THE EVOLUTION ACROSS AGES OF EFFICIENCY AND ECONOMY OF (ASSISTED) HUMAN LOCOMOTION AND EXERCISE

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The purpose of this study was to identify the causes of rejection of papers from conference proceedings and to present guidelines to limit the number of papers rejected from the Proceedings of the XXIVth International Symposium on Biomechanics in Sports hosted by the University of Salzburg, Austria. Scientists (n=95) with extensive experience in reviewing papers completed a survey. Each scientist selected their five most common reasons for rejecting papers. All scientists selected 'unsound experimental design' and 'lack of clarity' in one or more sections as common reasons for rejecting papers from proceedings. Other common reasons were poor identification of the problem (53), and poor analytical methods (65). Guidelines for authors arose from the study.

KEY WORDS: human evolution, locomotion, optimisation, economy.

Human evolution and ingenuity both collaborated in providing biological/technological tools to move faster, despite of the same actuator, and to better adapt our locomotion to very different environments. While evolution resulted in a versatile musculo-skeletal system featuring optimization and energy-saving mechanisms to produce force and work more effectively, humans also invented passive tools, particularly in the last 4-5 millennia, allowing to moving faster and more economically on land, on/under water and in the air. Among the most featured examples: bone skating on ice, ancient cross-country skiing, bicycling, rowing. But also hand-held masses (Minetti & Ardigo, 2002) enhanced standing long jump and bows/crossbows made us throwing objects at longer distances (a hand-thrown arrow barely reach 25 m, while with a modern bow the distance exceeds 1.3 km). In the past few years we reviewed the historic evolution of passive tools devoted to enhance human locomotion (Minetti, 2004; Ardigo et al., 2005). Sometimes we built replicas of ancient tools (as in cycling - Minetti et al., 2001, cross-country skiing - Formenti et al., 2005 and ice skating - Formenti & Minetti, 2006), in other cases we used modern tools (as fins - Zamparo et al., 2002) in order to study, through biomechanical and metabolic experiments, the progressive adaptation of (the same) muscle to the different machines and environments. The focus of my presentation will be on how limitations of the musculo-skeletal system have been attenuated both inside (gear ratio, tendons) and outside (crank, gears, poles, skis, fins) the body. The relevance into the necessary mechanical work, the economy of transport and the related efficiency of motion/locomotion will be discussed.

REFERENCES:

Ardigò L. P., V. L. Goosey-Tolfrey and A. E. Minetti. Biomechanics and energetics of basketball wheelchairs evolution. Int. J. Sports Med., 26: 389-397, 2005.

Formenti F., and A. E Minetti. Human locomotion on ice: the evolution of ice skating energetics through history. Submitted, 2006.

Formenti F., Ardigó L. P. and A. E. Minetti. Human locomotion on snow: determinants of economy and speed of skiing across the ages. Proc. Roy. Soc. B, 272(1572): 1561-1569, 2005.

Minetti A. E. and L. P. Ardigò. Halteres used in ancient Olympic long jump. Nature 420: 14-15, 2002.

Minetti A. E. Passive tools for enhancing muscle-driven motion and locomotion. J. Exp. Biol. 207: 1265-1272, 2004. [+Corrigendum in J Exp Biol 207: 2185, 2004]

Minetti A. E., J. Pinkerton and P. Zamparo. From bipedalism to bicyclism: evolution in bioenergetics and biomechanics of historic bicycles. Proc. R. Soc. B 268: 1351-1360, 2001.

Zamparo P., D. R. Pendergast, A. Termin and A. E. Minetti. How fins affect the economy and efficiency of human swimming. J. exp. Biol. 205: 2665-2676, 2002.