Changes in Red Blood Cell Deformability at the Beginning of the Winter Swimming Season in Females and Males: Preliminary Reports

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ABSTRACT
Health promotion is an important area of public health. A healthy lifestyle contributes to better health and early prevention of chronic diseases. Physical activity combined with winter swimming improves physical fitness, the capacity of many human body systems, as well as mental condition. It reduces the risk of infections, colds, illnesses. Winter swimming involves bathing in cold or icy water, which provides a positive effect on health and wellbeing[1,2].

INTRODUCTION
The aim of the NdS-II/SP/0368/2023/01 project entitled ‘Winter swimming is about passion and health,’ supported by the Ministry of Science and Higher Education in Poland, is to promote sport and health through cooperation with the Krakow Society of Winter Swimmers ‘Kaloryfer’ in Krakow (Poland). The cooperation consists in conducting slow jogging courses, enabling the project participants to access the Indoor Swimming Pool Complex of the University of Physical Education in Krakow, as well as performing basic red blood cell deformability tests among the winter swimmers in the Blood Physiology Laboratory of the Central Research and Development Laboratory, University of Physical Education in Krakow.

With in the ‘Winter swimming is about passion and health’ project, constituting part of the ‘Science for Society II’ program (the granted amount of funding: 169,334.00 PLN, time frame: 2023–2025), a qualified nurse collected fasting blood samples from the study group participants (winter swimmers from the Krakow Society of Winter Swimmers ‘Kaloryfer’; n = 30; 15 women and 15 men) in November, at the beginning of the 2023/2024 winter swimming season. At the same time, blood samples were taken from women (n = 15) and men (n = 15) included in the control group (who did not practise winter swimming or implement any training program). Samples of 5 ml of fasting blood were collected from the cubital vein into Vacuette® EDTA K2 vacuum tubes. Red blood cell deformability (elongation index) was tested with the Laser-Assisted Optical Rotational Red Cell Analyzer (Lorrca®) MaxSis (RR Mechatronics, The Netherlands) by using the method described by Hardeman and Baskurt. Mean elongation index was plotted versus the corresponding shear stress of 0.30–60.00 Pa. Calculations were performed with the Statistica 13 software (TIBCO Software Inc., USA). The study was approved by an Ethics Committee.

Inclusion criteria:sex: male, female; age: 35–55 years;no significant cardiovascular, respiratory, or musculoskeletal conditions;written informed consent to participate in the study.

Exclusion criteria:heart rate disorders; uncontrolled hypertension; cancer; oncological treatment; diabetes; rheumatic diseases.

RESULTS

No statistically significant differences between the studied groups were found for red blood cell or red blood cell deformability parameters. Between the male group and control or between the female group and control, no statistically significant changes were revealed in red blood cell elongation indices in shear stress.

The deformability of red blood cells plays an important role in their main function, which is the transportation of oxygen and carbon dioxide via blood circulation. The average size of a single erythrocyte is 7–8 µm, while the diameter of capillaries equals 3–5 µm, which denotes a necessity to deform the erythrocytes (the more, the better).

The study of potential rheological changes in blood at the beginning of the winter swimming season demonstrated no statistically significant modifications. See **Tab.1., Fig.1. and Fig.2.**

Table 1: Elongation index (EI)-shear stress (SS) curves for RBC in studied groups. $P<0.05$ compared to baseline and controls

	control			winter swimmers men			
	mean	±	SD	mean	±	SD	p
EI 0.3 Pa	0.058	±	0.010	0.056	±	0.017	0.701
EI 0.58 Pa	0.156	±	0.013	0.152	±	0.021	0.528
EI 1.13 Pa	0.242	±	0.013	0.238	±	0.021	0.528
EI 2.19 Pa	0.346	±	0.009	0.343	±	0.016	0.481
EI 4.24 Pa	0.438	±	0.007	0.437	±	0.012	0.714
EI 8.23 Pa	0.512	±	0.006	0.512	±	0.008	0.822
EI 15.59 Pa	0.563	±	0.007	0.563	±	0.007	0.932
EI 30.94 Pa	0.600	±	0.005	0.600	±	0.006	0.985
EI 59.97 Pa	0.630	±	0.006	0.628	±	0.006	0.248

	control			winter swimmers women			
	mean	±	SD	mean	±	SD	p
EI 0.3 Pa	0.051	±	0.015	0.048	±	0.012	0.531
EI 0.58 Pa	0.152	±	0.017	0.147	±	0.014	0.411
EI 1.13 Pa	0.239	±	0.014	0.234	±	0.015	0.428
EI 2.19 Pa	0.344	±	0.015	0.341	±	0.015	0.579
EI 4.24 Pa	0.440	±	0.011	0.434	±	0.013	0.241
EI 8.23 Pa	0.514	±	0.010	0.509	±	0.010	0.148
EI 15.59 Pa	0.564	±	0.010	0.559	±	0.008	0.217

EI 30.94 Pa	0.602 ± 0.008	0.596 ± 0.007	0.064
EI 59.97 Pa	0.632 ± 0.005	0.629 ± 0.007	0.164

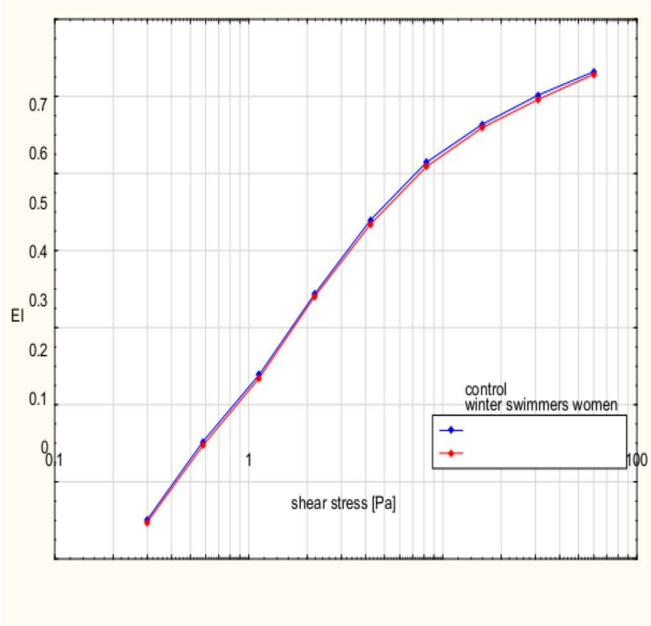

FIGURE 1: Elongation index (EI)-shear stress (SS) curves for RBC in studied groups. P<0.05 compared to baseline and controls in women

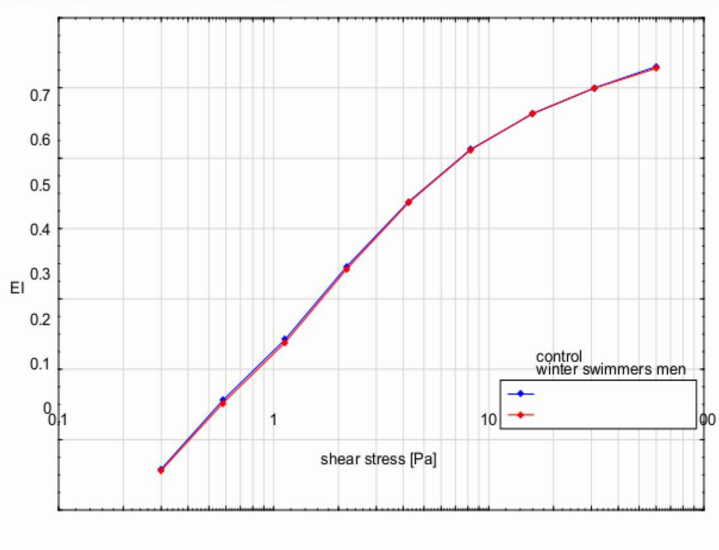

FIGURE 2: Elongation index (EI)-shear stress (SS) curves for RBC in studied groups. P<0.05 compared to baseline and controls in men

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