



# The age of the champion as a major determinant of (personalized) performance in different sports disciplines

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**Background:** Personalized medicine involves many putative domains including, but not limited to, gender, age and ethnic origin. The age of the athlete has often been regarded as a limiting factor for a number of sports, particularly sports in which strength, flexibility or endurance capacity required. However, both experience and skill are typically gained after years of practice, so that it is conventionally accepted that older athletes may be more successful in performing sports where these aspects prevail. Since no information has been published so far about the influence of age on success across different sports disciplines, we carried out a statistical study to establish whether any relationship exists between age and excellence in four different sports disciplines such as car racing, cycling, alpine ski and tennis.

**Methods:** The information about the official winners of four among the most popular individual sports disciplines such as car racing [i.e., formula 1 (F1) championship winners], cycling [i.e., Tour de France (TdF) winners], alpine ski (i.e., alpine ski world cup winners), and tennis (i.e., Wimbledon winners) was retrieved from the official databases of F1, Tour de France, International Ski Federation and Wimbledon Championship. The relationship between the age of the Winners and the years was assessed and with Spearman's correlation.

**Results:** The median age of winners of the different sport disciplines in the past 65 years was significantly different, with that of F1 winners [31 years, interquartile range (IQR) 28–34 years] being always greater than that of TdF winners (28 years, IQR 27–30 years), alpine ski world cup winners (25 years, IQR 23–28 years) and Wimbledon winners (24 years, IQR 22–27 years). Interestingly, a rather different trend was noticed when the age of the winners of the different sports disciplines were plotted against time.

**Conclusions:** The results of this analysis attest that the age has represented an important determinant in several sports disciplines in the past 65 years, although the strength of this association has considerably declined in the past decade.

**Keywords:** Sports; age; performance; experience; winners

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## Introduction

Excellence in sports performance is a multifactorial enterprise, which includes demographic and physiological characteristics (1,2), mental toughness, motivation, social and environmental changes, natural selection, advances in training and sport physiology, ergogenic aids, unfair practices (3), as well as by the occurrence the so-called “extreme outliers” among athletes (4). The major demographic determinants of performance vary widely among the different sports disciplines, since endurance, power, or motorized sports require different attitude and inclinations to succeed, coupled with a high degree of specific skills in each specific discipline. In general, excellence in endurance sports such as professional cycling requires a combination of maximal oxygen uptake, power output and efficient recovery (5), excellence in motorized sport requires a combination of fitness level, stress resistance and driving skills (6), excellence in alpine ski requires a combination of efficient use of potential energy, ability to minimize ski-snow friction and aerodynamic drag and skiing skills (7), whereas excellence in tennis requires a combination of maximal oxygen uptake, strength, agility and skill (8).

Among the various demographic determinants, the age of the athlete has often been regarded as a limiting factor for a number of sports. In particular, sports which require strength, flexibility or endurance capacity are seemingly more suited to young athletes, since all these factors gradually decline with ageing. On the other hand, both experience and skill are typically gained after years of practice, so that it is conventionally accepted that older athletes may be more successful in performing sports where these aspects prevail (9). In agreement with this hypothesis, Berthelot *et al.* recently studied the individual careers and world records by age class in athletes of 25 Olympic sports events and grandmaster chess players (10), and reported that mean age of performance peak was 26 years old for track and field and 21 years old for swimming. Interestingly, the age of performance peak of grandmaster chess players was much higher (i.e., 31 years), thus emphasizing the existence of a certain performance gain with ageing in those sports requiring skill and ability.

It was previously found that the effects of athletes' ageing are less consistent among individual sports than in team sports (11). Roman and Fuchslocher also reported that the influence of age varies widely across individual sports in females, and emphasized the need to include age as a main determinant of women's talent (12). Accordingly, age-related

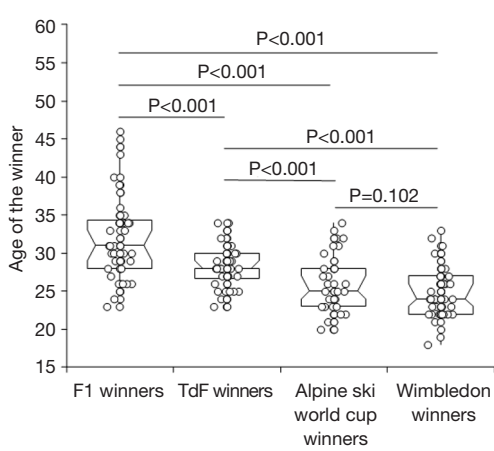
changes in shoulder and scapular strength were evident in elite adolescent tennis players (13). However, since no information has been published so far about the influence of age on success across different sports disciplines, we carried out a statistical study to establish whether any relationship exists between age and excellence in four different sports disciplines such as car racing, cycling, alpine ski and tennis.

## Methods

The information about the official winners of four among the most popular individual sports disciplines such as car racing [i.e., formula 1 (F1) championship winners], cycling [i.e., Tour de France (TdF) winners], alpine ski (i.e., alpine ski world cup winners), and tennis (i.e., Wimbledon winners) was retrieved from the official databases of F1 (14), Tour de France (15), International Ski Federation (16) and Wimbledon Championship (17). These sports were selected because reliable data could be accessed from the official websites, and the information was available on annual basis for not less than 45 years. We arbitrarily decided to limit our analysis to the period 1950–2014, since data before the 1950 was lacking or potentially biased by early period after the World War II. Data of alpine ski world cup winners were only available from 1967, since the first World Cup was only held in that year. The significance of differences was analyzed using a non-parametric approach (i.e., Mann-Whitney U test, whereas the relationship between the age of the Winners and the years was assessed and with Spearman's correlation, using Analyse-it (Analyse-it Software Ltd, Leeds, UK).

## Results

The median age of winners of the different sport disciplines in the past 65 years was significantly different, with that of F1 winners [31 years, interquartile range (IQR) 28–34 years] being always greater than that of TdF winners (28 years, IQR 27–30 years), alpine ski world cup winners (25 years, IQR 23–28 years) and Wimbledon winners (24 years, IQR 22–27 years) (see *Figure 1*). The only difference not reaching statistical significance was that between Alpine World Ski Champions and Wimbledon winners. It is noteworthy that when the analysis was limited to the past 15 years [2000–2014] the median age of the winners of the different sport disciplines became very similar, with that of Wimbledon winners (25 years, IQR, 24–28 years) only remaining significantly lower than



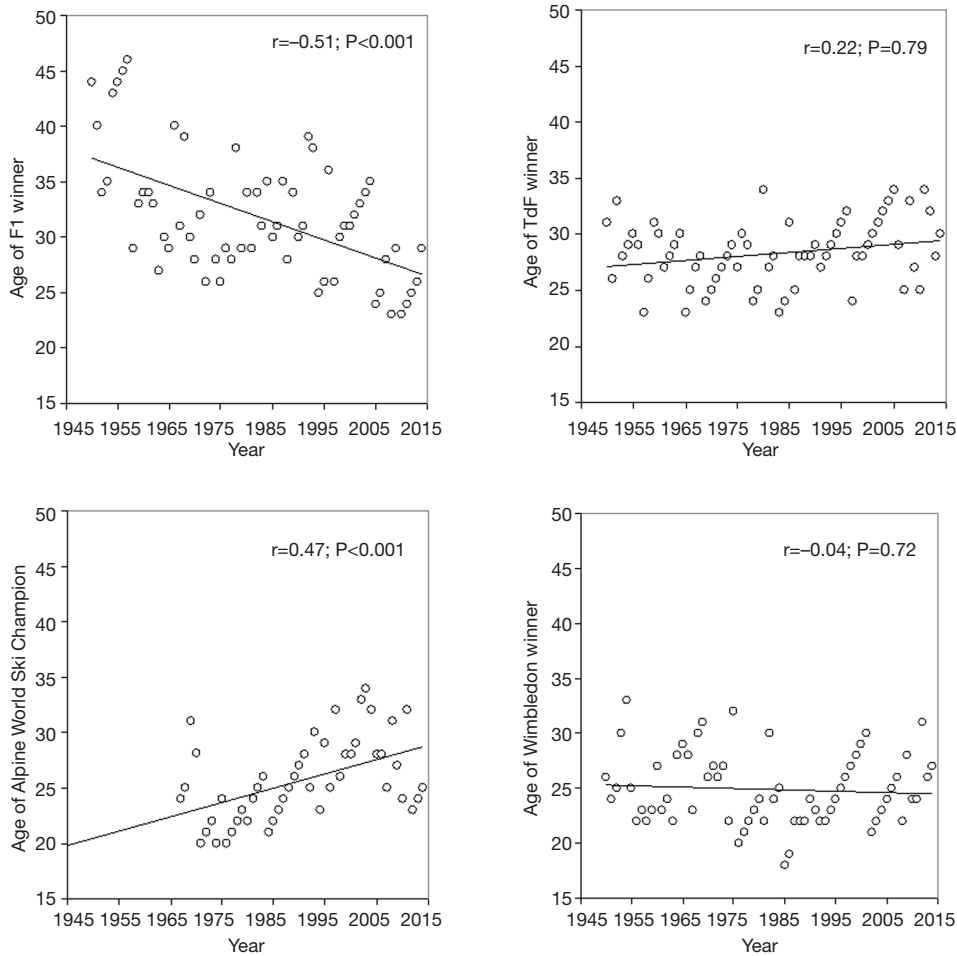
**Figure 1** Median age (and interquartile range) of winners of formula 1 (F1) championship, Tour de France (TdF), alpine ski world cup and Wimbledon in the past 65 years.

that of F1 winners (28 years, IQR 25–32;  $P=0.030$ ), TdF winners (30 years, 29–33 years;  $P<0.001$ ) and alpine ski world cup winners (28 years, IQR 25–32;  $P=0.016$ ).

Interestingly, a rather different trend was noticed when the age of the winners of the different sports disciplines were plotted against time. Specifically, a statistically significant and inverse correlation was found between age of F1 winners and time, a statistically significant and positive correlation was found between alpine ski world cup winners and time, whereas no association was found between the age of TdF or Wimbledon winners and time (see *Figure 2*).

### Discussion

A number of physiological parameters that characterize human capabilities (i.e., endurance capacity, power and



**Figure 2** Spearman's correlation between time and age of winners of formula 1 (F1) championship, Tour de France (TdF), alpine ski world cup and Wimbledon in the past 65 years.

capacity to perform tasks) evolve throughout the lifespan. The physical and intellectual abilities follow a rather similar pattern, although the peak performance is seemingly shifted towards an older age (10). Despite the fact that excellence in sports is influenced by a variety of human and environmental factors, the results of this historical analysis of champions of four individual sport disciplines attest that the age may have played a substantial role in succeeding in sports over the past 65 years. In agreement with previous evidence, the peak performance of sports involving a high physical effort such as cycling, alpine ski and tennis is achieved at a consistently lower age than motor racing, in which skill and experience both play a greater role. Interestingly, however, the gap between F1 and the other disciplines has been greatly reduced in the past 15 years, since the age of the F1 championship winners is now very similar to that of TdF or alpine ski world cup winners. This was mainly attributable to the fact that the age of peak performance has consistently decreased over the past 65 years in F1, whereas that of peak performance in alpine ski has increased. Interestingly, the age of peak performance in TdF or Wimbledon remained fairly stable throughout the past 65 years. Some reasonable explanations can be brought for these findings.

The gradual decrease in the age of peak performance in F1 is probably attributable to the evolution of this sport in the past decades, from a driver-centred discipline, to a sport in which engineering has replaced many drivers' skills. More specifically, the design and set up of the F1 cars are prevalently developed by the factory, so that the balance between skinless required for successful driving and car optimization has gradually moved toward the former parameter (18). The F1 car performance has also remarkably increased over the past 65 years, thus requiring a greater degree of physical fitness to sustain the greater impact of speed and gravitational force (19).

Regarding alpine ski, the progressive increase in the age of peak performance is mainly attributable to the change of materials (i.e., skis sizing) (20) as well as to the greater degree of safety of ski runs that the FIS has gradually introduced. The combination of these aspects has contributed a substantial increase in the mean speed of the leading disciplines (i.e., downhill, super giant slalom, giant slalom and slalom) (21), so that skill and technical abilities are now at least as important as physical fitness.

It is not surprising that the age of peak performance in cycling and tennis has remained virtually unchanged in the past decades, and this is mostly due to the fact that neither

discipline has undergone major changes throughout the last 65 years. Understandably, the original materials of bicycles and tennis racquets has been largely improved with the introduction of carbon fiber, but the skill or physical fitness required to the athletes to produce excellent performance has remained virtually the same.

## Conclusions

In conclusion, the results of this analysis attest that the age has represented an important determinant in several sports disciplines in the past 65 years, although the strength of this association has considerably declined in the past decade. This further strength the needs of focalizing more on a “personalized” approach of science and biology, even in the field of human athletic performance, where this issue has been only scarcely explored so far. It also paves the way to further basic research aimed to identify which biological pathways may be more involved in the age-dependent variation of physical performance.

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## Footnote

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/jlpm.2017.03.03>). Fabian Sanchis-Gomar serves as an unpaid editorial board member of *Journal of Laboratory and Precision Medicine* from December 2016 to November 2018. Giuseppe Lippi serves as the unpaid Editor-in-Chief of *Journal of Laboratory and Precision Medicine* from November 2016 to October 2021. The authors have no other conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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