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SECULAR CHANGES IN SPORT

SEKULARNE PROMJENE U SPORTU

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SAŽETAK

Generalno pod sekularnim promjenama podrazumijevaju se promjene veličine tijela i drugih morfoloških karakteristika, pokazatelja zrelosti i motoričkih sposobnosti tijekom jedne ili više dekada. Promjene mogu biti pozitivne, u smislu povećanja vrijednosti, tj. akceleracije ili negativne, u smislu smanjenja vrijednosti odnosno deceleracije. Pripadajući uzroci nisu poznati ali postoji nekoliko različitih hipoteza. Specifične populacije kao što su vrhunski sportaši također pokazuju sekularne promjene, međutim one su manje istraživane, barem u usporedbi s nekim drugim grupama.

Ključne riječi: sekularni trend, sport

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ABSTRACT

Secular trends refer, in general, to changes in body size and other somatic characteristics, indicators of maturity, and motor performance over one or usually several decades. These changes may be positive, i.e. increases or accelerations, or they may be negative, i.e. decreases. The underlying causes of secular changes are not known but several hypotheses have been proposed. Specific populations, such as top athletes, have also shown secular increases in size, although these phenomena have been less studied, at least compared to other groups.

Key words: secular changes, sport

INTRODUCTION

The concept of secular changes (better known as secular trends) is of classic interest in human biology, auxology and, as we shall see further, also in sport science or kinesiology. Secular trends refer, in general, to changes in body size and other somatic characteristics, indicators of maturity, and motor performance over one or usually several decades. These changes may be positive, i.e. increases or accelerations, or they may be negative, i.e. decreases. A positive change is not necessarily favorable, e.g. increase of fatness. The issue is not new as some investigators discussed the possibility of these changes as early as the beginning of the 19^{th} century, before the phenomenon had actually been observed (Van Wieringen 1986).

The literature on secular changes, especially in height and weight during growth and early adulthood, is extensive and covers large parts of the world, developed and less developed regions, male and female populations, low and higher social-economic strata, but is less extensive as far as special populations such as world class athletes is concerned. Height and weight have been studied most among all somatic characteristics.

Based on a synthesis of the literature, the following generalizations on secular changes in size seem warranted: secular differences in birth length and weight are slight; secular increases in height and weight are apparent by the end of the first year of life and become progressively larger with age until about 12-13 years in girls and about 14-15 years in boys. The largest secular differences in height and weight are apparent during puberty while there is a progressive reduction in the magnitude of secular increases in size from puberty until young adulthood. This increase in height up until puberty may be proportional, however, to the attained height in the age group. If a ratio between increase in height per decade and the mean stature of the first measurement period is taken into consideration, the secular changes in height with increasing age become somewhat less evident around puberty.

Secular changes have occurred in all socio-economic groups in Europe, USA and Japan but these changes are not universal. Indeed, populations in underdeveloped areas of Asia, Africa and Latin America show little, no or a negative secular trend in adult stature.

Size differences between children of different generations in part reflect maturity differences. Children today mature earlier than those of 100 years ago. Age at menarche, the most commonly reported indicator of maturity status, has decreased over the last 150 years in European populations by 3-4 years. The estimated rate at which menarche has diminished in Europe is about 4 months per decade from 1830 until now (Roche 1979). The percentage of adult height achieved at the age of menarche has remained, however, quite constant over several decades, i.e. at 95% although height, weight and age of menarche varied significantly.

Meta-analysis of 136 reports of changes in height and of 142 reports on weight reveals that over the past century the median increase in the height of children aged 5-16 years has been 1.23 cm and 0.80 kg respectively per decade. This rate of secular changes in height varies according to age and level of health and well being of a certain population. We would expect that the trend in weight would be proportional to the relationship with height. This is, however, not always the case as weight is more sensitive to the availability of food, and depends greatly on the individual's response.

There is evidence that the positive secular changes in height and weight, and the decrease in the age of menarche is slowing or has stopped in developed countries, during the 60's and the 70's. Nevertheless, an increase in height of British children between 1982 and 1990 was reported in the study of China and Rona (1994) This was attributed to decreased family size. In a follow up study on growth and fitness of Flemish children (Lefevre, Bouckaert, Duquet, 1997), it was shown that the rate of secular changes in height and weight has slowed down but has not stopped yet. Also in the Netherlands secular growth has not ended yet although the Dutch belong to the tallest populations in the world (Fredriks et al. 2000).

What is causing the secular change in size?

The underlying causes of secular changes are not known but several hypotheses have been proposed. Two hypotheses relate to the elimination of growth-inhibiting factors and the introduction of growth-stimulating factors. It is generally thought that the secular increase in height and weight over the past century is most probably due to improved living conditions, improvement in housing and sanitation (a very important factor for good health), immunization, urbanization, industrialization, improved medical technology, better nutrition and environmental quality, dietary changes, changing patterns of infant nutrition; increased availability of food, improved awareness of health issues, increased population mobility (heterosis), reduction in child labor and reduction in family size. The improved health conditions are reflected in e.g. a remarkable drop between 1896 and 1996 of infant mortality, a sensitive indicator of a population's social and economic well-being. Death rates from infectious diseases also declined between 1921 and 1995 from 185 to 5.5 per 100 000. Evidence for all this, is that the rate of change in height and mass has fluctuated over the past century and was likely influenced by changes in the environment and in the political climate.

Better nutrition has very likely been an influential factor for the secular changes. Most epidemiologists and nutritionists have assumed that the Western diet has been associated with improved life expectancy (e.g. Popkin 1994). But a number of nutritionists and growth experts have challenged this approach (e.g. Hauspie et al. 1997), claiming among else that excessive nutrition during child- and adulthood can lead to increases of cancer and other chronic diseases in middle age.

Both recently and in the past, societies have favored tall stature, and tallness has characterized upper social classes (Keyes 1980) although numerous exceptions exist as well. Human biologists but also economists support the thesis that taller stature is a correlate of productivity, standard of living in a country and superior health. But not everyone idolizes tall people. Charles H. Townes e.g., Nobel laureate in physics, proposed in 1996 a reduction of human size as the most effective means for improving the world because of the resources that would be conserved. In a very recent article Samaras and Storms (2002) presented an astonishing summary of the potential impact of a 20% taller US population on biodiversity and fiscal expenditures. Assuming that the variety of body types is maintained and that buildings, transport vehicles, roads etc. are scaled to the average height and body size of the population, extraordinary more food, water, farmland, natural resources and energy and so on would be needed. An enormous amount of extra garbage and industrial wastes would be produced and there would be more pollution with a substantial impact on biodiversity.

The amazing review of Samaras and Storms has provided a new view and a discussion forum on secular changes and particularly on the (relative) importance that is given to height. But height is only one factor out of many that determine health, well being or longevity of any one person. Therefore exercise, diet, stress management personal happiness, avoidance of smoking, obesity, and drugs, all combined, exert a much longer influence on any one person's length and quality of life than height on its own.

Secular changes in sport

Specific populations, such as top athletes, have also shown secular increases in size, although these phenomena have been less studied, at least compared to other groups. Comparisons of heights and weights of athletes studied at several Olympic Games between 1928 and 1976 have been reviewed by Borms and Hebbelinck (1984). In spite of variation in sampling and the different ethnic composition of athletic groups, it can be generalized that a considerable increase in size took place in this period. It remains of course difficult to partition the trends into separate estimates for secular effects per se and for those effects that might be attributed to selection or changes in rules and style of play, favoring larger athletes. Studying changes in the physical characteristics of athletes over time is one way to find out if size and shape are determinants for success in a particular sport. It is hereby assumed that physique is an important but not the only factor determining sporting success. In certain sports, such as soccer, there is hardly a difference to note between soccer players and the general population in terms of height and weight. In other sports though, such as e.g. tennis, a great variety of physique types among the players can be noted (although the advantage in tennis of being tall is recognized here), meaning that other characteristics (speed, technique, strategic skills, motor control…) play a great if not a greater role in success.

In several sports the rates of increases in height and weight have been higher than what could be expected from secular trend alone and therefore the changes point to the importance of changing physical attributes. Norton et al (1996) and Norton and Olds (2001) reviewed the secular trend in some sports where it is assumed that height and weight play an important role. To quantify differences between athletic and non-athletic populations in terms of e.g. height and weight, they designed the concept of the *overlap zone* (OZ). It is a mathematical method for calculating an overlapping zone, in percentage of the normal probability curve, between two bivariate distributions. It can best be visualized as the degree of superimposition of the frequency distributions of the two populations and can be quantified in a statistic called OZ or BOZ (bivariate overlap zone). The simple principle is that the sporting subpopulation is compared to the so-called 'source population' to recruit athletes from. The further the populations are apart, the more difficult it will become to recruit athletes with the desired physical attributes.

Anthropometric and other characteristics tend to be optimized and similar among elite athletes. The culmination of a final body shape and composition results from what Norton et al (1996) termed *morphological optimization*. The same authors used four broad groups of athletic events to describe their model, combining morphological optimization and the evolution of humans, both athletes and non-athletes. These four groups are open upper-end, relative, absolute and open lower-end optimization. We will provide an example of the first group.

The first category (open upper-end optimization) contains sports where athletes with a larger absolute or relative size will have an advantage such as super-heavyweight lifting, Sumo wrestling and American football for body mass; basketball and heavyweight rowing for height. The effect of this optimisation is the appearance of athletes in excess of 160 kg and world records for the super heavyweight lifters that have increased at a rate about twice that found with the other classes of lifters. Figure 1 illustrates the relationship between the weight lifted during world record lifts and the year of achievement for three weight classes. It is clear that the super-heavyweight records have increased at a greater rate than those in the two other weight classes.

Olds (2001) analyzed extensive data of elite rugby players. He reported major shifts in the physique of players who, as a whole, became taller, heavier and more mesomorphic. Over the last 25 years, particularly the BMI, body mass and mesomorphy have been increasing at a rate twice the average increase over the century as a whole, and at rates that may be 5 times as great as drifts in the source population.

Data collected on 'Australian rules' football players (Norton et al, 1996) also highlight the exaggerated rate of height of the tallest players relative to both the reference population and the smallest players over about 100 years.

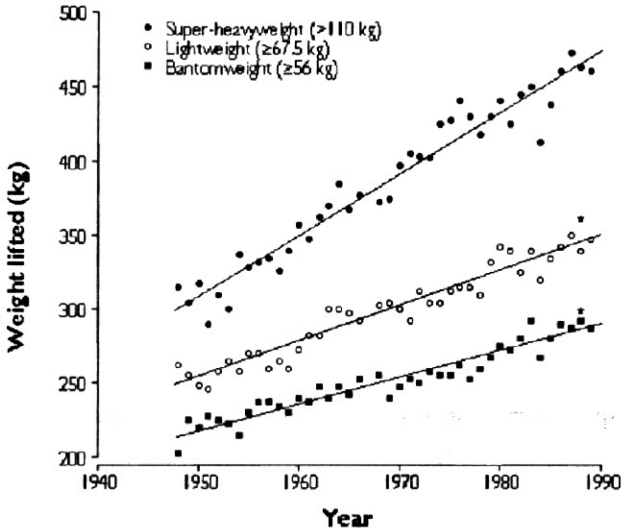
A last example relates to NBA basketball players (Norton et al 1996). Data collected since 1945 indicate that the rate of change in mean height of all players (2.25 cm/decade) is significantly greater than that of the general population. However, the rate of height increase for the taller NBA players is almost twice that of the mean height increase and about 4 times that of the general population.

A comparison of the change in body size from 1975 until now across 22 different sports tells us that the rate of change of body size is proportional to how much the characteristic body size deviates from the population average and thus the small remain small or get smaller, while the big get bigger (Norton and Olds, 2001).

The trend toward open upper-end optimisation is likely related to greater selectivity in recruitment, the generation of a genetic pool of big athletes, globalisation of sport, the greater financial incentives in professional sports but perhaps, and sadly enough, also drug (ab)use. This evolution is likely to continue in the future as the secular changes may persist and the sports may become more specialized, globalised and offering more financial incentives.

Figure 1 The relationship between the weight lifted during world record lifts and the year of achievement for three weight classes (graph graciously provided by Tim Olds)

Slika 1. Odnosi između podignute težine svjetskog rekorda i godine kada je uspjeh postignut (graf ustupljen od Tima Oldsa)



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