Maximum sustained fin-kick thrust in underwater swimming.

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We examined the upper limit of a diver's fin-kick thrust force using a stationary-swimming ergometer. Heart rate, respiratory minute volume, oxygen uptake, and performance rate were measured in four male subjects who swam constantly for 8 min to maintain a horizontal position against an applied force at a depth of 0.7 m. The water temperature was controlled at 26 degrees +/- 1 degree C. The performance rate, which was the parameter of how well the subjects compensated for the applied load, showed an upper limit around 64 N of sustainable thrust force. This meant that the diver could generate the swimming thrust force within 64 N continuously for 8 min in a steady state. Heart rate, respiratory minute volume, and O2 uptake showed almost proportional increases to the applied load within 64 N and tended to plateau about 69 N.

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Underwater fin swimming in women with reference to fin selection.

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Underwater swimmers use fins, which provide thrust to overcome drag and propel the diver. The type of fin used has been shown to affect diver performance, however data are lacking for women. The oxygen consumption (VdotO2) of swimming as a function of speed, velocity as a function of kick frequency, maximal speed (v), maximal VdotO2 and the maximal thrust were determined for 8 female divers swimming at 1.25 m depth in a 60 m annular pool. VdotO2 increased as a function of v as; 0.52 + -0.485 V + 2.85 V2 (r2 = 0.996) and 0.12 + 1.52 V +1.275 V2 (r2 = 0.999) for high (5 fins) and low (3 fins) groupings, respectively. Splits, vents and flanges did not significantly affect VdotO2.

Kick frequency increased linearly with v, with unique slopes for each fin. Maximal VdotO2 was not affect by fin type (1.46 +/- 0.05 l/min). Velocities that could be stained aerobically were 0.60 +/- 0.02 m/sec on average, with the most flexible fin higher (0.71 m/sec). Maximal v averaged 0.87 +/- 0.03 m/sec, with the most rigid fin lower (0.77 m/sec). Maximal thrust was not affected by fin and averaged 104 +/- 9 N. It can be concluded that female divers preferred the most flexible fins, which were also the most economical. This is most likely due to low leg power, which could also explain the absence of differences in maximal thrust and velocity.

Energetics of underwater swimming with SCUBA.

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Underwater swimming has unique features of breathing apparatus (SCUBA), thermal protective gear, and fins. The energy cost of underwater swimming is determined by the drag while swimming and the net mechanical efficiency. These are influenced by the cross-sectional area of the diver and gear and the frequency of the leg kick. The speeds that divers can achieve are relatively low, thus the VO(2) increases linearly with values of VO(2)*d(-1) of 30-50 l*km(-1)for women and men, respectively. Diving experience had little effect on VO(2) for women; however, male divers with experience had lower VO(2) than beginners. The location and density of the gear can alter the diver's attitude in the water and increase the energy cost of swimming by 30 percent at slow speeds. The type of fin used has an effect on the depth and frequency of the kick, thus on drag and efficiency, with a range of VO(2) from 25 to 50 l*km(-1). A large flexible fin had the lowest energy cost and a large rigid fin the highest. Adding extra air tanks or a dry suit increased the cost of swimming by 25 percent. The energy cost of underwater swimming is influenced by gender, gear and its placement, fin type, and experience of the diver.

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