A comparison of selected kinematic variables during standard and cambered barbell bench press.

The bench press is one of the most commonly used resistance exercises for assessing, developing, and monitoring maximal strength, power, and stimulating muscle hypertrophy of the upper body (Król & Gołaś, 2017; Schoenfeld et al., 2015). Besides exercise order, volume, and intensity, a significant element of resistance training methodology includes the performed exercises range of motion (Schoenfeld & Grgic, 2020). During the bench press exercise, the full physiological range of motion of the primarily engaged muscles (pectoralis major, anterior deltoid, and triceps brachii) is restricted by the barbell. During the final eccentric phase of the movement, the barbell touches the chest, thus preventing full stretching of these muscles. This issue seems to have been resolved by the introduction of a new type of curved barbell designed for the bench press (cambered barbell – CMB). This barbell serves as an alternative to the standard barbell (standard barbell – STD) and is increasingly being used in traditional upper body resistance training.

The three empirical studies presented in this dissertation aimed to evaluate the effectiveness and determine the level of neuromuscular fatigue, as well as muscle damage induced by an increased range of motion using the CMB barbell compared to the conventional range of motion with the use of an STD barbell during the flat bench press exercise. To achieve this, one of the studies focused on comparing the peak an mean velocity between the CMB and STD barbells in a protocol involving three sets of three repetitions with a load equal to 50% of 1RM (one-repetition maximum). In the next study, the level of neuromuscular fatigue was compared using two types of barbells in an exercise protocol, based on differences in peak barbell velocities during the bench press throws performed at 1 and 24 hours after the fatigue exercise protocol. The main goal of the final study of this dissertation was to determine the level of muscle damage based on creatine kinase (CK) activity in blood serum, measured at baseline, and 1, 24, and 48 hours after the experimental exercise protocol. The level of neuromuscular fatigue, determined based on barbell peak velocity during bench press throws, as well as the level of muscle damage, was assessed in a protocol involving 5 sets of bench press leading to volitional failure with a load equal to 70% of 1RM. The hypothesis was that an increased range of motion through the use of the CMB barbell would

lead to higher barbell velocities, greater levels of neuromuscular fatigue, and higher post exercise blood CK activity.

In each study, a CMB barbell and an STD barbell were used. A linear transducer Tendo Power Analyzer (Tendo Sport Machines, Trencin, Slovakia) was used to record the number of repetitions, mean and peak barbell velocities, and range of motion (displacement). The following inclusion criteria were applied in selecting the study group: a minimum of 5 years of strength training experience, a 1RM equal to or greater than 100% of body mass, and at least 4 weeks of prior familiarity with CMB bench press. Each experimental session was preceded by a familiarization session and started with a general warm-up, followed by a specific bench press warm-up. The first study demonstrated significantly higher barbell velocity when using the CMB barbell compared to the STD barbell with the same external load (50% 1RM for both CMB and STD barbells) in the execution of 3 sets of 3 repetitions. The results of these studies suggest that using the CMB barbell may be an alternative to the standard bench press in developing higher velocities. The subsequent study aimed to compare the level of neuromuscular fatigue determined based on the peak velocity during the bench press throws executed before, 1 hour, and 24 hours after performing the fatigue exercise protocol consisting of 5 sets of the bench press to volitional failure with an external load equal to 70%1RM (measured on the STD and CMB barbells independently). The results of these studies showed a similar downward trend in peak barbell velocity during the bench press throws executed 1 hour after the experimental session, with values returning to baseline after 24 hours of recovery. These results may suggest that bench presses performed using both STD and CMB barbells induce similar neuromuscular fatigue when using the same external load. The last planned study aimed to compare the effects of bench pressing with CMB and STD barbells on barbell velocity and muscle damage based on CK activity. CK activity demonstrated a general significant upward trend from baseline measurements to following time points (1, 24, 48 hours) after STD bench press exercise, whereas CK after 48 hours of CMB bench press was higher compared to pre-exercise and post-exercise states, but not higher than after 24 hours of recovery. Therefore, it might be concluded that performing the bench press exercise with the use of the CMB barbell does not require a different training strategy compared to using the STD barbell, and a higher training frequency may even be applied.