# I. ABSTRACT

**Background and objectives:** along their careers, elite athletes are subjected to specific constraints that distinguish them from the general population. Such constraints, related to the high intensity of their physical activity, their overexposure to injuries or particular lifestyle, may have long-term consequences on the athletes' health, and ultimately on their longevity. Thus, the main goals of the present study are the following: 1) to describe and analyze elite athletes' longevity and specific causes of mortality in comparison with the general population and according to the type of effort they performed; and 2) to investigate their lifespan trends in comparison with the longest-lived humans in order to apprehend the current scenario of human longevity trends.

**Methods:** we collected data on the biography and the athletic performances of all the French athletes who participated in the Olympic Games (OG) from 1912 to 2012 (n = 4708), and all the French cyclists who participated in the Tour de France (TDF) from 1947 to 2012 (n=786). Then, we verified their vital statuses through the National Registry of Identification of Physical Persons (RNIPP). For the deceased athletes, we obtained the causes of their deaths through the Centre for epidemiology on medical causes of death (CépiDc). We compared the athletes' overall and specific mortality (according to the main chapters of the International Classification of Disease) with the French civilian life tables using Standardized Mortality Ratio (SMR) and the Kaplan-Meier methods. We adapted and applied the life years-lost method under the competing risk model to quantify differences on longevity due to major causes of death according to the athletes' type of effort. Furthermore, we collected data on worldwide deceased Olympians participating in the OG from 1896 to 2012 (n=19 012) and on worldwide supercentenarians (>110 years) deceased between 1900 and 2013 (n= 1 205) in order to analyze their lifespan trends using a density analysis tool (total number of life durations per birth date).

**Findings and conclusion:** French elite athletes show consistently lower mortality (≈40-50% lower) in comparison with their compatriots, whether female or male Olympians, or professional cyclists, mostly related with a lower cardiovascular (≈ 40-60% lower) and cancer mortality (≈ 45% lower). No excess mortality was observed in elite athletes for any of the specific causes of death we studied. French Olympians' lower mortality results in an average of seven years of life saved in relation to the general population. This gain partitioned according to specific causes of deaths shows that cardiovascular longevity benefit is associated with the type of sports practiced during the Olympic career, favoring combined type of effort over very short- or very long-duration effort. In relation to cancer mortality, all types of effort studied were associated with better longevity. Despite their survival advantage, no Olympian in the world, up to date, has ever reached the status of a supercentenarian, as the longest-lived was 106 years old. The common lifespan trends between Olympians and supercentenarians indicate similar mortality pressures over both populations that increase with age, a scenario that is better explained by a biological "barrier" limiting further progression. The supercentenarians' density trends show a current stagnation of the human longevity.

**Keywords:** elite athletes, mortality, physical activity, years-lost, years-saved, human longevity trends, limit, epidemiology