



# MUSCLE FIBER CHARACTERISTICS OF A WEIGHTLIFTING WORLD CHAMPION AND WORLD RECORD HOLDER – A CASE STUDY

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## Introduction

The sport of weightlifting (i.e., snatch + clean & jerk) involves lifting very heavy loads extremely rapidly, resulting in very high barbell power production.

## Purpose

The purpose of the present study was to characterize the muscle fiber characteristics of an elite female world champion weightlifter who also held the world record in the snatch lift.

## Methods and Materials

A percutaneous muscle biopsy from the mid-belly of the right vastus lateralis m. was obtained from an actively competing elite female weightlifter (age = 24 yrs, height = 1.53 m, BW = 50 kg, relative 1 RM snatch = 1.69 x BW, relative clean & jerk = 1.98 x BW, 7-time world championship medalist, 10-time national champion, national and world record holder). Serial sections 12 μm thick of tissue (n = 615 fibers, >50 fibers/major fiber type) were fiber typed via mATPase histochemistry using the methods of Brooke & Kaiser and modified by Pette & Staron, which has been validated with sectioned single fiber MHC profiles (Staron 1991). Additional tissue sections were homogenized and lysed in a β-mercaptoethanol solution and heated at 60° C for 10 min. SDS-PAGE was used to determine relative expression (%) of MHC isoforms, which are highly correlated (r ≥ 0.90) to relative fiber type cross-sectional area (Fry et al. 1994). Data from previously reported national- and international-level male weightlifters are reported for comparative purposes (Fry et al. 2003).

## Results

Fiber type percentages for the case study weightlifter were as follows; I = 35.2%, IIA = 64.8%, IIX = 0.0%, with no evidence of any hybrid fibers (i.e., types IC, IIC, IIAC or IIAX). Previously reported high-level male weightlifters (n=6) exhibited the following % fiber types; I = 46.5±2.3%, IC = 1.2±0.7%, IIC = 0.6±0.2%, IIAC = 0.0±0.0%, IIA = 46.5±2.7%, IIAX = 2.8±0.7% and IIX = 2.4±2.0%. Relative MHC expression for the female case study was as follows; MHC I = 28.0%, MHC IIA = 72.0% and MHC IIX = 0.0%. The comparison male weightlifters exhibited the following %MHC; MHC I = 34.6±2.9%, MHC IIA = 64.0±2.3%, MHC IIX = 1.4±1.4%. Variables for the case study weightlifter outside the 95% CI for the comparison male weightlifters are indicated by an \* in the table.

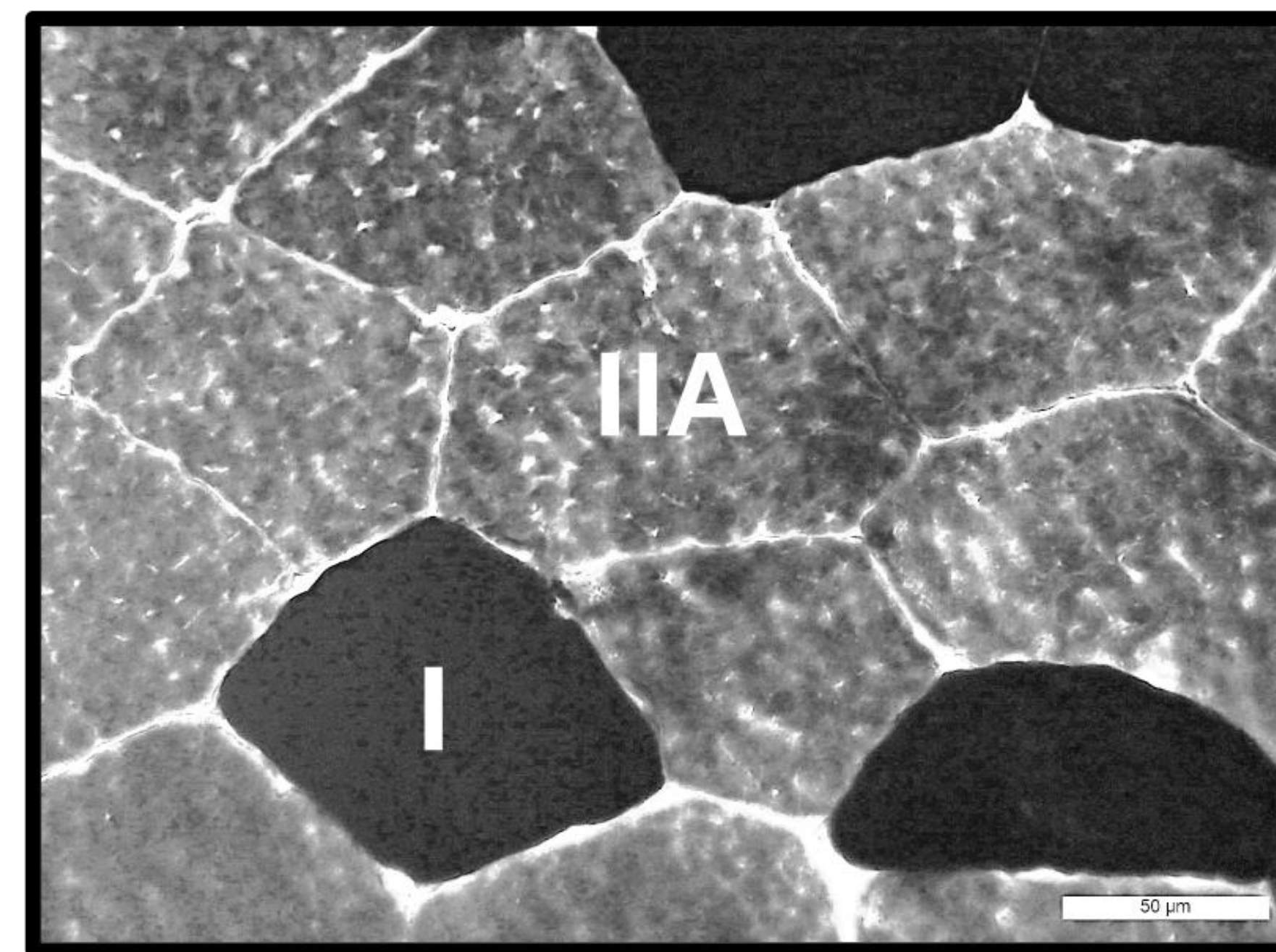


Above – Female weightlifter.  
Below – Muscle biopsy of the vastus lateralis m.  
Top & Bottom Right – Photomicrographs from the case study of tissue sections fiber typed via mATPase histochemistry pre-incubated at pH 4.6 & 10.6 that were used to determine fiber type counts and cross-sectional areas.

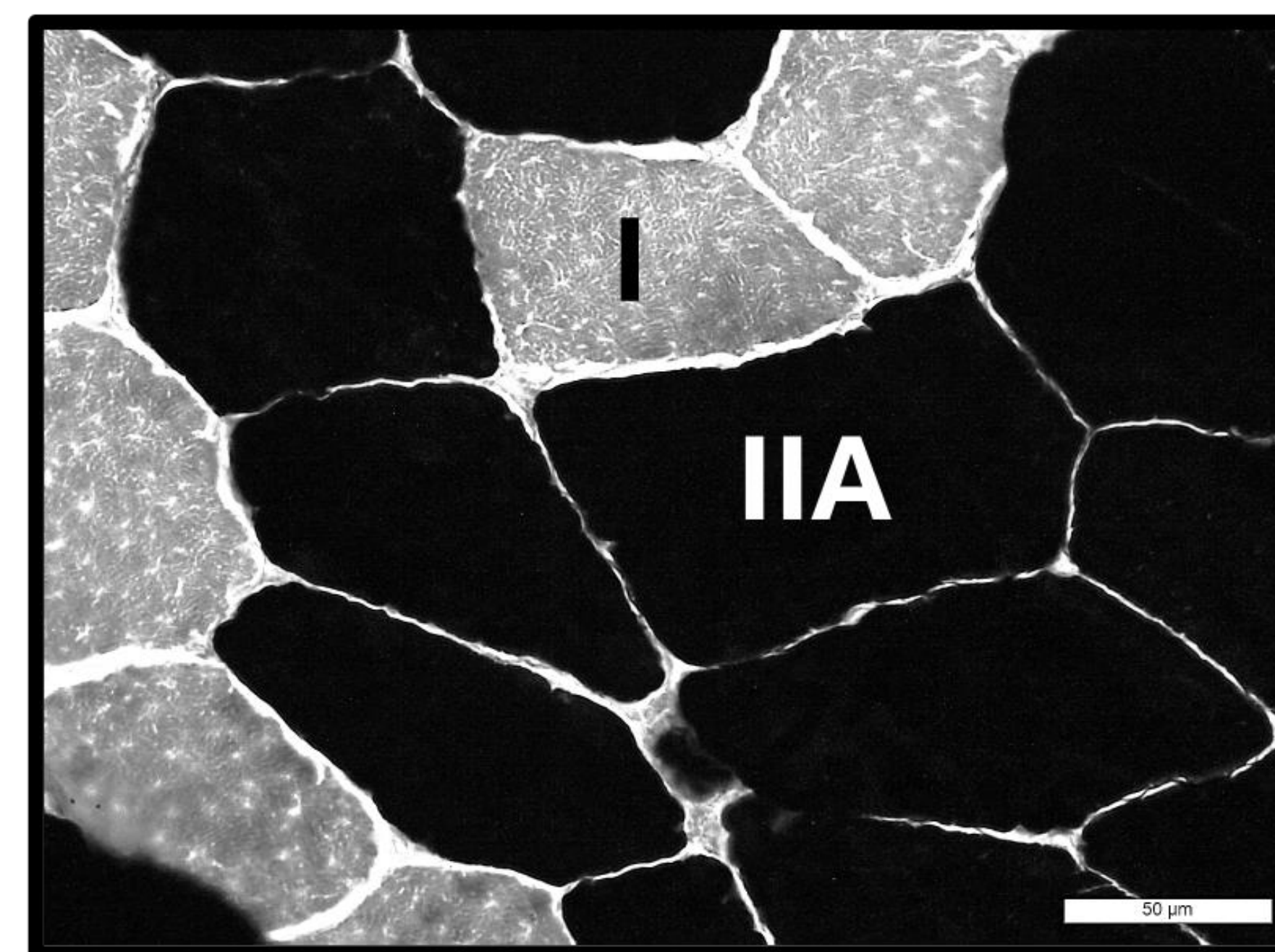


Table Below - Fiber type characteristics for the case study compared to previously published data for national- and international-level male weightlifters (Fry et al. 2003).  
\*outside the 95% CI for the comparison group.

	Case Study	Comparison Group	Comparison Group 95% CI
% Type I	35.2 *	46.5±2.3	40.6, 52.4
% Type IC	0.0	1.2±0.7	-0.6, 3.0
% Type IIC	0.0 *	0.6±0.2	0.6, 1.1
% Type IIAC	0.0	0.0±0.0	0.0, 0.0
% Type IA	64.8 *	46.5±2.7	39.6, 53.4
% Type IIAX	0.0 *	2.8±0.7	1.0, 4.6
% Type IIX	0.0	2.4±2.0	-2.7, 7.5
% Area Type I	26.1 *	40.2±2.9	32.8, 47.6
% Area Type IIA	73.9 *	56.7±2.5	50.3, 63.1
% Area Type IIX	0.0	3.1±2.4	-3.1, 9.3
% MHC I	28.0	34.6±2.9	27.2, 42.0
% MHC IIA	72.0 *	64.0±2.3	58.1, 69.9
% MHC IIX	0.0	1.4±1.4	-2.2, 5.0



pH 4.6



pH 10.4

## Discussion & Conclusion

To the authors' knowledge, this is the first analysis of this kind from an elite weightlifter's muscle biopsy while actively performing at the highest level of their sport. Fiber type % and %MHC data for the present case study female weightlifter were significantly different from the comparison group of male high-level weightlifters. This may explain in part the superior relative lifting performances of the present case study lifter, despite being the opposite sex. Other reports on elite female weightlifters (Serrano et al. 2019) have indicated somewhat similar fiber characteristics, although different muscle analysis methods were used. It is speculated that an additional contributing factor to performance for the present case study, although not measured in the present study, may be the large muscle volumes of some of the primary movers for weightlifting, the quadriceps muscles in this case. Regardless, these data suggest that extreme weightlifting capabilities are due in part to a high percentage of IIA fibers, along with a large relative cross-sectional area for the IIA fibers as indicated by the %MHC data.

## Practical Application

To enhance weightlifting performance, coaches may want to prescribe training protocols that induce preferential hypertrophy of the type IIA fibers, and shift fiber types to IIA.

## References

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