Title: The relevance of muscle fiber typology in sports

Short title: Muscle fiber typology and sports

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Word count: 800 words
What did I do?

For 50 years, we have known that muscle fiber typology is an important characteristic for sports performance [1]. Nevertheless, everyone seemed to have resigned themselves to the fact that the muscle fiber typology is not measurable and applicable in the daily guidance of athletes. I challenged this status quo, by successfully optimizing a non-invasive method to investigate the muscle fiber typology and I applied this technique to find several new links between the muscle fiber typology and sport performance (fatigue and recovery, talent identification and injury susceptibility).

Why did I do it?

The human skeletal muscle consists of two major cell types, slow-twitch fibers (also called type I fibers) and fast-twitch fibers (or type II fibers). These fibers have distinct characteristics, as fast-twitch fibers are able to generate a large amount of power at high shortening velocities, while slow-twitch fibers have a better energy efficiency, a higher resistance to fatigue and a more robust structural integrity [2]. On average, most humans will dispose of a roughly equal number of slow-twitch and fast-twitch fibers in the vastus lateralis. However, a big heterogeneity exists meaning that some persons may display a clear dominance of fast fibers (or others of slow fibers) and therefore possess an innate talent to excel in fast and sprint-like sport events. The high heterogeneity in the muscle fiber typology will thus have important implications for sports performance. Nevertheless, these typologies are currently not used in the daily coaching practice. This is probably due to the invasiveness of the current ‘gold’ standard to measure the muscle typology: a muscle biopsy, which is an invasive and labor intensive method that harbors a low generalizability[3].

How did I do it?

I further optimized a non-invasive way to estimate the muscle fiber type composition through the measurement of carnosine – a metabolite which is abundantly available in fast-twitch fibers – using proton magnetic resonance spectroscopy [4]. The non-invasiveness of this technique enables the use of this technique in both sport science and practice.

What did I find?

Before the start of the thesis, the construct validity of our method was confirmed in athletics, in which clear differences were determined in the muscle typology of either sprint or endurance disciplines[4]. Despite the fact that a similar distribution of the muscle typologies could be expected in other cyclic sports such as cycling and swimming, this was not yet investigated in elite athletes. Therefore, the relevance of the muscle typology for talent identification was examined in 80 world-class cyclists[5] and 73 world-class swimmers[6]. Clear differences were found in the muscle typology between cycling events. Keirin (a cycling discipline in which cyclist follow a pacemaker and then sprint for the last part of the race), bicycle motocross racing (BMX), sprint and 500 m to 1 km time trial cyclists can be considered as fast typology athletes. Time trial, points race, scratch, and omnium consist of intermediate typology athletes, while most individual pursuit, single-stage, cyclo-cross, mountain bike, and multistage cyclists have a slow typology. Nevertheless, this distribution was not present in
swimming, as no clear differences in the muscle typology were detected between short and long
distance swimming events in the different strokes.

Secondly, we investigated if fatigue and recovery were different when both slow and fast typology
subjects were exposed to the same high-intensity training (three Wingate tests)[7]. Fatigue during
three Wingate tests, determined by the power drop, was 20% higher in fast typology athletes. Even
though the same work was done during these Wingate tests, also the recovery from these Wingate
tests was found to be 15 times slower in fast typology athletes (20 minutes in slow typology vs. longer
than 5 hour in fast typology). If a training plan would be composed with a minimum of recovery in
between the training sessions, recovery might be insufficient for fast typology athletes, possibly
rendering them with a higher risk for muscle strains.

Consequently, we studied if the muscle typology is a risk factor for muscle strains in elite soccer players
(n=165). Fast typology soccer players were found to have a 5.3 times higher hamstring injury risk, when
compared to slow typology soccer players (longitudinal follow-up over three seasons)[8]. Next to a
higher accumulation of fatigue, a higher vulnerability in fast typology players could be expected due
to the lower structural integrity in fast-twitch fibers.

What is the most important clinical impact / practical application?

The muscle typology is an important characteristic, which could be non-invasively monitored using
proton magnetic resonance spectroscopy. This technique could help athletes to make an evidence
based decision on their ideal discipline during talent orientation. Moreover, it could help coaches
tailoring training to enlarge the athletes’ muscle potential and to prevent fatigue accumulation. This
endeavor might partly prevent fast typology athletes to be at a higher risk for strain injuries.

Contributors: Prof. Wim Derave and Prof. Erik Witvrouw supervised the PhD thesis summarized in
this manuscript. Moreover, the thesis would not have been possible without the help of all co-
authors who contributed to the project.

Ethical approval:
All studies were performed in accordance with the standards of ethics outlined in the Declaration of
Helsinki and were approved by the local ethics committee (Ghent University Hospital,
B67020097348; B670201628807; B670201837890).

Declaration of conflicts of interest:
Eline Lievens declares no conflict of interest.

Funding:
This PhD was funded by Research Foundation-Flanders (FWO 1104020N).
Figure legend:

Figure 1: Graphical summary of the PhD
References:


