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Do former elite athletes live longer? Potential role of critical window(s) in the development of the health-oriented behaviors and physiological adaptations

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Abstract

Introduction: Some epidemiological data indicate that moderate-to-vigorous levels of physical activity could be beneficial for longevity. Moreover, in terms of cognitive functioning, mental activities undertaking during first decades of life translate to better coping with pathological changes of brain during aging. Therefore, it is worth to examine the relationship between the most intense form of regular physical exercise undertaking, which is typical for the former elite athletes, with longevity.

Material and methods: Articles in the EBSCO database have been analyzed using keywords: longevity, ex-elite athletes, former elite athletes, ex-athletes, mortality, chronic diseases.

Results: Reviewed literature described the longevity of participants who were active elite athletes. Analyzed groups could be separated based on sport type: aerobic, anaerobic and mixed, and due to, inter alia, sex and race of sportsmen.

Conclusions: There is some evidence for increased longevity in the former elite athletes of aerobic and mixed sports and for decreased longevity in anaerobic, comparing to general population. However, there is need for further studies with design which could explain the mechanism of differences in longevity and incorporate potentially confounding factors.

Keywords: longevity, ex-elite athletes, former elite athletes, ex-athletes, mortality, chronic diseases

Introduction

There is no clear biological explanation of aging process [1]. However, almost all the recent theories share a one common point, namely that the primary cause of aging is the accumulation of molecules mainly caused by Reactive Oxygen Species (ROS) [2]. Despite the unsatisfactory evidences on ROS production during physical exercise [3, 4, 5], due to the technical limitations of techniques used, there is general consensus that, during exercise, reactive species production occurs mainly by contracting skeletal and heart muscle in exercise load-dependent manner [6]. Paradoxically, The Harvard Alumni Health Study based on 13.485 men showed no association between undertaking less-intense activities, defined by the <4 metabolic equivalent of task (MET), with reduced mortality rates, nevertheless undertaking vigorous activities (≥6 METs) were significantly related to the lower mortality rates [7]. The existence of a biological mechanism of adaptation to increased ROS production due to the physical exercise is obvious; there is a long history of researches on this phenomenon [8] without definitive answer. Moreover, the pattern of results of the Harvard Alumni Health Study were confirmed by the dose–response meta-analysis of cohort studies from 2011 [9]. Based on 1.338.143 participants, reduced all-cause mortality was shown to be associated with higher levels of physical activity. Moreover, analyzed sample obtained less benefits from moderate-intensity than vigorous exercise in terms of mortality risk reduction [9].

Education level is one of the most important factors in cognitive reserve concept propagated by Yaakov Stern [10]. Interestingly, education as a regular mental activity which is usually undertaken until first 3 decades of life have an impact on someone's capacity to tolerate a larger brain lesion in participants 60 years old and older. Various critical windows for development [11] were proposed, which can potentially explain the level of impact of activities during initial years of life on cognitive functioning in the rest of life. We would like to check if similar critical windows exists in case of pro-health and pro-longevity effects of physical exercise. Therefore, it is worth to examine the relationship between the most intense form of regular physical exercise undertaking, which is typical for elite athletes, with longevity.

Material and methods

Articles in the EBSCO database have been analyzed using keywords: longevity, ex-elite athletes, former elite athletes, ex-athletes, mortality, chronic diseases. The available literature was subjectively selected. Then, the newest version of every paper was searched for.

Results

1.1 The role of post-retirement lifestyle factors in longevity

The classic paper of Morgan revealed that comparing 294 oarsmen who had participated in Oxford vs Cambridge boatraces between 1829 and 1869 lifespan was about two years longer than the average for whole country population [12]. Since then, debate on longevity of former elite athletes began. Review from 1977 claimed no relationship between the cause of death and level of the physical activity during study at university [13]. Authors noted few more variables that are worth to adjust for statistical analysis in similar studies, such as daily habits after sport-retirement [13]. Indeed, as other Authors [14] note, an important challenge to researchers in this field is the lack of data on the health behaviors of athletes post retirement. Fortunately, some studies on groups of former elite endurance, team, and power athletes who represented Finland included post-retirement habits into analysis (e.g., [15, 16, 17, 18]). Being a former elite athlete is often related to better socio-economic status, health-oriented behaviors and those traits are in turn related to more healthy lifestyle, which are all together related to longevity [19].

The rate of maximal oxygen consumption (VO2max) value could be a reliable predictor of sport performance [20] and regular exercise can lead to significant increment of VO2max [21]. Interestingly, based on the numerous longitudinal studies the rate of VO2max decline during the aging process is observed. For example, results of 10-year longitudinal studies on the cohort of older participants [22] showed a 14% decline in VO2max in men and 7% in women. Moreover, VO2max is one of the strongest predictors of all-cause mortality, cardiovascular disease and overall functioning and health in older people [22], critical value of 15–18 ml/kg/min is necessary to maintain instrumental activities of daily living [23]. However, older former elite athletes which were sedentary after retirement have similar values of VO2max comparing to their peers [24].

1.2 Sport type and career achievements

Some studies [25] found a trend towards decreased mortality rate in endurance and mixed-sport athletes relative to anaerobic sport athletes and the rest of population. Elite cyclist - French [26, 27, 28], Italian [28], and Belgian [28] participants of Tour de France had greater longevity than their peers. The same pattern of longevity in former sportsmen of aerobic types of exercise was showed in samples of Norwegian skiers [29] and Italian track and field athletes [30]. In contrary, reduced lifespan in elite Finnish powerlifters comparing to control group was observed [31]. Analysis comparing different sport types in terms of longevity reported predominance of mixed and aerobic types [32]. In contrary, increased mortality rate comparing to general population from suicide in anaerobic sports could be attributed to anabolic steroid use [32, 33]. Interestingly, it leads to an interesting point, that analysis of younger cohorts (elite sportsmen who performed in 1980s and after) could reveal another pattern of results in terms of longevity because of one can suspect a wider use of banned drugs enhancing performance. Moreover, incorporating into analysis groups of former athletes from relatively newer sports (e.g., mixed martial arts) could have a potential influence on results [14].

Additionally, researches on former athletes of contact sports such in American football can lead results dependent on player's position on the field [34], potentially due to the higher risk of concussion of some groups. Interestingly, baseballers included into Hall of Fame had 5 years smaller median post-induction survival and significantly larger rate of deaths from cardiovascular or stroke causes than players not included into Hall of Fame [35]: these results directs to the idea that the rate of achievements should be incorporated into analysis of former elite athletes longevity. In soccer players, both greater survival rates in Denmark [36] and lesser survival rates in German population [37] were noted, however timeframe adjustment of 1908 to 2006 [37] could lead to biased results due to the increased and not accurately recorded mortality rate during both World Wars.

1.3 Race, age and sex

Another important mechanisms that may influence results could be sex, as indicated by results obtained on Olympic medal females which were characterized by greater longevity relative to Olympic medal male athletes [38].

Race could be also a potentially confounding variable, white professional basketball players tend to have 77 % lesser mortality risk than their African-American counterparts [39].

Moreover, age of becoming an elite athlete can be a crucial factor; sportsmen who gain elite status earlier are burdened with risk of earlier death [40]. In addition, current age of examined subjects can have a prominent role: in a group of former elite players < 50 years the mortality rate is lower comparing to the general population, but in former elite athletes > 50 years there was no significant differences between these two groups [41].

1.4 Genetic profile and gene expression

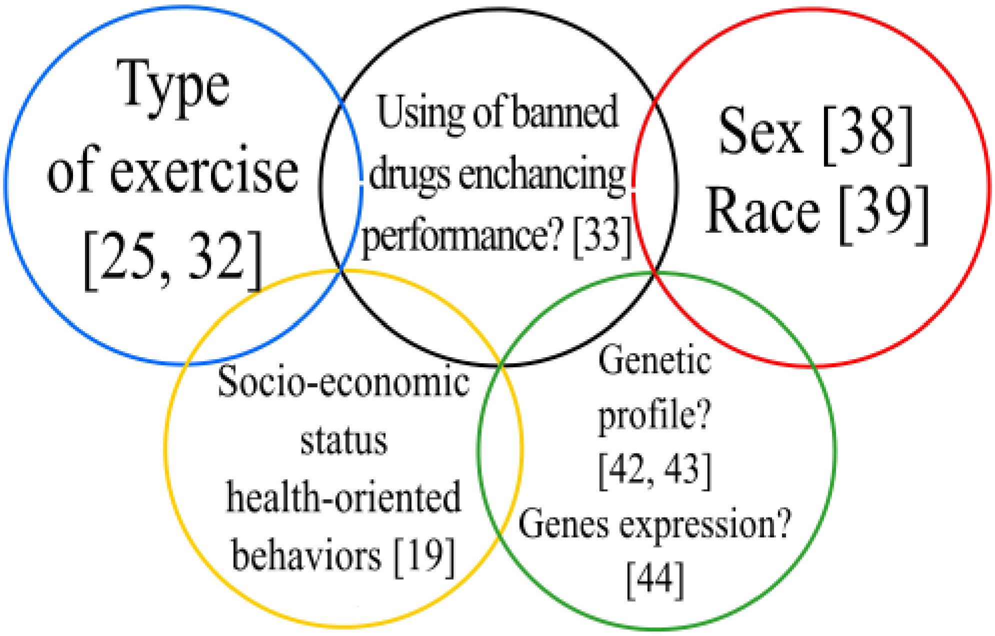
Another potential explanation for the increased longevity of elite athletes compared to the rest of the population are the differences in genetic profile [42]. Elite athletes became professional sportsmen often after being selected from large groups of peers on basis of their superior physical performance. If same sport group undergone similar training regime and, nevertheless, some individuals showed superior adaptation, then the genetic profile can play main role, indeed. However, some questions remains. If a superior genetic profile applies to genes related strictly to sport performance, or the same pools of genes are responsible for longevity and rarer/later occurrence of chronic diseases? Studies comparing 33 disease risk-related mutations and polymorphisms among 100 non-athletic male healthy controls and 100 elite athletes, showed no significant differences between genetic profile of these two groups [43]. It is obvious that considering even combinations of 33 variables could not lead to reveal differences in whole genetic profile, therefore further researches on this topic are needed. It is worth to mention that physical activity plays a crucial role in gene expression, while the phenotype of the modern subject's genome varies from that of ancestors, because of sedentary lifestyle [44]. Therefore, regular physical exercise may promote beneficial pattern of gene expression.

1.5 Overall load of exercise

Interestingly, O’Keefe [45] et al. proposed that “desired” adaptations due to chronic exercise can turn into pathological changes when the dose of exercise would be too strenuous. On the other hand, Sanchis-Gomar et al [28] conclude about the dose of pro-health exercise: “even a little is good; a lot is better if you are well trained". Therefore, future studies should focus on answer on question do such "critical point" above which exercise training is related to higher risk than benefit really exist, and if so, establish this point referring to an individual physical potential.

Figure 1. Variables which could play a role in former athlete longevity.

"?" denotes uncertain role based on evidences. Note that all the variables can interact with longevity and with each other also



Conclusion

Reviewed literature described the longevity of elite athletes: the very first studies included former elite athletes who were active in 1829. Despite such long history of researches, there is no definitive description of differences in longevity between group of former elite athletes comparing to the rest of population, mainly due to potentially confounding factors. Analyzed groups could be separated due to the type of exercise (aerobic, mixed, anaerobic). Moreover, socio-economic status and health-oriented behavior, sex, race, race, using of banned drugs enhancing performance and probably also genetic profile and gene expression should be all included into analysis as potentially explanatory variables of longevity.

There is some evidence for increased longevity in former elite athletes of aerobic and mixed sports and for decreased longevity in anaerobic comparing to general population. However, there is need for further studies incorporating potentially confounding factors, also deigned in way which would give an opportunity to explain the biological mechanism underlying the differences in longevity between separate groups.

Most importantly, above results can show the potential existence of critical window of the development of health-oriented behavior and potentially desired physiological adaptations which would lead less frequent or/and later chronic disease occurrence and increased longevity and the fact that introduction of these both factors in youngsters may potentially lead to healthy aging of the future generations.

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