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CHRONIC DISEASES AND ELITE ATHLETES: AN EPIDEMIOLOGICAL REVIEW

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Abstract

Aim of the study: to draw an epidemiological panorama of the link between elite athletes and chronic diseases.

Method: literature review conducted between June and Decembre 2008. Databases used: Medline Pubmed, Pascal, Cochrane Library, BDSP.

Results: apart from traumatology, there are very few epidemiological studies the topic. The incidence of many current chronic diseases, such as coronary artery disease or type 2 diabetes, is lower in elite athletes, especially endurance athlete, than in the general population, excepted for asthma and, undoubtedly, osteoarthritis. Moreover, their standardized mortality ratios are lower too, which results in a lengthened life expectancy.

Discussion: elite athletes naturally have a physiological and genetic profile, which is different from the rest of the population. Beyond physical activity, these elements have to be taken into account for the interpretation of results evoked above. Moreover, may be that the modifications of practice observed recently, such as professionalism, training techniques, or doping behaviors, will have, a few years from here, an impact on the morbidity of these athletes. Lastly, it should be stressed that certain results would deserve to be confirmed, either because the number of study, or the number of participant involved, is reduced, or because the method employed provides a low level of scientific proof (i.e: cohort studies).

Conclusion: it would be advisable to realize prospective epidemiological studies aiming to describe chronic diseases among active or former high level athletes, set up the influence of high level sport practice on health, and evaluate the health-related effects of a regular physical activity in retired high level athletes.

Key-words: *elite athletes, health, chronic diseases, epidemiology*

Introduction

The beneficial effects of a regular physical activity on health are largely admitted. An active way of life enables prevention of many chronic diseases, like diabetes mellitus, breast cancer or colon cancer, coronary artery diseases, anxiety, etc. For people already chronically ill, physical activity, which then constitutes a very part of the medical treatment, can involve a reduction of the amounts of drugs, complications of the disease, number of hospitalizations and an improvement of the quality of life (1-3).

These effects appear at a threshold of intensity and duration of physical activity, which vary with the individuals, chronically ill or not (4-6). This means that, for a given person, a physical activity will have to reach determined intensity and duration to generate benefits on health. On a population scale, the usually admitted average values for this threshold are 60% of maximum heart rate, approximately 4 MET, for the intensity and 30 minutes per day 5 days per week for the duration (7).

However, if there is a threshold of benefit, one can also describe a threshold of damage for health: intensity, duration or methods of practice beyond of which occur physical activity-induced pathologies, like traumatic lesions, overuse pathologies or medical pathologies. If any physically active person is likely to exceed this second threshold, high level or professionals athletes are especially concerned. Thus, sport traumatology is the topic of an abundant medical literature and of numerous specialized congresses.

This is not the case for other health subjects, such as chronic diseases, life expectancy or quality of life. However, these areas constitute common topics in the field of public health. In addition, high level athletes' health is often a subject of interest for the general public, at least through the link between health and physical performance or enhancement. This interest is expressed in mass-media via opinions like: "High level athletes, such as cyclists, live less longer than the general population" or "Elite sport practice involves pathology, but anti-doping texts often foreclose athletes from medical treatment" (8, 9).

The purpose of this study is to carry out an epidemiological panorama of morbidity and mortality related to high level or professional sports, traumatology excluded.

Methods

Data were collected between June and December 2008 from:

- Electronic databases: Medline Pubmed, Pascal, Cochrane and the French Database in Public Health

(BDSP). The main searched keywords were: "epidemiology", "elite sports", "high level sports", "elite athletes", "morbidity", mortality", "life expectancy", "health expectancy", "quality of life", associated with "cardiovascular disease", "lung disease", etc. The search was limited, when possible, to paper with abstract, humans, all adults 19 + years and adolescent 13-18 years. The same keywords were used to investigate all the electronic databases (but translated in French for BDSP).
- Internet sites of various organizations of sports medicine, public health and epidemiology, and sporting federations, for example: American College of Sports Medicine (www.acsm.org), Centers for Disease Control and Prevention (www.cdc.gov), International Amateur Athletic Foundation, (www.iaaf.org), Federal Office of Sport Macolin (www.baspo.admin.ch), Public Health Agency of Canada (www.phac-aspc.gc.ca), etc.

This procedure was supplemented by manual searches of previous reviews.

The principal papers selected satisfied the following criteria:
- Design: epidemiological study, reviews, meta-analysis, original articles, and reports (provided that they were dated and that they indicated the authors name)
- Population: high level (involved in national level competitions at least) or professionals athletes;
- Method: randomized controlled studies, prospective studies.

Grids of reading allowed a fast and homogeneous analysis of the preselected articles.

Results

1) General

A Medline search, with the key words *epidemiology elite sports* found 346 papers, which represents only 0.03% of the articles on epidemiology (293/1173667). To compare, the part of epidemiology of diabetes mellitus is 3.50%.

According to the same data base, but now considering the sole field of sport, epidemiology in high level sport accounts for approximately 0.3% of the whole publications related to sport.

The large majority of epidemiological works in high level sport concerns traumatology.

2) Morbidity

Research on Medline, with the key words *morbidity sports* found 9913 references and *morbidity elite sports* 369 references. Research on the other databases brought back very few articles: thus, on Pascal and BDSP, *morbidity sport* found 0 and 59 references, respectively.

This first result was refined by the addition of key words and limiting factors (Tab. 1).

In a second step, papers are preselected only if they correspond to the criteria defined higher. Others are excluded.

Asthma

Compared to the general population, an elevated prevalence of asthma or exercise-induced asthma (EIA) is well known among high level athletes, especially in sports like Scandinavian ski, swimming, or ice hockey (10-18), and more commonly among elite swimmers than among other high-level athletes (19).

Thus, in 2000, the *American College of Medicine Sports* has estimated that EIA could involve 10 - 50% of the athletes, and 10 to 15% of the general population (20).

These results were confirmed by recent studies (21-23). Moreover, according to some authors, prevalence of EIA is progressively increasing since the years 1980 (24, 25).

Allergies

In the field of allergies, allergic rhinitis constitutes the main object of concern in high-level sports. Indeed, its prevalence appears high, even in increase (25),

Table 1. *Number of references on Medline for morbidity in high-level sport*

Terms	Number of references		
	Term alone	Term associated with *morbidity elite sports (MES)*	Term associated with *MES* + Limits = *Only with abstracts - Humans - All adults 19+ years - Adolescent 13-18 years*
Cardiovascular disease	1524378	28	23
Lung disease	609030	21	14
Neurological disease	1635637	42	25
Renal disease	397364	0	0
Inflammatory disease	119173	1	0
Diabetes	323973	3	3
Osteoporosis	45220	7	6
Drug abuse	189247	8	7

and allergic rhinitis is likely to deteriorate athletes' performance, in particular when associated with an allergic conjunctivitis (26).

Thus, in a study among 494 high level athletes, 36% of endurance athletes stated that they had an allergic rhinitis (diagnosed by a physician), against 23% of the others, and 20% of young adults of the same age being used as a reference group (27). On the all, half of them used anti-allergic drugs, but endurance athletes more often than the others.

Diabetes, overweight

In a previous study among 1282 former Finnish elite male athletes, Kujala et al (28), found a lower risk for diabetes when compared with referents, in particular endurance athletes. However, although reduced, this risk was a little higher in former tobacco smokers and those whose body mass index was high. This result was confirmed by recent works (29-31).

Few studies were devoted to overweight in high level sports risk. However, this risk appears small, although it is not nil (32). Thus, Garry and McShane (33), in an observational study of 70 professional football players from one National Football League team, found a mean body mass index (BMI) at 31 kg/m2 (from 23 to 43). There are some other exceptions; especially professional Sumo wrestlers were the mean of BMI can reach 36 kg/m2 and even 40 kg/m2 (extreme obesity) (34, 35).

In former elite athletes, little is known about overweight risk but power-sports athletes appear more exposed (28). Moreover, according to Saarni et al (36), repeated cycles of weight loss and regain seem to increase subsequent weight gain and may predispose to obesity.

Cardiovascular diseases

Ischemic heart disease is less frequent among physically active subjects (28, 30, 31).

After retirement from active sports, the risk for coronary artery disease (CAD) or levels of selected CAD risk factors of former athletes seems more related to their present-day physical activity (37). But if a previous aptitude for endurance athletic events appears to give a protection against CAD, it is not the case for a previous aptitude for power speed events (38).

Former endurance elite athletes are less exposed than referents to hypertension (28, 39). A high proportion of type I muscle fibers (*slow-twitch fibers*) in these athletes could be a part of the association between high levels of physical activity and low blood pressure (40).

In disabled athletes, an observational study of 79 Brazilian Paralympic athletes showed a high prevalence of coronary risk factors: 41% had one factor, 4% two and 6% three or more, systemic hypertension being the most frequent one (41).

Cancers

A cohort study involving 2269 men, former world-class athletes, followed up for 28 years showed that the risk of lung cancer was lower than in the general population, especially among endurance athletes (42). The risk of kidney cancer was also lower. According to the authors, this result could possibly be related to a small use of tobacco and a better diet (more fruit and vegetables, less fat). Incidence of other cancers was not significantly reduced.

On the other hand, Ambros-Rudolph et al (43) found an increased risk for malignant melanoma in marathon runners.

Osteoporosis

In elite athletes, some studies suggest that: 1) bone mineral density (BMD) is not appreciably altered during sports practice, and 2) sports practice could have positive effects on BMD. This result has been observed, for example, among runners (44), professional volleyball players (45), elite climbers (46), professional football players (47), professional tennis players (48), or female boxers (49). However, some works find opposite results (50), especially in amenorrheic female athletes (51-54).

In former high level athletes, the risk of osteoporosis could be very low compared to the general population, for instance in former professional football players (55), in particular when a regular present-day physical activity is maintained (56). This result could be true in female athletes, whose BMD is higher than what is observed among inactive women (57).

Depression

An interesting work was undertaken among 758 retired high level athletes: anxiety and depression were assessed in a follow-up with the Basic Symptom Inventory-53 (BSI-53) and compared to 578 referents (58). The authors found a significant difference between the two groups as referents were more depressed than endurance sport and team sport athletes (no difference in anxiety).

Two years later, the same researchers investigated the influence of leisure physical activity on the mood of former elite male athletes. They showed that being active has a protective effect against depressiveness: an increase of one MET-unit (hour/day) significantly decreased the risk of depressiveness by 8% (59). To be married and no misuse of alcohol were two other factors linked to a reduced risk.

In a recent survey among 3 377 former professional football players, Schwenk et al (60) observed that 14,7% experienced moderate to severe depression, a prevalence similar to that of the general population. However, this rate was higher at those which complained about chronic pains. The association of depression and pain was predictive of sleep disorders, social relationships difficulties and financial difficulties.

This work consolidates old results according to which some athletes are at risk of depression when they are wounded (61, 62).

3) Mortality

A search on Medline, with the key words *life expectancy sports* brought back 111 references, *health expectancy sports* 57 references (*healthy life expectancy sports* found 9 of them), *quality of life sports* 1420 references and *health-related quality of life sports* 208. The other databases provided nothing else. For example, *life expectancy sport*, or *health expectancy sport* brought nothing, neither on Pascal, neither on BDSP, nor on Cochrane Library. On the other hand, if *quality of life sport* found no document on BDSP, it provided 5 papers on Pascal and 1 on Cochrane (none related to high-level sport, however).

This first result was refined by the addition of key words and limiting factors (Tab. 2).

Various publications suggest a lifespan lengthening in high level athletes compared to the general population.

Thus, a Finnish study highlights cause of death of retired high level male athletes (63). Over a 24 years period, all-cause standardized mortality ratio (SMR: ratios between the observed and expected deaths during a given period) was statistically lower among the athletes (0.74) compared with the general population (1.00), particularly for endurance athletes whose SMR was 0.57. However, SMR of hypertension-related death was higher in power athletes (2.63)

This result confirms a paper published in 1993 and conducted among 2613 male athletes, who were engaged in international competitions (64). The authors reported the following average life expectancies: 75.6 years in endurance athletes, 73.9 years in team sport athletes and 71.5 years in power athletes, while in the general population, the average life expectancy was 69.9 years.

The 29 years follow-up of 6 848 *National Football League* players had similar conclusions: life expectancy of the players was higher than that of the general population (65). But there was an exception: those whose body mass index (BMI) was higher than 32 kg/m2 had an increased mortality rate by ischemic cardiopathy (on average 6 times higher compared with players with BMI < 28 kg/m2).

More recently, in the United States, Abel and Kruger (66) reported that *Major League* baseball players (4492 subjects) lived an average 4.8 years longer than age-matched controls from the general population. This gain of longevity is related to the career length: 4.1 years on average for the players playing only one season, to 7.4 years for those playing 11 or more years (67).

In Italy, Belli and Vanacore (68) and Taioli (69) studied overall and cause-specific SMR in a cohort of professional soccer players. They found a lower mortality ratio for cardiovascular disease, cancer and immune deficiency. But the SMR for car accidents and amyotrophic lateral sclerosis were higher than expected.

According to a recent study (70), life expectancy of top-level athletes (boxing, swimming, baseball, track and field, ice hockey, tennis, football and wrestling) could be unaffected by the type of discipline, and not linked to physiological demand.

Discussion

The majority of epidemiological studies suggest that high level athletes, or former high level athletes, could be less exposed than the general population to some current chronic diseases. Thus, for many authors, high level sport practice is not a risk factor for morbidity (apart from traumatology) (29, 30).

On the other hand, there is a lack of epidemiological data on many health subjects, in spite of possible health hazards. For instance on osteoporosis, especially when this pathology is associated with amenorrhea and eating disorders (female athlete triad).

Compared to the general population, different papers suggest a lifespan lengthening in elite athletes. This lengthening could be explained by a lower risk for coronary artery disease, particularly in endurance athletes, but also by a different way of living, more «healthy». For instance, athletes seem more prone to eat fruit and vegetables, and less prone to use tobacco or alcohol (71).

Table 2. *Number of references on Medline for the life expectancy in the high level sport*

Terms	Number of references		
	Term alone	Term associated with *elite sports (ES)*	Term associated with *ES* + Limits = *Only with abstracts - Humans - All adults 19+ years - Adolescent 13-18 years*
Life expectancy	19996	3	1
Health expectancy	8135	2	1
Quality of life	126563	12	10
Health related quality of life	19924	2	2

However, the majority of elite athletes naturally have a physiological and genetic profile, which is different from the rest of the population. Beyond physical activity, these elements have undoubtedly to be taken into account for the interpretation of the results presented above.

Moreover, may be that the modifications of practice observed recently, such as professionalism, training techniques, or doping behaviors, will have, a few years from here, an impact on the morbidity of these athletes.

Lastly, it should be stressed that certain results would deserve to be confirmed. Indeed, the number of study, as well as the number of participant involved, is sometimes insufficient for a statistical standpoint. Another factor that may limit the results is the methods employed, when they provide a low level of scientific proof, such as cohort studies.

Conclusions

Scientific literature offers few epidemiological data on health of top-level or professional athletes, apart from traumatological considerations.

The majority of available studies show a low incidence for current chronic diseases in elite athletes, compared with the general population, excepted for asthma. Moreover, their standardized mortality ratio is lower, which results in a lengthened life expectancy.

It would be advisable to conduct epidemiological studies aiming to:

- Describe chronic diseases among active or former high level athletes (prevalence, risk and protective factors, comparison with non elite athletes and with general public, etc),
- Set up the influence of high level sport practice on health,
- Evaluate the health-related effects of a regular physical activity in retired high level athletes.

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