	SESSION 0	SESSION 9	MEAN DIFFERENCE	T	S/NS
A	80.98±6.7	58.0±6.78	22.93	40.16	S
B	69.73±14.4	52.9±14.53	16.77	22.72	S

G stands for Group

The major goal in mobility of the glenohumeral joint in caudal or posterior direction is to increase its abduction range of motion. The results from the present study suggest that caudal and antero-posterior glide mobilisation at the end of available range is effective in improving glenohumeral abduction ROM in patients of adhesive capsulitis.

The detailed mechanical behavior and biomechanical changes that occur with caudal glide mobilisation are not very clear. The tissue targeted for stretching during caudal glide procedure is believed to be the caudal glenohumeral ligament as the head of humerus glide downward relative to the glenoid fossa. This is based on concavo-convex rule.

Antero-posterior glide can effectively be used to increase abduction range of motion when given at the end of available range. It can be used as a substitute to caudal glide, though caudal glide being the most effective.

The study of *Hsu et al (2000a, b and c)* and *Hsu & Hedman (2000)* also supports the results of present study. The findings of *Poppen & Walker (1976)* and *O'Brien and Bowen (1995)* and & *Warren et al (1984)* on capsular restraints to anterior-posterior and caudal stability provided the rationales for choosing antero-posterior glide at nearly end range of abduction when treating glenohumeral abduction hypomobility.

The studies of *Hsu et al (2000a, b & c)* states that anterior, posterior and axillary pouch of inferior glenohumeral ligament are primary restraints to the abduction of the glenohumeral joint. Stretching of these capsular ligaments in then opinion can lead to improvement in abduction ROM *(Wyke, 1972).*

Antero-Posterior mobilisation of the glenohumeral joint is usually indicated in hypomobility in the direction of flexion, internal rotation and horizontal adduction in accordance with Concave-Convex Rule and Circle Stability Concept. The tissue targeted for stretching is believed to be the posterior capsule of glenohumeral joint since it is located directly in the direction of translation movement and thus acts as a primary restrainer.

The use of Antero-posterior glide to improve glenohumeral abduction ROM is although clinically popular it appears to contradict the Circle Stability Concepts and the Concavo-Convex rule. According to *O'Brien and Bowen (1995)*, the primary constraints to the posterior displacement of the humeral head in the glenoid fossa appear to be position dependent. When the arm is positioned at 45^0 of abduction the posterior joint capsule provides the primary restraint to the posterior displacement of humeral head. With the arm close to 90^0 of abduction, however, the inferior glenohumeral ligament complex becomes the primary passive stabilizer against anterior posterior instability. At this position the posterior band of the inferior glenohumeral ligament so also the primary stabilizer against inferior translation of the humeral head on the glenoid. Thus as the glenohumeral joint approaches end range of abduction the posterior band of the inferior glenohumeral ligament becomes the primary structure against inferior gliding of humeral head on the glenoid fossa. In this position Antero-Posterior glide will most effectively stretch the posterior band of the inferior glenohumeral ligament releasing the tightened posterior band and allowing more inferior glide of the humeral head to occur during abduction.

Selecting an appropriate joint position could be a very important factor in the success of the joint mobilisation procedure. Several authors *(Goldstein 2004)* have advocated that resting position is not the most effective position for increasing ROM of the joint treated. Results of various studies *Hsu et al (2000a, b and c)* showed that mobilisation of glenohumeral joint at its resting position is less effective than the end range position in improving abduction ROM. This may be because the periarticular tissue that limits joint ROM is most stretched when the joint is positioned close to the restricted range.

The SPADI is a shoulder region functional status measure that is responsive to clinical change. There is remarkable increase in functional status of the patient following mobilisation procedure. There was a marked decrease in pain and disability following treatment session especially in group A followed by group B .There is no previous study as per the supporting article of similar study. As the increase in abduction ROM was seen there was remarkable decrease in pain and disability in the similar fashion.

Limitation of the Study

1. Number of subjects was less.
2. No control group was taken.
3. No groups had similar patients with the same degree of involvement.
4. Age variation was there from 40-65years.
5. Patients built was variable
6. Adhesive capsulitis is a self-limiting disease so the actual improvement through the treatment cannot be evaluated.
7. Photographic method for measurement of abduction ROM was not used.
8. Marked amount of tissue resistance is experienced while applying the glide which has not been taken into consideration
9. Proper strengthening program was not followed after mobilisation sessions due to lack of time.

Conclusions

This study provides preliminary evidence that antero-posterior glide is also effective in improving glenohumeral abduction ROM when given at the end of available range. However, it is less effective than the traditional caudal glide mobilisation.

Clinical Implication

This study provides some evidence for the use of both Antero posterior and inferior glide performed close to the end range of abduction to increase the abduction ROM. This study also states that inferior glide is most effective in increasing abduction ROM. The significant increase in abduction range seen after Antero posterior glide procedure performed at a joint angle close to its end might be a good alternative for treating abduction hypomobility. This is because inferior glenohumeral ligament is preferentially stressed in this position.

Patient's functional recovery was evaluated using SPADI. A significant improvement in functional activities was in the same pattern as for the improvement in the abduction ROM. This provides an evidence for the functional rehabilitation of the patient.

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Effect of Exercise on BMI and Biochemical Profile of Selected Obese Diabetic Women

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Abstract

The present study was undertaken to investigate the effect of modified diet and exercise among the selected 100 obese type 2 diabetic women in the age group of 25-45 years having fasting blood sugar levels above 150mg/dl, post prandial blood sugar level above 250mg/dl and with elevated blood lipid values. Out of the hundred subjects, 40 were taken as control group (Group I) and the remaining 60 were divided into 3 groups of 20 each as experimental group II, III and IV respectively. All the subjects were advised to take the diet with modified calories as per their Ideal Body Weight but group II, III and IV were advised with different exercise pattern like walking (30 minutes), treadmill (30 minutes) and walking and treadmill (15 minutes each) respectively along with modified diet. Results revealed that, among the three types of exercises, treadmill exercise shows significant reduction in body mass index (BMI), fasting blood sugar, post prandial blood sugar, total cholesterol, triglyceride, low density lipoprotein (LDL) and body fat and significant increase in high density lipoprotein (HDL) level.

Key Words: Walking, Treadmill, BMI, Blood Sugar, Lipid Profile

Introduction

Diabetes is one of the oldest diseases documented in medical literature before over 2000 years (*The Hindu, 2000*). World over in 2003, there were 180 million diabetics and the estimated prevalence of diabetes by the beginning of the new millennium in the year 2025, will be 500 million globally and India may have the maximum number of diabetics (57.2 million) in the world (*The Hindu, 2004*).

Diabetes mellitus is a chronic disorder of glucose metabolism resulting from dysfunction of pancreatic beta cells and insulin resistance. It is still a series health problem all over the world (*Day, 2000*). Physical inactivity leading to increase in obesity is considered to be an important reason for the development of diabetes in various populations. The prevalence of obesity has increased considerably in many countries in recent decades and is affecting both sexes (*Boker et al., 2005*).

Even though millions of people all over the world are affected with diabetes, not all are well informed about the nature of the disease *(Raghuram and Swaransharma, 2003)*. Lower education has been reported to be associated with higher obesity rates. *Boker (2005)* reported that age, education and origin were important risk factors for obesity in women. In general, due to lack of dietary control and energy expenditure by adequate exercise, the obese women with diabetes mellitus experience disturbed blood glucose level; lipid profile and body fat and thus aggravate the problems associated with diabetes.

According to *Bauman (2004),* the physical activity confers a positive benefit on health that includes updates in all cause mortality and in cardiovascular, diabetes and in obesity prevention. *Mary et al.,* (1999) states that exercise is a wonderful drug and is freely available to almost everyone. It can prevent or delay the onset of type 2 diabetes, controls blood sugar levels in people with diabetes, cuts the risk of heart disease, high blood pressure and colon cancer, improves mood and gives a sense of well being, promotes weight loss and an improved appearance and is not only easy, but pleasant to take. Exercise was advocated as beneficial for patients with diabetes. Thus exercise – together with insulin and diet was considered as one of the three central elements in the management of diabetes (*Amisola, 2003*). Thus the present study focuses attention on the importance of exercise and modified diet in reducing weight, improving blood glucose and lipid profile values in selected obese diabetic women.

Materials and Methods

The study was conducted on 100 type 2 diabetic women in the age range of 25 to 45 years who were using oral hypoglycemic drugs and were free from complications like hypertension, cardiac disease etc. The other criteria for the selection of the subjects included BMI (>25), body fat (>30%), disturbed blood glucose (BG) values (fasting BG 150-175mg/dl and post prandial BG 250 to 275 mg/dl) and disturbed lipid profile (Low Density lipoprotein 150 to 170 mg/dl., Serum Cholesterol l 225 to 275 mg/dl, Serum Triglyceride 150 to 200 mg/dl, High Density lipoprotein 30 to 55 mg/dl)

The selected patients were divided into 4 Groups. Group I constituted of 40 diabetics that served as the control group and the remaining 60 subjects were equally divided into three experimental groups as group II, III and IV. All the hundred subjects were recommended to take the diet with modified calories as indicated by their ideal body weight calculation for a period of 60 days. The experimental groups were instructed to undergo different exercise regimens for 60 days in addition to the recommended diet. Group II subjects were advised 30 minutes of walking and Group III subjects did 30 minutes of treadmill exercise while Group IV subjects were administered a combination of normal walking and treadmill exercise each of 15 minutes duration daily.

BMI, blood glucose levels (fasting and post prandial), lipid profile and body fat percentage of all the patients were measured at the start and finally after 60 days of the study using standard techniques.

Information regarding the socio-personal profile of all the selected subjects was collected by using the interview schedule proforma.

Results & Discussion

Information collected from the subjects relating to their age, educational status, physical work, type of family, their dietary pattern, total income and expenditure on food are presented in Table 1.

Table 1. Socio- Personal Profile of the Selected Diabetic Patients

DETAILS	% AGE OF RESPONDENTS (N=100)
Age wise distribution (in years)	
25-30	20
31-35	26
36-40	11
41-50	43
Literacy level	
Primary (1-5)	10
Middle (6-8)	19
Secondary (9-10)	12

Higher secondary (11-12)	12
Under Graduate	13
Post Graduate	10
Illiterate	24
Nature of Work	
Sedentary	90
Moderate	10
Heavy	-
Type of Family	
Nuclear	63
Joint	37
Dietary Pattern	
Vegetarian	21
Non-Vegetarian	79
Total income per month	
Economically weaker section (below Rs. 2100)	09
Low Income Group (Rs.2101-Rs.4500)	26
Middle Income Group (Rs.4501-Rs.7500)	43
High Income Group (Above Rs.7501)	22
Income spent on food	
20-40%	20
40-60%	41
61-80%	30
81% and above	09

Impact results of modified diet and exercise.

Results regarding the height showed that 85% of the selected subjects ranged between 141-170cm, and only 6 and 9% of the subjects were above 171 cm or below 140 cm respectively. With regard to the weight 97% of the subjects demonstrated their body weight between 56 to 85 Kg and only 3 % of the subjects had their weight between 45 to 55 kg.

Table 2. Effect of diet control and exercise advice on weight, BMI and body fat of diabetic patients

	INITIAL MEAN ±S.D.	FINAL MEAN ±S.D.	CHANGE	'T"	P
Weight (in Kg)					
Group I	72.1 ±6.74	69.4 ±6.39	2.7	2.69*	<0.01
Group II	72.3 ±7.68	68.0 ±7.20	4.3	2.68*	<0.05
Group III	64.3 ±7.61	58.7 ±7.58	5.6	3.30*	<0.01
Group IV	72.9 ±5.95	67.0 ±6.26	5.9	4.36*	<0.01
BMI (Kg/M²)					
Group I	29.6 ±1.86	28.6 ±1.77	1.0	3.49*	<0.01
Group II	31.1 ±3.60	29.3 ±3.40	1.8	2.37**	<0.05
Group III	31.6 ±3.07	27.0 ±3.00	4.6	6.85*	<0.01
Group IV	31.1 ±2.31	26.9 ±1.94	4..2	8.85*	<0.01
Body Fat %					
Group I	36.0 ± 1.78	33.0 ±1.43	3.0	10.70*	<0.01
Group II	35.0 ± 1.89	30.0 ±1.41	5.0	15.82*	<0.01
Group III	40.0 ± 2.10	31.0 ±2.44	9.0	16.66*	<0.01
Group IV	38.0 ±1.99	32.0 ±3.79	6.0	7.14*	<0.01

Note: *-Significant at 1% level **Significant at 5% level

A significant decrease in weight, BMI and body fat values was observed in all the groups after the completion of the study and the magnitude of decrease was found to be greater among the experimental groups as compared to control group. Among the experimental groups, a greater decrease in weight, BMI and body fat was noticed in group III subjects who followed the controlled dietary schedule coupled with treadmill exercise for 30 minutes for a period of 60 days.

Biochemical Profile

There was a significant decrease at one percent level in fasting and post prandial blood glucose levels in all the four groups after the study period. But more significant reduction was found in group III who followed the diet control with treadmill exercise for 30 minutes for a period of 60 days.

Table 3. Effect of diet control and exercise on blood glucose levels (mg/dl) of the patients

	INITIAL MEAN ±S.D.	FINAL MEAN ±S.D.	CHANGE	'T"	P
Fasting Blood Glucose (in mg/dl)					
Group I	168.5 ±8.86	153.2 ±8.90	15.3	10.88*	<0.01
Group II	167.5 ±8.21	138.4 ±8.82	29.1	15.28*	<0.01
Group III	163.7 ±8.08	113.4 ±8.90	50.3	26.30*	<0.01
Group IV	166.8 ±8.10	121.0 ±11.0	45.8	21.43*	<0.01
Post Prandial Blood Glucose (mg/dl)					
Group I	263.5 ±7.3	250.9 ±7.5	12.6	10.76*	<0.01
Group II	264.1 ± 8.0	233.0 ±7.8	31.1	17.67*	<0.01
Group III	264.8 ± 6.1	205.1 ±12.0	59.7	28.00*	<0.01
Group IV	264.5 ±7.1	221.1 ±5.5	43.4	31.00*	<0.01

Note: - *- Significant at one percent level.

An exercise program can be an important part of a treatment regimen for NIDDM. According to *Lampman and Sehteigart (1994), r*egular exercise programs potentiate the effects of diet or sulfonylurea therapy to lower glucose levels and improve insulin sensitivity in obese NIDDM subjects

Exercise tends to lower the blood sugar in the diabetic in whose body there is an adequate supply of endogenous insulin. This effect is so striking and so beneficial that exercise along with diet and insulin is now accorded a definite and prominent place in the everyday treatment of diabetes *(Rajiswamy, 1995)*

Table 4. Effect of diet control and exercise on lipid profile (mg/dl) of the selected patients

	INITIAL MEAN ±S.D.	FINAL MEAN ±S.D.	CHANGE	'T"	P
Total Cholesterol (in mg)					
Group I	251.6 ±16.04	226.4 ±20.26	25.2	7.63*	<0.01
Group II	252.5 ±16.67	200.8 ±16.40	51.7	14.04*	<0.01
Group III	252.4 ±16.49	166.0 ±18.40	86.4	21.02*	<0.01
Group IV	254.4 ±12.32	189.0 ±15.56	65.4	18.53*	<0.01
Triglycerides (Kg/M^2)					
Group I	176.8 ±14.31	154.6 ±14.22	22.2	9.73*	<0.01
Group II	175.6 ±15.36	120.4 ±14.00	55.2	17.95*	<0.01
Group III	175.6 ±14.65	89.8 ±13.42	85.8	28.60*	<0.01
Group IV	177.1 ±14.73	108.1 ±14.41	69	91.42*	<0.01
Low Density Lipoproteins					
Group I	160.0 ±6.63	142.0 ±11.3	18.0	9.94*	<0.01
Group II	160.3 ±5.84	137.1 ±8.07	23.2	12.80*	<0.01
Group III	160.3 ±5.84	120.3 ±6.08	40.0	29.44*	<0.01
Group IV	160.3 ±5.84	125.8 ±6.1	34.5	25.36*	<0.01
High Density Lipoproteins					
Group I	41.9± 7.0	51.0 ±7.4	9.1	7.01*	<0.01
Group II	43.8 ±7.1	66.3 ±6.4	22.5	19.56*	<0.01
Group III	43.8 ±7.0	81.1 ±6.2	37.3	25.25*	<0.01
Group IV	43.8 ±7.0	74.7 ±6.1	30.9	21.16*	<0.01

Note: *-Significant at one percent level

The Total cholesterol, Triglyceride and LDL confirmed significant reduction at 1 % level in all the four groups after treatment (Table 4). Among the four groups, Group III which practiced the treadmill exercise had showed the remarkable reduction than the other three groups. In case of High Density lipoprotein, all the groups showed significant increase at 1% level but it was prominent in group III which followed the diet control with treadmill exercise.

Mary et al (1999) in their study reported a trend towards weight loss after following a low intensity aquatic exercise programme 3 times per week with duration of 45 minutes. They observed no change in total lipid profile, blood pressure, and heart rate after the exercise programme.

The present study concluded that the obese type 2 diabetic women treated with diet control and different types of exercise modes demonstrated reduction in weight, BMI, fasting blood sugar level, post prandial blood sugar level, low density lipoprotein level, total cholesterol level, triglyceride level and body fat and an increase in high density lipoprotein level. The changes were found to be remarkable among grouped women who were advised with diet control with treadmill exercise as compared to other groups. Thus, the diet being an integral component, the exercise acts as a wonderful drug in treating the obese diabetic women.

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Comparative Study of Complex Training and Conventional Training in Developing Linear Power among School Children

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Abstract

The effects of complex training and conventional training in developing linear power among school children have been compared. For this purpose a group of 72 boys of 14 to 16 years of age was selected at random out of a universe of 200 children, who were medically fit. AAHPERD youth fitness test was conducted to assign the 72 boys into 3 different groups of 24 each namely complex training group, conventional training group and control group by using snake system based on their performance rankings. To verify that the groups were equated, mean and standard deviations were also calculated and assigned the groups for different treatments on random basis as A, B and C. With this setting, complex training was given to group A and conventional training was given to group B and group C control group did not participate in any of the training programmes, for a period of 12 weeks duration. This process was repeated and for a period of every two-week the data was collected along with pre-test, mid-test and post-test data from the experimental groups and control group on selected motor performance variables. A two way Analysis of Variance (ANOVA) was applied to determine the differences if any among the training methods and duration intervals for experimental and control groups. The Duncan Multiple Range Test (DMRT) was applied wherever applicable on the results of ANOVA to find the hierarchy among the methods of training and the duration intervals. As a result of the above analysis, the boys trained through complex training method gave more significant increase in the linear power as compared to conventional training method and 'No' training group that is control group. It was concluded that the linear power developed through complex training method was much faster than conventional training method within 12 weeks of training period. In fact, it was twice better than the other.

Key Words: Linear Power, Resistance Training, Plyometrics

Introduction

Children involved in sports should be encouraged to participate in a variety of activities and develop in a wide range of skills. The success of young children can serve as a powerful inducement for others to follow. Most Olympic sports have selection processes that attempt to identify future champions and initiate specialised training at the younger age. This means that preparation for competition at the highest level is starting for many sports persons in their early teens and many of them achieve high standards of performance reaching finals or even the victory rostrum. This suggests that growing children can accept training loads compatible with performances, required for success at world level *(Anderson, 200).*

The adolescent period is the most important period to exercise because of the fact that there takes place hormonal changes, growth and development, neural adaptations, inter and intra muscular coordination besides a higher level of stimulus to learn among them. It is because of all these substantiated facts; the study is directed towards the age group of 14 to 16 years. There are empirical evidences to show that sports persons normally gain strength and power through the conventional training method refers to periodised strength training followed by anatomical adaptations which is followed by maximum strength and progresses to power conversion phase, which in turn followed by a maintenance phase and concludes with a regeneration phase *Bompa (1994),* and it is a longer process. He further reported that explosive movements are required in many sports and are typically performed at high speeds against resistance. *Blakey & Southard (1987)* reported that resistive training improves leg power.

The complex training method is a workout system, which combines strength and plyometric for an optimal positive effect to improve the linear power *(Chu, 1996). Burgener (1998)* and *Chu et al (2000)* advocated the value of complex training to develop overall body control. According to *Brown et al (1986),* plyometric training (depth jumps) with coordinated arm movement and leg drive helps to enhance vertical jump. *Duke & BenEliyahu (1992),* conducted similar study and suggested that it would be logical to combine resistance training, plyometrics and speed training in the same session to increase power. Anecdotal evidence suggests that this is the optimal method for maximum power conversion. *Gemar (1998)* reported that resistance training and plyometric training on high school children showed significant differences in the performance of vertical jump, standing broad jump and 30 meters sprint. *Zepeda and Gonzalez (2000)* reported that plyometric training enhances speed within 3 to 8 weeks period and resembles the training effect produces as a result of 30 to 50% of 1RM of three weeks.

Fleck & Steven (2000) observed that extensive studies are also needed to examine the response of females, children and men to periodised resistance training programs and also to periodised models other than the conventional resistance or power training model. *Burger et al (2000)* also reported that complex training is just as effective if not more effective as conventional training in a 7 week study. *Faigenbaum et. al. (1999)* revealed that children can experience similar gains in upper body strength and endurance within 8 weeks of training using conventional strength training and complex training.

From the above cited literature and investigations, it is evident that there is a significant difference in the development of power by using both conventional training method and complex training method. As many earlier studies have revealed that short-term resistance training will not hamper the growth and development of the children, it was proposed in the present study to conduct a comparative study of complex training and conventional training in developing linear power among school children in the age group of 14 to 16 years for the benefit of posterity.

Objectives

1. To study the effectiveness of conventional training method in developing linear power.
2. To find out the relative effectiveness of complex training method and conventional training method in developing linear power.
3. To suggest an optimum combination of the two training methods for future adaptation.

Hypotheses

1. The conventional training method is not significantly effective in developing linear power.

2. The complex training method is not significantly effective in developing linear power.
3. There is no significant difference between complex training and conventional training methods in developing linear power.

Materials and Methods

The sample:
Step 1: Selection of boys 14 to 16 years of age.
Step 2: Screening for medical fitness test by a registered medical practitioner to ensure their medical fitness.
Step 3: The sample unit consisted of 72 boys selected at random out of a universe of 200 children who were medically fit.
Step 4: In order to equate the groups AAHPERD youth fitness was conducted to assign the 72 boys into 3 different groups namely complex training group, conventional training group and control group by using snake system based on their performance rankings.
Step 5: To verify that the groups were equated, mean and standard deviations were also calculated.
Step 6: Assigning the groups for different treatments on random basis as A, B and C.

A two way Analysis of Variance (ANOVA) was applied to determine the differences if any among the training methods and duration intervals for experimental and control groups. For comparison purposes percentiles, mean and standard deviation and t-values have also been calculated. The Duncan Multiple Range Test (DMRT) was applied wherever applicable on the results of ANOVA to find the hierarchy among the methods of training and the duration intervals. ANOVA, Mean, Standard deviation (SD), and t - tests have been computed using SPSS - 10.0 software. The percentile analysis was carried out using The Unscrambler 9.01 software**.** The level of significance was fixed at 0.05.

Results and Discussion

The results of the study are given in the following percentile values and mean ± standard deviation in graphical form of linear power in centimeters are illustrated in Fig. 1, Fig. 2 and Fig. 3. These figures explain the increase in linear power by conventional and complex training methods. As evidenced by the Fig. 1, there is no significant effect on the increase of linear power for control group.

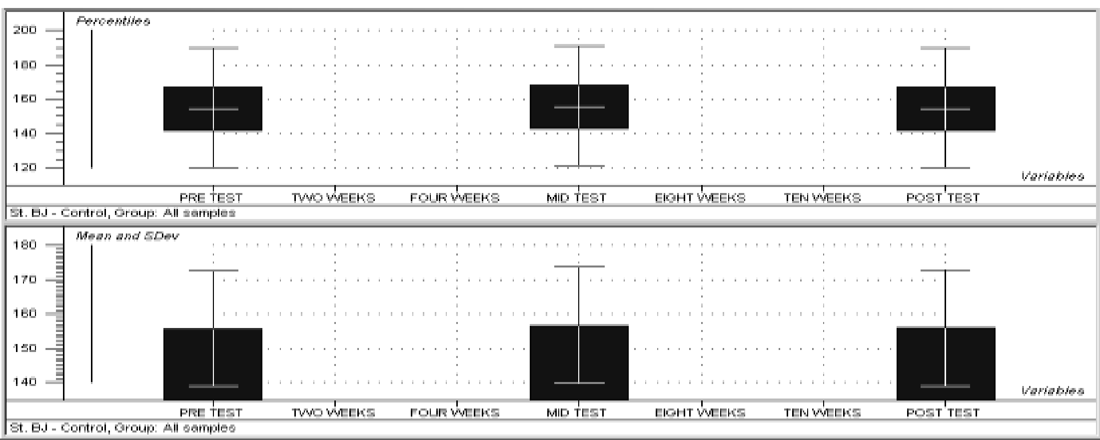

Figure 1. Percentiles and Means ± SD Values of linear power for control group

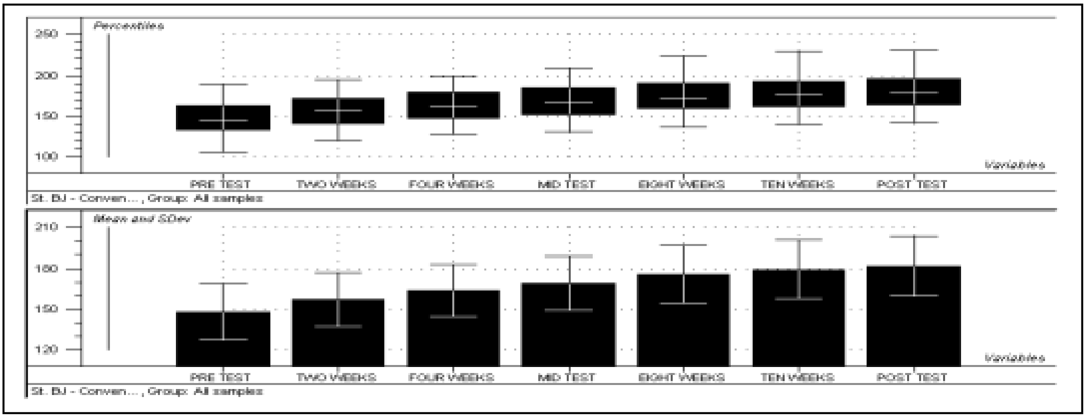

Figure 2. Percentiles and Means + SD Values of linear power for conventional training group

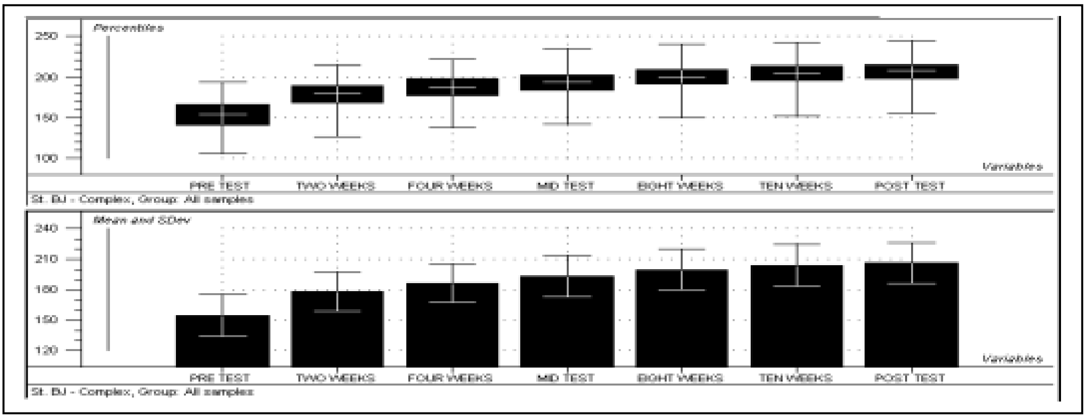

Figure 3. Percentiles and Means + SD Values of linear power for complex training group.

The above percentiles graph show that the distribution of subjects around the median have narrower limits from Pre test to Mid test and thereafter it became slightly broader up to Post test under complex training method compared to conventional training method. This proves that the rate of increase in linear power is faster under complex training method than the conventional training method. Therefore from Fig. 2 and Fig. 3, it may be concluded that the complex training method gives the rapid increase in the linear power during the first two weeks period and then it is consistent in the increase of linear power.

Table 1. Mean Values of Linear Power Distance (in centimeters) with SD and t-values

Tests	Control		Conventional		Complex		t-value	ρ - Value
Pre test	155.79	16.89	148.03	20.95	154.71	20.63	1.08	-
2 weeks	155.69	16.88	157.00	19.82	178.33	19.29	3.70	ρ < 0.01
4 weeks	155.63	16.89	163.75	19.27	186.75	19.10	4.07	ρ < 0.01
Mid test	156.63	16.96	169.25	19.93	193.50	20.13	4.11	ρ < 0.01
8 weeks	155.69	16.89	175.71	21.40	199.92	19.72	3.99	ρ < 0.01
10 weeks	155.79	16.88	179.21	21.52	203.92	19.99	4.03	ρ < 0.01
Post test	155.92	17.01	181.67	21.68	206.29	20.05	4.00	ρ < 0.01

Table 1 reveals the mean and standard deviation (SD) values of control, conventional and complex training methods. Also provided in the table are the t-values and their significance for comparing the conventional and complex training methods. The average linear power distance performance of the subjects during Pre test 148.03 ± 20.95 cms under conventional training group was not significantly different from that of complex training group 154.71 ± 20.63 cms. From the second week period onwards, there had been high significant difference (P<0.01) between the conventional and complex training methods. Also at the at Post test the average linear power distance performance of the subjects belonged to the complex training group 206.29 ± 20.05 cms, which is significantly more than that of conventional training group 181.67 ± 21.68 cms that is significant at 1 percent level.

Hence it can be inferred that the complex training method improves linear power distance performance very quickly, when compared to conventional training method within the twelve-week duration of training period.

Table 2. ANOVA Results of Linear Power Variable

SOURCE	Type III sum of squares	Df	Mean Square	F	Sig	ρ - Value
Methods	93200.4	2	46600.2	9425,3	.000	ρ < 0.01
Duration	44286.2	6	7381.0	1492.9	.000	ρ < 0.01
Duration * Methods	24468.7	12	2039.9	412.6	.000	ρ < 0.01
Duration * Subjects	793. 9	138	5.75	1.16	.147	NS
Methods *Subjects	146132.9	46	3176.8	642.5	.000	ρ < 0.01

Table 2 shows the results of the two way ANOVA for the linear power variable. The ANOVA results include the main effects namely the different methods of training and the duration intervals.
The results indicated that,

The different methods of training are significantly different (ρ<0.01).

The duration intervals are significantly different (ρ<0.01)

The interaction between the subjects and methods (ρ<0.01) and methods and duration (ρ<0.01) are significantly different.

The interaction between subjects and duration intervals are not significantly different.

The subjects were initially homogenized with respect to their physical fitness level, based on the six fitness variables considered in this study. It was expected that the same to be maintained during the entire duration of training period. The interaction between the subjects and duration is being not significant as revealed by ANOVA established this fact.

As the training methods and duration intervals are significantly different, the Duncan Multiple Range Test (DMRT) was applied on the results of ANOVA to find the hierarchy among the methods of training and the duration intervals.

Table 3 indicates that the DMRT results for duration intervals of the total sample of the subjects. The averages furnished in the above table are harmonic means of the linear power distance achieved by the subjects to perform standing broad jump over the two methods of training during the seven duration intervals. It is clearly evident from the table that the different duration intervals of the study were significantly different between each other. On the average, there had been significant increase in the linear power distance in the standing broad jump achieved by the subjects at all duration intervals. The least average linear power performed by the subjects at the Pre test was 152.86 cms and the maximum linear power distance achieved was 181.29 cms at the Post test.

Table 3. DMRT Results of Duration of Training of Linear Power Variable

TEST	DURATION	1	2	3	4	5	6	7
Post test	7.00	181.3						
	6.00		179.9					
	5.00			177.4				
	4.00				173.1			
	3.00					168.8		
	2.00						163.8	
Pre test	1.00							152.9

Source: Compiled Means in the same group are not significantly different.

Table 4 reveals that the DMRT results of methods of training of subjects in the total sample across the seven duration intervals of training.

Table 4. DMRT Results of Methods of Training of Linear Power Variable

GROUPS	METHODS	SUB SET		
		1	2	3
Complex	3.00	189.0595		
Conventional	2.00		167.8095	
Control	1.00			156.2202

Source: Compiled Means in the same group are not significantly different.

The averages furnished in the above table are harmonic means of the linear power distance achieved by the subjects over the seven duration intervals of training. It may be seen from the table that the two methods of training are significantly different among each other in increasing the linear power distance achieved by the subjects to perform standing broad jump. The complex training method showed the maximum average linear power distance 189.05 cms compared to conventional training method 167.80 cms and control group 156.22 cms. This indicates that the complex training method develops the linear power more quickly when compared to conventional training method in a given time duration.

Since the means of complex training method and conventional training method are significantly more that of control and also the complex training method yielded better results than the conventional training method, it implies that the complex training method is more effective in developing the linear power variable, although they do not differ between themselves.

Findings:

The findings concerned with the linear power performance for different tests conducted at different periods among the experimental groups and control group revealed the following results.

There was no significant difference among the complex training group, conventional training group and control group before administering the experimental treatment that is Pre test. But there were differences in linear performance between the three groups at mid test and Post test.

Among the tests conducted for the conventional training method at different interval periods, during the Pre test to Post test period the linear power performance was uniformly increased and the rate of increase was being almost the same for every two every week period.

Among the tests conducted for the complex training method at different interval periods, there was faster increase in the linear power performance for the first two-week period and thereafter, the rate of increase became uniform and consistent till Post test. In the case of the control group there were no significant improvement observed in the linear power performance between the Pre test and all the other tests conducted at different intervals that is Mid test and Post test. It was found that the rate of increase in linear power performance was faster under complex training method than conventional training method. The complex training method yielded a greater linear power distance performance compared to the conventional training method and control group. This proves that the complex training method develops the fastest increase in the linear power distance performance when compared to conventional training method and control group.

The findings related to the linear power performance of two experimental groups conventional and complex training methods have shown significant increase and among them, complex training method had shown faster increase in linear power distance performance compared to conventional training method within the twelve week duration of training period. The reason could be the link between power and plyometric exercises which is caused by five critical components. These components are slow velocity strength, high velocity strength, and rate of force development, stretch shortening cycle and inter-muscular coordination and skill. Therefore combining resistance training and plyometrics is the most effective method in maximizing power development as it allows more components of explosive power to be developed. This finding is in concurrence with the results of *Newton and William (1994).* Similarly, the present study is in conformity with the study of *Radcliffe (1994), Bielik et. al (1986), Chu (1996)* and National strength and conditioning association (NSCA) round table discussion on plyometrics with resistance training (complex training). Thus the hypotheses stand vindicated.

Conclusions

The study leads us to arrive at the following conclusions;

1. Resistance training (conventional training method) should be performed at a high speed if explosive power is to be developed.
2. Combining resistance training and plyometrics that is complex training method one can increase more than resistance or plyometrics alone in developing linear power.
3. Combining resistance training and plyometrics that is complex training method is the optimal method for maximum power conversion.
4. The rate of increase in linear power performance during the first two-week period was significantly more

for complex training method as compared to conventional training method within 12 weeks duration of training period.

Thus, it may be concluded that the linear power developed through complex training method is much faster than conventional training method within 12weeks duration of training period. Infact, it is twice better than the other.

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Incidence of Overweight and Obesity among Urban and Rural Males of Amritsar

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Abstract

Global epidemic of obesity is one of the main public health problems in developed as well as developing countries. The present study was undertaken to assess the prevalence of overweight and obesity among urban and rural males of Amritsar district of Punjab. 1,000 adult males (500 urban and 500 rural) in the age group 20-50 years were screened for overweight and obesity from height and weight measurements. The prevalence rate of malnutrition was calculated according to the critical limits of body mass index (BMI). The observations show that the combined overall prevalence rate of overweight and obesity, according to WHO (1998) and WHO (2000) classification, in the present study is 24.7% and 46.1%, respectively. The frequency of overweight and obesity is more among urban males than in their rural counterparts.

Key Words: Body Mass Index, Overweight, Obesity, Punjabi Males

Introduction

As the pandemic of overweight and obesity around the globe continues to rise, many developing countries face a double burden of over nutrition and under nutrition *(WHO/FAO, 2002).* The scope and distribution of both types of malnutrition must be understood so that public health resources can be channelled appropriately. In recent years, India has controlled the problem of severe under nutrition to a substantial extent among young children but now facing a rising epidemic of overweight and obesity among children and adults. Only limited data on prevalence of overweight and obesity are available for adults in India. According to *WHO (1998),* there is a special need to collect good quality nationally representative prevalence data on obesity from countries, those are undergoing the so-called nutrition transition. India, especially the state of Punjab, is also passing through such a transitional phase of socio-economic development which has the potential of altering the nutritional status of her population groups. Therefore, in the present study, an attempt has been made to investigate the prevalence of overweight and obesity in urban and rural adult males of Amritsar district of Punjab.

Materials and Methods

The data for the present study have been collected from 500 urban and 500 rural males of age 20 years and above during the year 2004-2005. All subjects were of Punjabi origin and belonged to upper middle class with an increase ranging from Rs. 10000 to Rs. 30000 per month. The majority of the urban data were collected from residential colonies, occupied by well-to-do officers, professors and doctors of Amritsar city of Punjab. Rural data were collected from landowners of 'Ram Tirath' and 'Chugawan' village of the Amritsar district of Punjab. Urban males in this sample lead a very sedentary and comfortable life, but rural males are very hardworking. They work is farms, take care of the products of the farms and even look after the cattle, etc. The information regarding age, occupation, income, etc. was collected through the pre-tested interview schedule from each individual.

For the assessment of overweight and obesity, height and weight measurements were taken on each subject using the standard protocol given by *Weiner and Lourie (1981).* The practical and clinical definition of obesity is based on body mass index (BMI). Therefore, the value of BMI was calculated for each subject as follows:

$$BMI = Weight (kg) / Height^2 (m)$$

The suggested critical limits of BMI by *WHO (1998, 2000)* were utilised for the assessment of overweight and obesity.

WHO (1998) Classification

Classification	BMI (kg/m²)
Underweight	< 18.5
Normal	18.5-24.9
Overweight	25.0-29.9
Obese Grade I	30.0-34.9
Obese Grade II	35.0-39.9
Obese Grade III	≥ 40.0

WHO (2000) Classification

Classification	BMI (kg/m²)
Underweight	< 18.5
Normal	18.5-22.9
Overweight	23.0-24.9
Obese Grade I	25.0-29.9
Obese Grade II	≥ 30.0

Results & Discussion:

Table 1. Classification of urban and rural adult males of Amritsar according to WHO (1998) criteria of BMI

BMI	Urban males		Rural males		Nutritional status
	N	%age prevalence	N	%age prevalence	
< 18.5	16	3.2	46	9.2	Under nourished
18.5-24.9	321	64.2	370	74.0	Normal
25.0-29.9	99	19.8	64	12.8	Overweight
30.0-34.9	41	8.2	13	2.6	Obese I
35.0-39.9	9	3.8	7	1.4	Obese II
≥ 40.0	4	0.8	–	–	Obese III

Table 1 presents the distribution of all subjects according to BMI classification *(WHO, 1998).* Out of 500 urban males, only 16 (3.20%) are underweight, 321 (64.2%) are normal and 99 (19.8%) are overweight while 41 (8.2%) are in obesity grade I, 9 (3.8%) in grade II and 4 (0.8%) are in obesity grade III. On the other hand, out of 500 rural males, 46 (9.2%) are undernourished and 370 (74.0%) are normal while 64 (12.8%) are overweight and 30 (14.0%) are obese. In other words, the overall combined prevalence of overweight and obesity in urban and rural males is 32.6% and 16.8%, respectively. It is also apparent from Table 1 that urban males show higher prevalence rate of overweight and obesity than rural males.

Table 2. Classification of adult urban and rural males of Amritsar according to WHO (2000) criteria of BMI

BMI	Urban males		Rural males		Nutritional status
	N	%age prevalence	N	%age prevalence	
< 18.5	16	3.2	46	9.2	Under nourished
18.5-22.9	205	41.2	272	54.4	Normal
23.0-24.9	126	25.2	98	19.6	Over weight

25.0-29.9	99	19.8	64	12.8	Obese I
≥ 30.0	54	10.8	20	4.0	Obese II

On using the lower cut-off values of BMI recommended by *WHO (2000)* for Asians, percentage prevalence of overweight and obesity becomes 55.8% in urban males and 36.4% in rural males (Table 2). But, on the other hand, percentage prevalence of normal individuals decreases to 41.0% and 54.4% in urban and rural males, respectively.

It is evident from the present study (Tables 1, 2) that the overall prevalence of overweight and obesity among Punjabi adult men, according to *WHO (1998)* classification, is 24.7%, but according to *WHO (2000)* classification it becomes 46.1%. The changed perception about body mass index (BMI) classification has drawn a drastic situation in this study. The prevalence of obesity in terms of number of people almost doubled according to new classification. This has not only of statistical significance but also is alarming for the health planners.

Table 3. Comparison of prevalence of overweight and obesity in urban and rural males of Amritsar

Area	**N**	**Prevalence of overweight and obesity**			
		WHO (1998)		**WHO (2000)**	
		N	**%age prevalence**	***N***	**%age prevalence**
Urban	500	163	32.6	279	55.8
Rural	500	84	16.8	182	36.4
Total	1000	247	24.7	461	46.1

Further, it is also observed from the present data (Table 3) that in terms of both the criteria *(WHO, 1998, 2000)*, urban males show high incidence of obesity (32.6% and 55.8%) than the rural ones (16.8% and 36.4%). The Chi-square test was also employed to note the urban and rural differences in the prevalence of overweight and obesity. Urban males show significantly (χ^2=33.48, 37.84; $p < 0.001$) higher prevalence estimates than the rural counterparts. Urban-rural differences in the prevalence of overweight and obesity are also evident in other parts of Asia *(Ge, 1997; Martorell et al., 2000; WHO/FAO, 2002).* The possible reasons for higher rate of incidence among urban males might include the resultants of their sedentary lifestyle and changes in dietary practices. In urban Punjab, the traditional diet of coarse grains and millets has given way to refined wheat and rice as the staple cereal, leading to a substantial reduction in fibre content and possibly micronutrients in diet. This shift has resulted in Punjabi urban affluent consuming more fat, oils and western-style fast foods. The variety of fast foods available in the market today has also contributed to the problem of obesity. This is coupled with physical activity and availability of advances in technology and transportation. As a result, there is a network of these factors which play an important role in the development of present state of obesity. On the other hand, rural males of the present sample are mainly engaged in manual labour and fairly high level of physical activity. But now-a-days, labour-saving devices have eliminated many of the back-breaking tasks of agricultural and industrial sector occupations and reduced the time it takes to complete them. That is why the present sample shows higher prevalence of overweight and obesity in rural males than the other rural populations of India. The underweight prevalence in the present sample is about three times higher in rural areas than in urban areas.

The data on prevalence of overweight and obesity in various studies

(Gopinath et al., 1994; Visweswara Rao, 1995; Gopalan, 1998; Zargar et al., 2000; Mishra et al., 2001; Shukla et al., 2002; Reddy et al., 2002; Sidhu and Sandhu, 2005) in India are shown in Table 4.

Table 4. Prevalence rate of overweight and obesity in India

Reference	Place	Area	Obesity criteria of BMI	%age prevalence of overweight and obesity
Sidhu and Sandhu (2005)	Amritsar	(Urban)	≥ 23	51.5
Reddy et al. (2002)	New Delhi	(Urban) (Rural)	> 25	35.0 8.0
Shukla et al. (2002)	Mumbai		> 25	19.0
Mishra et al. (2001)	New Delhi	(Slum)	> 25	13.0
Zargar et al. (2000)	Kashmir Valley	(Combined)	≥ 27	7.0
Gopalan (1998)	Delhi	(Combined)	> 25	29.2
Visweswara Rao (1995)	Hyderabad	(Urban) (Rural)	≥ 30	2.1 0.8
Gopinath et al. (1994)	Delhi	(Combined)	≥ 25	21.3
Present study	Amritsar	(Urban) (Rural)	≥ 25	32.6 16.8
		(Urban) (Rural)	≥ 23	55.8 36.4

However, the extent of overweight and obesity reported in these studies is not strictly comparable because of the variation in the criteria of BMI cut-off points used and variation in age and socio-economic status of the subjects. It is discernible from Table 4 that the prevalence rates of overweight and obesity in Punjabi adult males are slightly higher than in other populations of India but are slightly less than what has been reported for Europe or USA *(WHO, 1998; Flegal et al., 2002).* This comparative profile of incidence of overweight and obesity clearly indicates that the men in Punjab are at an increased risk of malnutrition in the form of overweight and obesity. If the present trends continue, the situation can get worse even within a decade, and overweight can emerge as a single most important public health problem in adults. Overweight/obesity might not be considered as a specific disease, but it is certainly the ‘mother’ of various degenerative diseases in adult life. Obesity also increases a person's number of unhealthy life years, work disability, hospitalization due to cardiovascular disease and need long-term medication. The social and economic cost of the diseases is so high that a country, like India, can ill-afford to spend its paltry resources on the co-morbidities which are strongly influenced by obesity. Prevention and control of this problem must, therefore, claim priority attention.

Conclusion

This is the first and the only comprehensive study on the prevalence of overweight and obesity among urban and rural adult males of Amritsar. This study has revealed that the overall prevalence of overweight and obesity in urban and rural males is 55.8% and 36.4%, respectively, according to new classification of BMI. This shows that the burden of this disease is substantial in both urban and rural population. Notably, there was far more occurrence of overweight than underweight among adult men of Punjab. Not only the appropriate precautionary measures to prevent further progression of the problem into an epidemic are urgently required, but also there is a strong need for prospective epidemiological studies to better understand the causes and consequences of this growing obesity epidemic in Punjab. Therefore, multicentric approaches and research are needed with reference to this epidemic in those populations which are undergoing such nutritional transition.

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Short Communication

Role of Music on Muscle Recruitment

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Abstract

The study was conducted to register the occurrence of Bioccipital/ Rotator Cuff Tendonitis in the subjects involved in Bench Press Activity in gymnasium**.** Fifty male subjects (age group 20-30 years), having shoulder pain for at least three weeks, were selected randomly and were interviewed for the present history of shoulder pain, from various gymnasia. The subjects were interviewed through a questionnaire and assessed using standard orthopedic examination techniques. The value of Z (3.68) >3 showed a definite relationship between subjects doing Bench Press activity in gymnasium and occurrence of Bioccipital / Rotator Cuff tendonitis. This study gave preliminary data on the incidence of tendonitis in subjects who train with weights. Occurrence of these shoulder injuries can be prevented by a proper knowledge of the technique, supervision and knowledge about the mass of poundage lifted.

Key Words: Hawkin's Test, Isometric Abduction, Isometric External Rotation, Injury

Introduction

Physical activities have major role in the human beings, these activities can vary depends upon the physiological and psychological functions. The activities if done while listening to music can alter the physiological and psychological functions, because music affects the physiological and psychological actions and may even are music specific. *Sears in 1957* observed that muscle tension can be altered by music: who reported that stimulating music increased muscle tension while sedative music decreased muscle tension. *Pearce (1981)* revealed the effects of different types of music on physical strength. *Johnson et al (2002)* conducted a study that demonstrated some positive responses to familiar music as an external stimuli that facilitated adherence to a physical rehabilitation exercise program with persons who were elderly.

According to *Chipman (1966)* music accompaniment improved muscular endurance in the performance of junior high students doing sit-ups. *Copeland & Franks (1991)* observed that soft music as compared to loud fast music increased walking/jogging on a treadmill time at sub maximal intensity. A review of studies by *Dainow, (1977)* indicates that heart rate tends to only moderately follow the music; increasing in response to fast music and decreasing in response to slow music. The study was conducted with the following specific aims:

- To find out the effects of music on muscle recruitment
- To compare the effectiveness between Stimulative music, sedative music and music silence on various neuromuscular part.

Materials and Methods

The study was conducted on randomly selected 60 physically and medically normal subjects of S.B.S.P.G.I, Balawala, Dehradun of both sexes between 19 – 25 yrs of age, having normal muscle power and endurance and BMI between 21 – 25 adult students.

The subjects having any musculoskeletal, cardiovascular, auditory, psychological disorders, signs and symptoms of peripheral neuropathy or H/O neuromuscular disease or not interested in listening music, history of Diabetes Mellitus or thyroid diseases or having difficulty in joint positioning were not included in the study.

Electrodiagnosis machine with software computer (diagnosis EMG and NCV machine) was used to record the EMG (dependent variable) and karaoke (only music without lyrics, independent variable) was administered. Two types of music were selected. These were named as stimulating and sedative types of music as per the assessment of the eminent musician. Stimulating music included songs like “Dhol Taro Dhol” and “Man Mohini” of Hum Dil De Chuke Sanam movie, “Chori Pe Chori” of Sathiyaa, “Dhoom Machale” of Dhoom, “Balle Balle” and “Dharak Dharak” of Bunty aur Bablie“ and Babuji Zara” of Dum. Similarly the sedative category of music included tunes of the songs “Man Tarpat Hari Darshan Ka”, “Man Re Te Kahe Na Dheer Dhare”, “Roja JaneZa”, “Dil Hai Chotasa“, Albela Sajan”, “Ayo Kahan Se Ghanshyam” and “Jonn Tere Charan Kamal” from Baiju Bawra, Chitralekha, Roja, Roja, Hum Dil De Chuke Sanam, Buddha Mil Gaya, Sursangam movies respectively.

This music was applied in the Karaoke manner, that is without lyrics and only music of these songs was used. The atmosphere of the research lab was kept free from noise pollution and air pollution and room temperature was maintained. The execution of the experiment was completed in the following steps:

Step I: The subject was positioned in a comfortable pose (High sitting without ground contact) and all metallic contacts were removed to avoid artifacts.

Step II: In the next step the subject was instructed to gently respond to the touch at the tip of great toe of the subject whenever applied by the investigator. The response should be bending the hand three times during music playing.

Step III: The subject was then asked to close the eyes and a headphone was placed in a comfortable manner.

Step IV: After 5 minutes of positioning of the subject, the tip of the great toe was touched by the investigator and amplitude of biceps muscle recruitment was recorded without music (Music silence)

Step – V: The above step was repeated with music on for 5 to 10 minutes (first stimulating music and then after a gap of 15 minutes sedative music) and the biceps muscle activity was recorded.

Results & Discussion

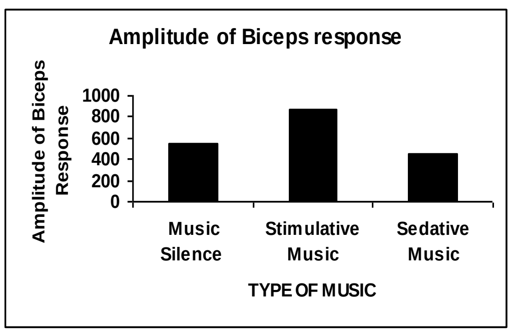

Figure 1. Amplitude of biceps response to different types of music

Table 1: Comparison of magnitude of muscle recruitment among subjects to different types of music

Type of Music	Mean	±S.D
Music Silence	543.75	251.36
Stimulative Music	877.36	336.12
Sedative Music	454.55	178.93

Table 2. 't' test between the variables

Variables	t value	P value
Music Silence Vs. Stimulative Music	**-7.14**	**P<0.05**
Stimulative Music Vs. Sedative Music	**8.24**	**P<0.05**
Music Silence Vs. Sedative Music	**3.27**	**P<0.05**

There is a significant difference of muscle recruitment between stimulative music, sedative music and music silence (Table 2). Stimulative music is observed to increase the muscle recruitment and sedative music decreases it (Table 1), so one can apply the stimulative music for flaccid muscles to increase the muscle tone and sedative music for spastic muscle conditions to decrease the muscle tone. It is indicated by the study that the stimulative music can increase muscle recruitment and the sedative music can decrease muscle recruitment (Figure 1) in the normal muscle, as a result the music can play an important part in the rehabilitation depending upon the different muscular conditions. Future scope of the study includes thorough investigations in studying the role of music in Flaccidity, spastic conditions and gait rehabilitation.

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Effectiveness of Telemedicine Services Integrated Into Physiotherapeutic Health Care System

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Abstract

To study was conducted to investigate the effectiveness of telemedicine system for the management of continually growing patient's physiotherapeutic needs while maintaining high quality care and services. The videoconferencing system, telephone, e-mail, videotapes and CDs, VAS were used in the study. Patients of back pain in the remote area were first asserted through videoconferencing. VAS was used to assess the severity of pain; muscle strength was assessed by MMT whereas functional assessment was judged by using Oswestry Disability Index. Treatment consisted of heat therapy, back exercises; ergonomic care was explained through videoconferencing. Reassessment was done after the completion of two weeks and then four weeks of treatment program. Significant improvement was found in relief of pain and improvement in muscle strength as well as functional ability. It was concluded that telemedicine can be used effectively for administering instant care and manage the increasing number of patient's input.

Key Words: Telemedicine, Videoconferencing, E-Mail, Oswestry Disability Index.

Introduction

Change is the only constant in the world, or better said, advancement and evolution is imperative to any field of science and technology. Medical field too has been no exception. With the advent of telemedicine the dramatic changes have been taken place in health environment.

Definition of telemedicine:

The term telemedicine was first coined by Thomas Bud and later on it was redefined by *Reid* in *1996* as the use of advanced telecommunication technologies to exchange health information to provide healthcare services across geographic, time, social and cultural barriers *(Sharma, 2005).*

It may be as simple as two health professionals discussing a case over the telephone, or as sophisticated as using internet or satellite or videoconferencing equipment in order to improve access to healthcare to sites that are at a distance from provider *(Brown, 1996).*

A brief history of telemedicine:

While the explosion of interest in telemedicine over the past four or five years makes it appear that it is a relatively new use of telecommunications technology, the truth is that telemedicine has been in use in some or other form from last about 40 years. The National Aeronautics and Space Administration (NASA) played an important role in the early development of telemedicine *(Bashshur and Lovett, 1977).*

Duration	*Institution*	*Telemedicine Program*
Early 1960s	NASA	Physiological parameters were telemetered from both the space craft and the space suits when humans began flying in

		space
1964	Nebraska Medical center	A two-way link between the psychiatric center and Norfolk State Hospital, 112 miles away, was established for consultations between specialists and general practitioners
1967	Massachusetts General Hospital/Logan International Airport Medical Station	To provide occupational health services to airport employees and to deliver emergency care and medical attention to travelers.
1971	National Library of Medicine's Lister Hill National Center for Biomedical Communication	26 sites in Alaska were Chosen to see if reliable Communication would improve village health care
1974	NASA	A study was conducted to determine the minimal television system requirements for telediagnosis
1977	Memorial University of Newfoundland	Teleconferencing system began
1984	Australia	The North-West Telemedicine Project
1989	NASA	Conducted the first international telemedicine program – Space Bridge to Armenia/USA
Early 1990s	Wide spectrum of users	A steady increase in number of telemedicine projects throughout the U.S. and internationally
2002	Care Hospital Hyderabad	To provide remote screening facility to villagers who were located far away from Tirupura.

Thus, telemedicine has begun to take hold, almost 40 years after the first experiments in providing medical care at distant places. The technology has reduced in price and complexity over the past five years. Computer hardware and software have become fast, powerful, easy to use and affordable. Compressible, high-resolution digital images can be enhanced. The availability of and access to health-related information has improved substantially. Telemedicine is utilised by health providers in a growing number of medical specialties, including, but not limited to: radiology, pathology, dermatology, oncology, surgery, cardiology, psychiatry, rehabilitation and neurology.

Nevertheless, the number of patients receiving the services that use the technology of telemedicine remains low in India and when it comes to physiotherapeutic services, this number still lowers down. On the other hand, the number of patients requiring physiotherapeutic services is steadily increasing; particularly in the present era of sedentary life style. Therefore, the present study was conducted to study the effectiveness of telemedicine system for the management of continually growing patient's physiotherapeutic needs while maintaining high quality care and services.

Materials and Methods

STEP I – Selection of Remote Area

A village named Sapehra-Sahabapur was located 15 kms away from M. M. institute of Physiotherapy and Rehabilitation, Mullana.

STEP II – Setting Up of Telemedicine Center

Call center at originating site:

A call center outfitted with videoconferencing equipment was established in village Sapehra-Sahabapur to receive patients of low back pain.

Call center at referral site:

Department of Information and Technology, M.M. Engineering College, Mullana, outfitted with videoconferencing equipment provided access to physiotherapeutic services.

STEP III – Selection of Subjects

- Patients of low back pain in the village Sapehra-Sahabapur were first asserted through videoconferencing. Thirty patients ranging in age from 30 to 50 years were recruited for the study.
- Any systemic disease
- Osteoporosis
- Any fracture
- Any deformity or contracture cases
- Radiating pain
- Exaggerated lordosis

STEP IV – Evaluation of Patients

VAS was used to assess the severity of pain; muscle strength was assessed by MMT whereas functional assessment was judged by using Oswestry Disability Index.

STEP V – Execution of Treatment Plan

Treatment plan consisted of hot water fermentation, ergonomic care and back exercises based on McKenzie approach was executed from referral site in following sequence:

Day 1: patients were asked to apply hot water fermentation for three days.

Day 4: Isometric exercise for lumbar extensors was explained

Day 5: Isotonic exercise for lumbar extensors in graded form were explained

Day 12: Rotational spinal exercise for upper as well as lower back was added

Day 15: Isometric exercise for lumbar flexors was explained

Day 17: Isotonic exercise for lumbar flexors in graded form were explained

Day 30: Re-evaluation was done

STEP VI – Data Analysis

Statistical analysis was carried out by using SPSS for Windows Version 7.5.1. t-test was used to judge the significance of difference between the base line score and score at the end of the treatment program. Statistical significance was set at 0.05.

Results

Table-1 displays the demographic data of patients. Mean age was 42.09 and most of them were involved in the occupations encouraging more of flexion attitude of trunk. Table-2 presents pre treatment and post treatment scores of VAS, MMT & ODI with t = 10.34, 5.81 and 4.809 respectively. This suggests that difference between pre treatment and post treatment values was statistically significant.

Table 1. Demography of Patients

No of Patients	30 (M=9, F=21)
Mean Age (Years)	42.09
Occupation	18-Housewives, 5-Shopkeepers, 4-Gardeners, 2-Tailors, 1-Teacher
Leisure Activities	20-Indoor activities, 4-Sports, 6-Both

Table 2. Comparison of pre treatment and post treatment scores of VAS, MMT & ODI

Parameters	Pre Treatment Score			Post Treatment Score			T-Value	D.F.	95% confidence interval of the Difference	
	Mean	SD	SE	Mean	SD	SE		29	Lower	Upper
VAS	6.0	3.02	0.55	4.1	3.52	0.64	10.34*	29	-0.6	3.86
MMT	3.33	0.47	0.09	4.4	3.63	0.66	5.81*	29	-0.89	3.03
ODI	4.25	1.08	0.20	3.37	2.71	0.49	4.81*	29	-1.08	2.84

***$p < 0.05$**

Discussion

Statistically significant improvement found in pain, muscle strength and functional capacity in the patients of low back pain has demonstrated the potential of telemedicine to revolutionize the delivery of physiotherapeutic services to the benefit of patients living in periphery. Nevertheless, the effectiveness of the telecommunication depends upon the efficiency of a physiotherapist for the effective explanation of the procedure for assessment as well as therapeutic intervention.

At the same time, the present study has also documented the efficacy of treatment program consisting of heat, ergonomic care and McKenzie approach.

Demographic data of patients suggests that most of them were involved in the occupations requiring either repeated movements of forward flexion or prolonged flexion posture of trunk that results into

- Elongation of posterior structures
- Excessive compression over the anterior surfaces of vertebral bodies
- Protective spasm of extensors
- Flattening of lordosis

Therefore, it is reasonable to assume that extension exercises done in graded form can alleviate low back pain and increase the muscle strength, particularly when they are carried out after the reduction of muscle spasm with the help of heat application.

Due to the shortage of time, clinical consultation in physiotherapy O.P.D. does not deal with the issue of health education, which is an important part of the physiotherapist's role in health care, especially in case of low back pain, where poor posture, wrong working habits, etc. are the precipitating factors. The result of present study has demonstrated that with the advent of telemedicine, new vistas have opened for improving the community health and physiotherapist-patient relationship. These findings are still more important in our country because the proportion of physiotherapists in the total population of India is very much negligible, (18200 qualified physiotherapists for a population of 1060000000). Hence, to provide physiotherapeutic services up to the root level of India, it is **need of the hour** to develop and execute more and more programs of telephysiotherapy.

However, while conducting the present study we faced certain troubles such as:

- Lack of consistent coverage
- Computer illiteracy
- Payment policy
- Difficulty in locating tenderness points

- Inability to execute specialized techniques like traction, mobilisation, manual therapy, etc.

This suggests that higher information content is required for the development of the new concept of telephysiotherapy. In cyber surgeries, a qualified surgeon, with the help of Commutation and Robotic technology can effectively operate upon a patient from around the globe. In teleradiology, the radiological images such as X-rays, CTs and MRIs can be transmitted from one location to another through digital computer assisted transmission. However, the present study has documented that such advancements have not happened in telephysiotherapy.

Thus, in this era of fast changing technology if there was a field, which has sadly not reaped the benefits of this fast changing technology of Information and Communication even a certain extent, it would surely be the field of physiotherapy. Hence, it is imperative to take up a challenge of developing the concept of telephysiotherapy for the management of continually growing patient's physiotherapeutic needs while maintaining high quality care and services.

Conclusion

Telephysiotherapy saves time of patient as well as of therapist, provides instant care and manages well with the increasing number of patient's input though it is still in a budding stage.

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Age Changes in the Speed of Running during 30 meter Sprint Running

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Abstract

The purpose of the present study was to determine age changes in various biomechanical variables such as stride length, stride rate and 30m sprint performance in boys from age 8 to 16 years. The speed of running in general exhibit a general trend of increase with age as well as with the course of running. Phase by phase analysis of change in speed during the course of running in 8 to 12 years age groups reveal that increase in the speed of the running from one phase to the next is mainly brought about by increase the stride length while increase in stride frequency are used by the subjects in varying manners.

Key Words: Stride Rate, Flight Time, Contact Time, Stride Cycle, Age Changes

Introduction

Review of studies in general suggests a comprehensive analysis of strength, spatial and temporal characteristics of adult sprinters *(Mann & Hagy, 1980; Mann & Herman, 1985; Adellar, 1986; Mann, 1986; Mero, 1988; Chelly & Denis, 2001)*. There seems to be a void regarding such evaluation in boys during growth period. Such attempts are necessary in view of the recent emphasis to catch the athlete at young age and provide scientifically oriented training backup. It is unfortunate that despite poor record of India in various international competitions the requisite attention on these lines has not been paid. In order to keep pace with the global trends, for spotting sports talent at young age and develop it, and also orient the training programme on scientific basis for the full realisation of sporting talent, the present study has therefore been conducted to report age changes in biomechanical correlates of sprint running in boys from age 8 to 16.

Materials and Methods

The present investigation was conducted on 180 male school going boys of Patiala district and were divided into 9 yearly age groups (N=20 in each age group) as per *Weiner and Lourie (1981).* To measure speed and stride characteristics during running, 30m sprint test was administered to each subject on a sandy track and cinematographic recording was done by a video movie camera (Panasonic) running at 60 frames/sec. Recording of video film was analysed on high quality Panasonic playback system. Contact time, flight time, stride length, stride rate and total time of 30m run time were measured for the analysis. For the purpose of analysis the first twenty strides taken by the subjects for running 30m sprint have been divided into four phases viz phase 1 (P 1), phase 2 (P 2), phase 3 (P 3) and phase 4 (P 4) respectively. Each phase comprised of five strides.

Results & Discussion

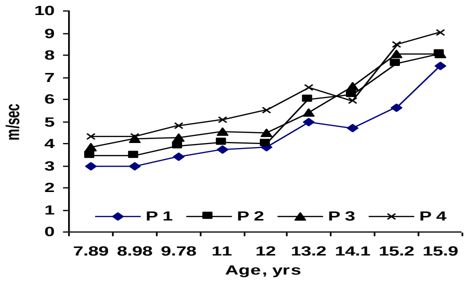

Figure 1. Age changes in the speed of 30 meter running

The age changes in the speed of running in general exhibit a general trend of increase with age as well as with the course of running. The age changes in the speed characteristics of boys during the various phases of running (Table 1) reveal that (i) boys belonging to age groups 8 to12 & 15 years exhibit a continuous increase in speed of running from phase one to phase four. (ii) 13 years old boys demonstrate an alternating phase of increase and decrease in speed of running from phase 1 to phase 4. (iii) 14 years age group show a marked increase in speed of running from phase one to phase two followed by small increase and then decrease in velocity during 4th phase of running (iv) Boys belonging to 16 years age group recorded an initial increase followed by maintenance of speed of running and then a marked increase in the speed in the P 4 of the running.

Table 1. Stride length (cms) with respect to age and phase of running 30m distance in boys

Age (yrs)	Phase 1		Phase 2		Phase 3		P 4	
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.
7.89	88.4	16.9	116.3	7.7	123.6	1.7	132.2	4.7
8.98	90.5	16.2	114.0	6.3	127.6	3.4	133.3	1.0
9.78	99.7	13.3	122.3	2.6	133.0	3.6	143.6	4.4
10.98	102.8	10.6	12.66	5.6	140.1	4.6	149.5	3.5
11.99	103.5	8.4	124.5	6.4	138.4	2.8	148.8	2.8
13.15	119.6	25.4	159.3	8.6	173.2	2.3	182.2	2.8
14.12	116.7	21.1	151.8	3.0	159.0	3.5	164.4	4.2
15.21	121.0	22.9	161.2	7.0	176.7	4.4	189.0	4.4
15.92	124.8	21.3	165.0	8.0	182.8	6.3	202.1	4.3

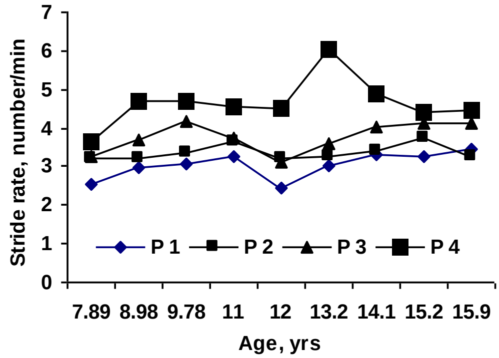

Figure 2. Age changes in stride rate

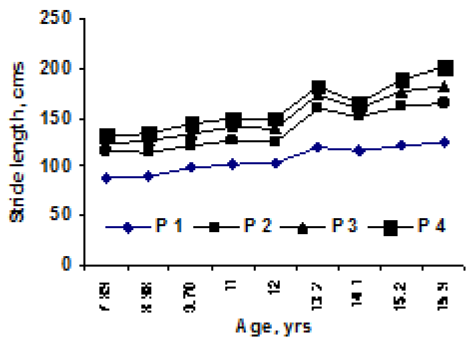

Figure 3. Age changes in stride length

Phase by phase analysis of change in speed during the course of running in 8 to 12 years age groups (Figure 1) reveal that increase in the speed of the running from one phase to the next is mainly brought about by increase the stride length while increase in stride frequency (Table 1) are used by the subjects in varying manners. For instance increase in speed of running from phase one to two has been brought about by increase in both stride length (Figure 3) & stride rate (Figure 2) by 8 and 9 years boys, while there is decrease in stride length in 10 to 12 year age groups but the net effect is of increase in speed during the corresponding phase of sprinting. During the subsequent phase of running, the stride rate indicate a general trend of increase except for a decrease noticed in 9 years old boys from phase 3 to phase 3.

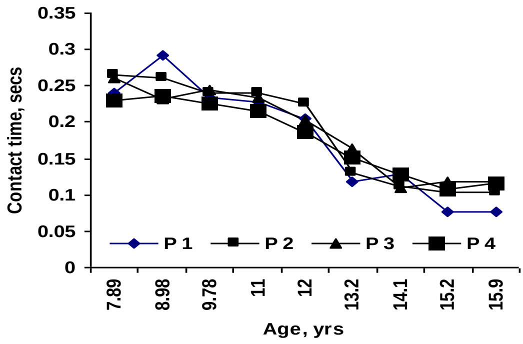

Figure 4. Age changes in contact time

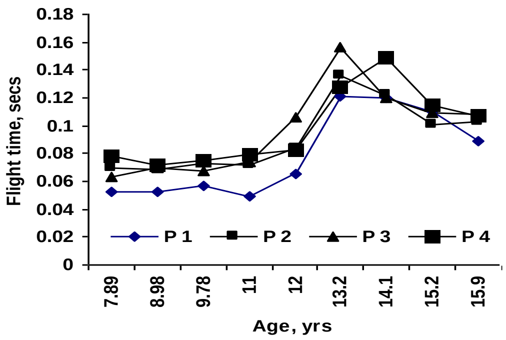

Figure 5. Age changes in flight time

Table 2. Contact time (Sec.) with respect to age and phase of running 30m distance in boys

Age (in years)	P 1		P 2		P 3		P 4	
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.
7.89	0.241	0.02	0.266	0.01	0.261	0.00	0.229	0.01
8.98	0.291	0.09	0.261	0.01	0.232	0.1	0.236	0.00
9.78	0.235	0.01	0.241	0.01	0.244	0.00	0.225	0.01
10.98	0.228	0.01	0.241	0.01	0.233	0.01	0.216	0.01
11.99	0.206	0.00	0.225	0.01	0.203	0.02	0.187	0.01
13.15	0.119	0.00	0.131	0.02	0.163	0.03	0.151	0.02
14.12	0.128	0.01	0.112	0.00	0.110	0.01	0.129	0.00
15.21	0.077	0.01	0.104	0.01	0.119	0.00	0.108	0.00
15.92	0.077	0.01	0.104	0.01	0.119	0.00	0.117	0.01

Table 3. Flight time (Sec.) with respect to age and phase of running 30m distance in boys

Age (in years)	P 1		P 2		P 3		P 4	
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.
7.89	0.053	0.01	0.070	0.00	0.063	0.00	0.078	0.00
8.98	0.052	0.01	0.069	0.00	0.070	0.00	0.072	0.01
9.78	0.057	0.01	0.073	0.00	0.068	0.00	0.075	0.01
10.98	0.049	0.01	0.072	0.01	0.074	0.01	0.079	0.00
11.99	0.065	0.01	0.084	0.01	0.106	0.02	0.083	0.01
13.15	0.121	0.00	0.136	0.02	0.156	0.04	0.127	0.01
14.12	0.120	0.00	0.122	0.00	0.120	0.00	0.149	0.01
15.21	0.110	0.01	0.101	0.01	0.109	0.01	0.115	0.01
15.92	0.089	0.01	0.103	0.01	0.108	0.01	0.107	0.01

Another interesting observation relates to the behaviour of contact time (CT) and flight tome (FT). Regarding CT a trend of decrease is observed in later phase of running (Table 2) (Figure 4). The FT on the other hand gives a quite variable picture but the net tendency of increase in FT needs mention (Table 3) (Figure 5).

Luhtanen & Komi (1972) reported a strong relationship between velocity of running and ground contact time. The results of the present study therefore support their view. Physiologically speaking the ground CT may be considered to reflect the force generating capacity of neuromuscular system i.e. the muscle fibre composition in terms of FT & ST fibres. Contact period is one of the most critical factor in the sprint running because it is during this phase that vertical fall generated the descent portion of the air phase must be reversed. In addition, it is during this time that any horizontal velocity that is lost due to air resistance and horizontal breaking is regenerated.

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Effectiveness of Aerobic and Strength Training in Causing Weight Loss and Favourable Body Composition in Females

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Abstract

The present study was conducted on 120 females ranging in age from 20 to 40 years to determine the effectivity of different exercise programmes in causing weight loss and favourable body composition. Based on the results of the study, it is concluded that both the strength training and aerobic exercise programs exhibit great potentials for weight management. Aerobic training has been observed to decrease body weight from both the fat and muscle compartments while strength training conserved the lean body mass and reduced the fat compartment and thus caused favourable body composition in females.

Key Words: Fat Free Mass, Body Composition, Resting Metabolic Rate, Females, Aerobic Training, Strength Training

Introduction

Obesity is a risk factor for several health problems including diabetes mellitus, arthritis, cardiovascular disease (CVD), and kidney dysfunction *(Stone et al., 1991).* Aerobic exercise has been widely prescribed and utilized as a means of weight control and fat loss. There is also evidence indicating that strength exercise is an effective means of influencing body composition. *Gettman and Pollock (1981)* summarized the effects of five weight training and six circuit weight training studies on changes in body composition. The studies showed a mean decrease in body weight of 0.12kg, increase in lean body mass of 1.5kg, and a decrease in fat mass of 1.7kg. The added benefit of strength training to an aerobic exercise program (caloric expenditure) is its effect on developing and maintaining muscle mass and metabolic rate.

Metabolic rate decreases with age and a primary factor influencing this decrease is reduced fat-free mass. *Campbell et al. (1995)* reported that resting metabolic rate and energy intake required to maintain body weight significantly increased in older adults following 12 weeks of strength training. These data are in agreement with *Pratley et al. (1994).* Thus it appears that resistance exercise should be a part of a well-rounded program including aerobic endurance exercise for weight loss and controlling weight with age.

For years the intrinsic worth and values of aerobic exercise have been adorned and celebrated while the benefits of resistance training have been minimized to that of building muscles and improving sports performance. More recently, the traditional perception of resistance training has undergone revitalization due to scientific evidence suggesting powerful health status betterment. In fact, there are a lot of voices that resistance training is the superior and only form of exercise you need. How the pendulum has changed! The good news is that the indications support significant claims for aerobics and resistance training for improvement in health. Therefore, the purpose of this article is to compare the effect of resistance training and aerobic exercise in influencing body weight and composition in females.

Materials and Methods

A total of 120 females ranging in age from 20 to 40 years comprised the subjects of the study. They were grouped into the following four categories of 30 subjects each on random basis.

GROUP	N	EXERCISE PROGRAMME	DURATION	FREQUENCY
I	30	Aerobic	6 Weeks	5 Days/Week
II	30	Control	6 Weeks	No training
III	30	Mixed (Aerobic+Strength	6 Weeks	5 Days/Week
IV	30	Strength	6 Weeks	5 Days/Week

The details of the exercise programmes are given below:

A. *Aerobic Exercise Protocol*

Based on the principles of aerobic exercise prescription, the aerobic exercise protocol was prepared and included the following important components.

Warm Up (10 minutes)
Mode of Exercise (Brisk Walking)
Exercise Period (30 minutes/session, 5 days/week for 6 weeks)
Cool Down (slow walking plus static stretching exercises for 8-10 minutes)

Following is the list of warm up exercises, which closely resembles the actions central to the training programme. Standing Spinal Twist, Low Back Press, Side Bends, Crossed Leg, Seated Straight Leg, Legs Spread, Legs Spread progression, Side Stretch, Double Knee to the Shoulders, Abdominal Stretch, Inverted Hurdler.

B. *Strengthening Exercise Programme*

Following strengthening exercise programme was designed for administration to a group of females in the present study. The exercise programme consisted of the following components as is typical of any strength exercise programme.

Warm up: Same exercises as given under the sub heading of warm up in the aerobic exercise protocol were given for warm up.

Stretching Exercises: Shoulder Stretch-Anterior & Posterior, Back Extensions Lying & Cross Over Stretch Lying, Back Stretch- Upper One Arm Rows, Push Ups Wide, Neck Stretch Chin-Shoulder, Lying Oblique & Vertical Leg Crunches, Quadriceps Stretch Lying and Toe Drag

Strengthening Exercises: Back Extensions Standing, Fly Dumbbells, Shrug Dumbbells, Abdominal Oblique Twists, Step Ups

Cool Down: Exercises given under the subheading of cool down in the aerobic exercise protocol were used after the strengthening/stretching exercises for cool down.

The focus of strength training programme was to develop muscular strength endurance and to achieve this, high repetition, low resistance principle was followed. While administering strengthening exercises to the subjects, a mixture of stretching and strengthening exercises were used in the protocol. Each exercise was repeated 8-12 times and carried in sets of 2-4 with interval of about 40 seconds. Where stretching was involved, the subject in general was instructed to hold the stretch for 10 or more seconds.

C. *Mixed Exercise Protocol*

This exercise protocol comprised of both aerobic as well as strengthening exercises. The details of these protocols have already been given above. The aerobic and the strengthening exercises were used alternately during the six weeks period. By alternating, it is meant that on one-day aerobic exercise programme was given and the following session was devoted to the strength building exercises. Frequency of exercise programme was kept five days/week. The subjects performed warm up and cool down exercises in the same manner as described for other exercise programmes.

Statistical Analysis

SPSS version 10.0 was used for the statistical analysis of the data collected on females of the present study. Usual statistical derivatives like mean and standard deviation were obtained for the various variables before and after the exercise programmes for the different groups.

To test the impact of different types of exercise programmes, paired 't' test was applied.

Results & Discussion

The impact of aerobic training strongly indicated a significant reduction in the % body fat in this group of females (table 1, fig. 1).

Table 1. Effect of different types of exercise programmes on various body components

Parameter	Exercise Programme	N	Before Training	After Training	Change
Body Weight, kg	Aerobic	30	63.92	61.60	-2.32*
	Control	30	63.05	62.95	-0.10
	Mixed	30	59.90	57.80	-2.10*
	Strength	30	61.98	61.58	-0.40
% Body Fat	Aerobic	30	35.50	34.86	-0.64
	Control	30	36.08	36.01	-0.07
	Mixed	30	35.27	34.64	-0.63*
	Strength	30	35.69	35.16	-0.53*
Body Fat, kg	Aerobic	30	22.69	21.47	-1.22*
	Control	30	22.75	22.67	-0.08
	Mixed	30	21.13	20.02	-1.10*
	Strength	30	22.12	21.65	-0.47
Lean body Mass, kg	Aerobic	30	41.23	40.13	-1.10*
	Control	30	40.30	40.28	-0.02
	Mixed	30	38.77	37.78	-0.99*
	Strength	30	39.86	39.93	0.07

* Significant at 5% level

On an average 0.64% fat reduction was seen in the aerobic group of females after the completion of the program. The aerobic group of females lost 2.32 kg in body weight after undergoing six weeks of aerobic training, out of which 1.2 kg came from the fat stores and the rest 1.1 kg from the lean body mass compartment. Six weeks of strength exercises also successfully reduced the % body fat of the subjects by 0.53%. In absolute terms, strength exercise programmme on an average resulted in a decrease of 0.47 kgs of fat from the bodies of the subjects, which is relatively much lower than a corresponding value of 1.2 kgs detected in the aerobic group of females (Table 1 & Figure1).

Interestingly the subjects who underwent strength training for six weeks demonstrated a small gain of 0.07 kgs in lean body mass after the completion of the program. This can be explained based on the findings of many investigators, who have reported different responses in muscle protein metabolism depending upon the type of exercise. For example muscle protein synthesis has been shown to be stimulated by resistance exercise as long as the intensity of exercise is enough to challenge the muscles *(Chesley et al, 1992; Farrell et al; 1999; Phillips et al, 1999 and Tipton & Wolfe, 2001).* Resistance exercise causes increase in muscle protein breakdown but not as much as protein synthesis *(Biolo, 1995 and Phillips et al, 1999).* The relationship between these two parameters (rate of muscle protein synthesis and muscle protein breakdown) represents the metabolic basis of muscle growth. Keeping in view the physiological principles of strength training, this change seems to be in accordance. Stressing of muscles by weights as is followed in the present study, leads to hypertrophy of the muscles by adding mass to it.

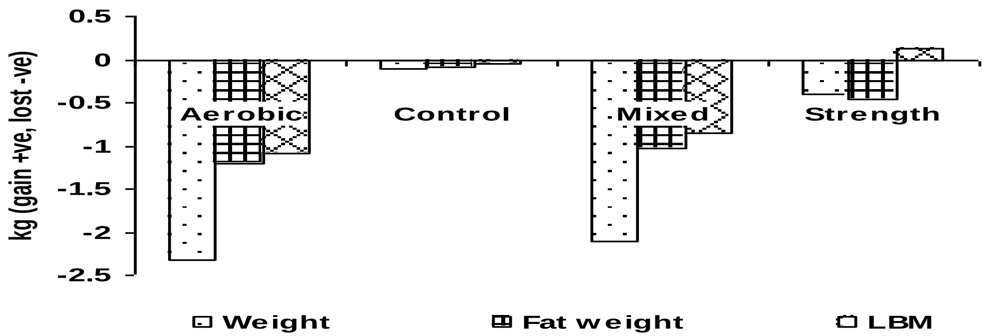

FIGURE 1. EFFECT OF EXERCISE PROGRAMMES ON WEIGHT AND ITS COMPONENTS

Percent body fat has been found to decrease by 0.63% after six weeks of mixed exercise regimen, which is almost similar to the effect, noticed in the aerobic group of females. In absolute terms mixed training has caused a decrease of 1.1 kgs of fat and 0.99 kgs of lean body mass i.e. a total of 2.1 kg reduction in body weight.

In the control group no significant impact was observed after the completion of the study.

Conclusions

Based on the results of the study, it is concluded that both resistance training and aerobic exercise programs exhibit great potentials for weight management. Aerobic training has been observed to decrease body weight from both the fat and muscle compartments while strength training conserved the lean body mass and reduced the fat compartment and thus caused favourable body composition in females. If health and fitness professionals prescribe to the new expanding model of ‘physical activity for the enhancement of health,’ it is recommended that program prescriptions need to include aerobic exercise and resistance training in optimum proportions. Instead of debating the pros and cons of aerobic vs. resistance training, perhaps there is a need to focus now on how to best design optimal workout programs for the demands of the next century.

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Chronic Lateral Elbow Pain with Nerve Entrapment - An Advanced Physiotherapeutic Approach

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Abstract

The case study was conducted on a female patient age 45 years, a computer professional complaining pain on lateral elbow. Study was conducted to differentially diagnose the lateral elbow pain as it is difficult to diagnose because of different pathologies. Secondly this study was done to see the effectiveness of nerve tension testing procedure as a diagnostic and treatment tool. Based on result of the study, it is concluded that lateral elbow pain in this case was due to radial tunnel syndrome which is mostly misinterpreted as lateral epicondylitis. In this two nerve tension tests were used i.e. ULTT 1, ULTT.2b and it is concluded that mobilisation of nerve is a very effective tool in cases of RTS.

Key Words: Radial Tunnel Syndrome, Mobilisation, Lateral Epicondylitis, VAS Scale

Introduction

Patient experienced right lateral elbow pain from last four months. Cause of the injury could not be identified but complained of increased pain while working on a key-board. Her pain varied day to day depending upon activities. Gripping activities like using scissors, wringing aggravated her symptoms. Occasionally she felt burning pain over the lateral epicondyle. She pointed to an area corresponding to radial tunnel as location of her pain. VAS scale varied from 1 to 6 depending upon the activity.

Evaluation & Assessment

1. Cervical Clearing Examination ROM was normal.
2. Compression & Distraction tests were negative.
3. No movement produced elbow pain.
4. ROM of shoulder, elbow, wrist, fingers was normal.
5. Passive stretching of extensors forearm musculature with wrist and fingers flexed and elbow extended caused moderate tolerable pain with no limitation in ROM
6. Isometric contraction of wrist extensors with elbow extended caused pain in radial tunnel area
7. M.M.T: Wrist finger thumb extensor – 4

   Grip force measured by Hand Dynamometer was 28kg on left with no pain. 14 kg right with pain

On Palpation: Mild discomfort was noted on palpation of Lateral Epicondyle while patient reported acute pain on palpation of radial tunnel. Tenderness on muscle bellies of external Carpi Radialis Brevis & Longus.

Neural Tension Testing: was performed on both upper limbs for comparison.

Median nerve testing (ULTT1) & Radial nerve testing (ULTT 2b) was performed. With Median Nerve Test there was limitation of 15 degree of elbow extension when the wrist was extended before elbow. Radial Nerve Testing reproduced pain in the right lateral elbow.

Differential Diagnosis

Radial tunnel Syndrome & Lateral Epicondylitis.

1. Patient felt burning sensation over lateral elbow which indicated nerve irritation.
2. On palpation she had more pain on radial tunnel than lateral epicondyle.
3. Resisted wrist extension caused more pain over the radial tunnel.

4. Based on MMT, patient had weakness in wrist, thumb & finger extension & decreased Grip force.

Provisional Diagnosis

Patient's primary problem was entrapment of Deep Radial Nerve.

Intervention

- Patient was instructed to avoid activities that aggravate her problem.
- Ultrasound was given on radial tunnel 1MHz at 0.5 W/cm sq for 8 min to improve soft tissue extensibility followed by neural mobilization techniques
- Mobilisation of radial & median nerve was done 6 to 7 mobilization were done emphasizing the median & Radial Nerve
- Patient was instructed to perform neural mobilization one time per day at home.
- Patient was treated on alternative days

Outcome:

1. After one week of Physical Intervention ROM in right upper limb increased.
2. Patient's pain rating on the VAS remained the same.
3. Grip Force in right hand increased 20kg
4. During palpation there was decreased tenderness over right radial tunnel & lateral epicondyle
5. Strengthening & stretching programs was started after one week.
6. Strengthening consisted of resistive exercises with 1/2kg weight 3 sets of 10 repetitions was done followed by 20 seconds stretch of wrist extensors.
7. After two weeks pain rating on VAS ranged from 1To 4.

VAS Scale

PRE INTERVENTION DEPENDING ON ACTIVITY	0------------**6**--------10
Post intervention - 2 weeks depending on activity	0--------**4**------------10
Post intervention - 3 weeks	No Pain

Treatment was continued for a total of 3 weeks. After three weeks ROM of elbow extension was same on both sides during ULTT1.

8. Grip force improved to 30 kg on right & patient had no pain on slight stretching of right wrist extension.

GRIP STRENGTH WITH DYNAMOMETER

	Right	Left
Pre Intervention	14 Kg	28 Kg
Post Intervention	30 Kg	28 Kg

Discussion

Lateral elbow pain was difficult to diagnose because of different pathological and combination of pathologies. Patient in this case had variety of signs and symptoms that let us conclude that primary problem was mild entrapment of deep radial nerve that led to Radial Tunnel Syndrome. Radial tunnel begins where the radial nerve runs in a furrow between brachoradialis and brachialis. The nerve passes through substance of supinator muscle and exist the supinator muscle about 6.4 cm. distal to Radiohumeral joint where radial nerve terminate. It innervate the extensor digitorum, extensor digiti minimi, extensor carpi ulnaris, extensor pollicis longus, extensor pollicis brevis, extensor indicis. Entrapment of radial nerve in the area of radial tunnel often causes lateral elbow pain. Symptoms which mimic lateral epicondylitis and are often treated wrongly. In this study, we have pointed to some science and symptoms that clearly differential diagnose RTS from lateral epicondylitis and we have worked on two nerve tension testing procedures i.e. ULTT1, ULTT2b which have markedly improved symptoms in case of RTS within three weeks.

Rehabilitation of Patient after Colle's Fracture using NMES - IS NMES Successful?

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Abstract

The case study was conducted on a Female patient age 45 years with Colle's fracture who was referred to Physiotherapy after immobilization period of six weeks. The study was done to determine the effectiveness of NMES in a post fracture stiffness case. Based on the study, it is concluded that NMES is an effective modality in increasing the ROM and Strength in a case of Post fracture stiffness. Patient showed marked increase in ROM and near normal muscle strength after five weeks of rehabilitation Programme which shows that NMES is a very effective Programme.

Key Words: **NMES (Neuro Muscular Electrical Stimulation), Mobilisation, Range of Motion, Colle's fracture**

Introduction

Patient was a 45 year old female who fractured her right wrist after an accident.

Examination of orthopedist revealed Colle's fracture and a cast was given for 6 weeks with wrist in 10º flexion and 8º of ulnar deviation. Immobilization was discontinued after 6 weeks when X-Ray showed healing of fracture site and patient was referred to physiotherapy.

Evaluation and Assessment

ROM measurement was done for wrist joint

	ACTIVE	PASSIVE
Wrist Flexion	10º	15º
Wrist Extension	25º	30º
Radial Deviation	10º	15º
Ulnar Deviation	15º	25º
Pronation	45º	50º
Supination	30º	35º

ROM for shoulder, elbow and finger was normal.

MMT was not done due to pain.

Intervention

Short term goals

To decrease pain

To decrease oedema

Long term goals

To regain adequate ROM and strength

- NMES was selected to assist ROM by preventing fibrous restriction and joint contractures. To decrease pain and to increase sensory, visual and propioceptive input.
- Patient also received joint mobilization, active and active assisted range of motion. Exercise to wrist, elbow and digits.

NMES

Stimulation was given to both the flexors and extensor groups of muscles. Parameters chosen for the treatment were pulse width 300µs and pulse frequency was 30pps. For flexor group of muscles one electrode was placed on proximal one third of forearm over flexor muscle Belly and other electrode was placed centrally over flexor tendon approximately 7 cm proximal to wrist crease. For extensor group of muscle the proximal electrode was placed on proximal one third of forearm over extensor muscle belly and digital electrode was placed 5 cm proximally to the wrist crease 10-15 muscle contraction for both the muscle groups were given twice daily and treatment was given 5 day a week for 5 weeks.

Joint Mobilisation

Grade 1 and Grade 2 mobilization was given to all the joints of wrist and hand followed by active exercises and active assisted exercise. A hot pack was given prior to the treatment and ice was given after the treatment to prevent muscle guarding.

A slight electrode placement change of electrode was done due to skin sensitivity of the patient.

Outcome

Range of Motion after 5 weeks of treatment

	ACTIVE	PASSIVE
Wrist Flexion	75º	80º
Wrist Extension	70º	70º
Radial Deviation	25º	25º
Ulnar Deviation	30º	32º
Supination	80º	85º
Pronation	80º	82º

NMES was discontinued after 5 weeks when patient was able to perform good muscle contraction and had achieved 90 percent of ROM of wrist as compared to unaffected hand.

Discussion

Although the importance of NMES is regaining ROM and strength has not been well documented but NMES appeared to facilitate a faster and less painful return to function for patient after Colle's fracture. In this study NMES was used for five weeks and after five weeks programme ROM has markedly increased to near normal. After this study we can conclude the NMES is an effective modality for maintaining and increasing the length and tension of the muscle after a period of mobilisation. Moreover, it can also be very effective in preventing intra and extra articular adhesion formation after the period of immobilization. As in this study alongwith NMES mobilisation and strengthening technique were also used so efficacy of NMES for regaining ROM & Strength are needed to identify maximally effective treatment protocol. NMES appeared to be effective in faster and less painful means of regaining range of motion and strength after five weeks period of treatment.

NUTRITION EXERCISE AND WEIGHT REDUCTION

BY

S.K. VERMA & R. MOKHA

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Purpose: The purpose of the book is to bring together the scientific information related to the role of nutrition and exercise in reducing excess body weight. A special emphasis has been made on the significance of optimal/ideal body weight for the average sedentary humans and athletes participating in various physical activities. Keeping in mind the fact that the readers of this may range from general public to physical education students, athletes and coaches, the authors of the book have included a certain amount of basic knowledge about the nutrition to make it understandable and implemental. In the selection of the material for this book the authors have made an attempt to meet the modern needs of the students of physical education at both under-graduate and post-graduate levels. It is envisaged that the book may find utility not only in the teaching of scientific basis of weight reduction through a combination of nutritional and exercise approach to the students of physical education and physiotherapy but also with the practical designing of weight loss programmes for overweight persons in our society as well as the athletes in attaining optimal weight for achieving best performance.

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Reviewer: Dr. D.P. Bhatnagar, M.Sc., Ph.D.,
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