

## ORIGINAL RESEARCH PAPER

**FUNCTIONAL CHANGES OF THE MUSCULAR-SKELETAL SYSTEM OF ATHLETES****Jeļena Solovjova<sup>1</sup>, Imants Upītis<sup>1</sup>, Juris Grants<sup>1</sup>, Joy Jarvie Kalmikovs<sup>2</sup>**

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**Abstract**

*Athletes across all sports face sporting injuries stemming from overuse of specific muscle groups for that particular sport. Overuse of specific muscle groups causes functional muscle imbalance leading to postural changes. It was hypothesized that athletes from each sport would show similar muscular-skeletal changes allowing the formation of a postural stereotype for each sport. The aim of this study was to determine the postural changes of 92 athletes aged 14 to 17 years old in Latvia; 20 Swimmers, 20 ice-hockey players, 19 basketball players, 17 handball players, and 16 cyclists. The previously tested express diagnostic program (Solovjova & Upītis, 2008), was employed to evaluate muscular-skeletal changes. Results indicate specific sporting stereotypes exist. The presence of a postural stereotype indicates these muscular-skeletal changes are of benefit to the athlete. How much benefit athletes gain from these postural changes before injury occurs is open to debate among coaches, athletes, support staff and sporting officials.*

**Key words:** *sporting postural stereotypes, postural stereotypes, functional postural changes,*

**Introduction**

Athletes across all sports face sporting injuries stemming from overuse of specific muscle groups for that particular sport. Overuse of specific muscle groups causes functional muscle imbalance leading to postural changes. These postural changes can provide benefits and advantages to athletes making them better adapted to their sport, therefore these changes

are functional for athletes. Just as species have evolved through a series of adaptations over time, sporting exercises, drills, and strengthening programs drive to adapt and evolve the athletes that participate in them. Despite the fact that in certain studies and literature we may find results that speak of changes in the spinal cord in athletes of different sports that involve large rotations, such as gymnastics, ballet, swimming, wrestling, javelin throwing, etc., it has not yet been determined that these activities lead to a direct acceleration or worsening of postural disorders (Slawinska, Rožek, & Ignasiak, 2006),( Tanchev, Dzherov, Parushev, Dikov, & Todorov, 2000), (Wood, 2002).

The problem professional/elite athletes face today is finding the balance between sporting advantage and injury: functionality versus detrimental change. This study is the first step in solving the problem of ensuring balance of functional muscular-skeletal changes and its advantages. It is hotly debated between coaches, athletes and support staff how, and where that balance point is to be found, and applied.

The aim of this study was to determine the postural changes of 92 athletes aged 14 to 17 years old in Latvia (20 Swimmers, 20 ice-hockey players, 19 basketball players, 17 handball players, and 16 cyclists) to see if sporting stereotypes occur across the five sports. It was hypothesized that athletes from each sport would show similar muscular-skeletal changes allowing a postural stereotype for each sport to be allocated.

## **Methods**

92 athletes in Latvia; 20 swimmers, 20 ice-hockey players and 19 basketball players, 17 handball players and 16 cyclists aged 14 – 17 and having different preparation level were examined. Tests were completed using methods by (Vasiljeva, 1996) for visual diagnostics and by (Janda, 1994, Kendall & Kendall, 1982), for muscular functional testing. From these methods a diagnostic program was developed, ( Solovjova, & Uptis, 2008) which included measuring the changes of 8 sagittal points from the vertical plane along with functional testing of 11 muscle groups.

*Express-diagnostics of posture statics.* The following points were marked on the athlete: the external ear opening, acromion, radial point, outer points of the palm, the highest point of the iliac crest, the trochanter, the upper end of the fibula bone and outer ankle. The subject stood at a vertical wall. The distance from the marked point to the vertical wall on the right and left side was measured.

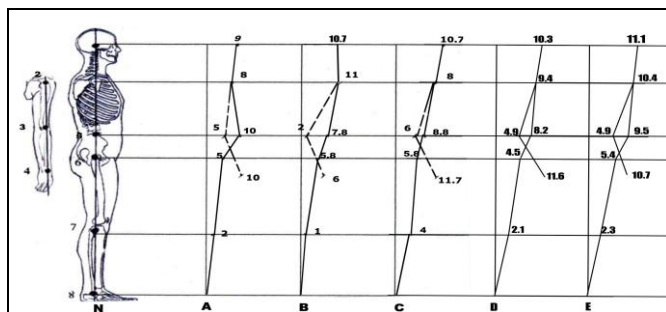
*Muscle functional testing.* To state the postural tone and phasic contraction muscle functional condition, the major body and leg muscles

that are involved in posture forming were tested according to (Kendall & Kendall, 1982). To indicate muscle shortening and weakening, muscles were tested at rest condition. Ten muscle groups were examined all together: the phasic muscles such as the blade fixators, *m. rectus abdominis*, *m.m. medius*, and the postural muscles such as *m.m. erector cervicis*, *m. pectoralis major*, *m. iliopsoas*, *m. quadriceps femoris*, hamstring muscles and *m. triceps surae*. The functional condition of the postural muscles was assessed according to 3 point system: 1 point was considered to be the norm, points 2 and 3 were considered to be changes.

## Results

Results indicate that all athletes showed functional muscular-skeletal changes at various skeletal points. Asymmetry of the point distance from the vertical line between the left and right sides were observed in two swimmers, one ice-hockey player and one basketball player. These measurements were averaged for ease of profiling.

The following peculiarities of posture statics can be marked in the athletes' individual posture profile: the body deviation forward, so-called "body falling" forward was observed in athletes of all groups; the distance from the vertical line between the outer ankle and the auricle of the ear in group A was 9.1 cm, in group B – 5.5 cm, in group C – 10.7 cm; the hip rotation forward was observed in all athletes. It can be concluded that the difference between the highest point of the iliac crest (point 5 on Fig.1) and the trochanter, (point 6 on Fig.1) – in the ice-hockey players is 5.5 cm, swimmers – 2.0 cm and basketball players – 3.5 cm. The greatest distance from the vertical line in the swimmers is in the shoulder girdle (11cm), ice-hockey players – the highest point of the iliac crest (8 cm), basketball players – the auricle of the ear point (10.7 cm).



**Figure 1.** Deviations of the body vertical line from the side, vertical line parameters, cm. N-optimal position; A-ice-hockey players (n=20), B-swimmers (n=20), C basketball players (n=19), D- handball players (n=17) and E-cyclists (n=16) average data, cm

In general the following peculiarities of posture statics can be marked in the athletes' individual posture profile. All sporting profiles were found to fall forward; cyclists being the most pronounced. Swimmers have a round back and a slight forward rotation of the pelvis. Ice-hockey and handball players along with cyclists have explicit forward rotation of the pelvis.

*Muscle functional condition (Groups: A – ice-hockey, B - swimmers, C – basketball players, D – cyclists, E – handball players)*

Muscle testing results indicate that the greatest changes were found in the postural muscles *m. rectus femoris* – in all 20 ice-hockey players and cyclists (100%), in handball players (91.2%), in basketball players (84.2%) and swimmers (41%).

Changes in the hamstring muscles were recorded in hockey (64%) and handball players (64.7%), swimmers (60%), basketball players (57.9%) and cyclists (55.6%). The greatest changes of *m. triceps surae* were in the swimmers group (41%), and handball players 35.3%. Ice-hockey players and cyclists both recorded 22.3% change and basketball players 21.1%.

Athletes in all groups have short pelvic muscles (A – 77.2%, B – 84%, C – 73%, D – 82.4%, E – 83.4%) and hamstring muscles. The changes of the shoulder girdle muscle tone were as follows: *m. pectoralis major* 21% in 4 swimmers, 5% in 2 basketball players, the ice-hockey players, handball players and cyclists do not have any changes. Handball players have the greatest number of changes in *m. pectoralis major* – 70.6%, swimmers have the smallest – 49%, but cyclists, basketball players and hockey players have respectively 66.7%, 63.2% and 54.4%.

Having the results of the muscle testing we can see the changes in the phasic muscles when their effectiveness decreases, that is, they extend and are not able to contract effectively: *m. rectus abdominis* – 47% of swimmers and 77% of ice-hockey players, 47% of basketball players, 70.6% of handball players and 44.5% of cyclists. Swimmers have the lowest tone of the shoulder blade fixators – 70%, basketball players – 42%, cyclists – 61.2%, hockey riders – 54.4% and handball players – 41.2% .

## Conclusions

All athletes showed individual changes from a neutral posture (deviation from the vertical line in the sagittal plane) characteristic to their sport due to overloaded muscle groups.

Analysis of muscles according to their tone development, they can be divided into two groups: posturally and phasically contracting muscles. The

postural muscles that form posture have rather high tone, but if these muscles are overloaded, the tone pathologically increases and the muscle cannot contract nor relax effectively enough to allow the antagonist to work. Phasically contracting muscles that provide movements have lower tone than postural muscles. If they are overloaded, their efficiency decreases, they lengthen and cannot contract effectively.

Balanced work of the phasic and postural muscles is one of the preconditions to form a correct posture. The muscles are in definite strength relations providing typical or correct stereotype, thus every movement is executed with optimal strength.

Athletes in all groups have short pelvic (A – 77.2%, B – 84%, C – 73%, D – 82.4%, E – 83.4%) and hamstring muscles. If the leg and pelvic muscles are shorter, the lordosis of the lower back increases the function of the spine amortization decreases, as well as equal load division. If the body adaptation ability is low, it can cause pain in the lower back and knee joints. Basketball players' hamstring muscles have significantly higher tone than those of swimmers.

The shortened muscles of the shoulder girdle in group B – *m.m. erector cervicis*, *m. pectoralis major* and *m. pectoralis minor* indicate these muscles are overloaded. The upper cross syndrome is characteristic for athletes of repetitive shoulder sports such as swimming and rowing Коган et al.(1986); ИВАНИЧЕВ (1999). Loading of the sport on the shoulder girdle, we have shown that the spine hyper-kiphozis of the chest part and the shortening of the small chest and upper trapezius muscles (Solovjov, 2004).

The lower cross syndrome is characteristic for athletes of the sports requiring complicated coordination (eg. Ice-hockey, basketball) at high load on lower extremities: “body falling” forward, hyper-lordosis of the chest-pelvis area and the shortening of the pelvic muscles at weakened major hip muscles and *m. rectus abdominis* (Travell & Simons 1992).

#### *Correction and Prophylaxis*

The measurements shown on the athlete profiles indicate that these changes occur at a young age during the training process as these athletes are aged between 14 and 17 years of age. For superior athletic performance, athlete posture profiles should be monitored throughout an athlete's development to indicate the speed that these changes occur. With monitoring of the athletes profiles early intervention can be made to keep a more neutral posture and eliminate the chance of injury.

However, participation in any sport should not affect an athlete's posture to the extent that joint/muscle pain occurs due to muscle imbalance. If the correct training program is adopted (one that incorporates

strengthening of antagonistic muscles) a more neutral balanced posture should be maintained throughout the course of an athlete's career. This should allow the athlete to maintain superior athletic performances with minimal injuries due to posture changes. Yet, in order to achieve a neutral posture, athletes must spend equal time working on the antagonist muscle groups. This may not be feasible due to time and physical limitations.

Where, when and how do coaches draw the line of balance between functional and detrimental musculoskeletal changes? When an athlete sees a physiotherapist to start correcting muscle imbalance may already be too late. How do we educate coaches that the antagonist muscle groups need to be incorporated into their training schedules? How much of these exercises/activities do coaches need to enforce upon their athletes?

Without long term studies across all sports, following the individual athletes, these questions cannot be answered.

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