Correlation between age, nationality and results of elite ski racers between 1982 and 2025

UDC 796.922

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Received by the editorial office on 21.06.2025

Abstract

Objective of the study is to investigate the relationship between the age and nationality of athletes and their performance at various distances in World Cups, World Championships and Olympic Games between 1982 and 2025 in order to identify current trends in the development of the sport.

Methods and structure of the study. Data for the period 1982-2025 was downloaded from the International Ski Federation website and the 'Statistics' section for analysis.

Results and conclusions. Trends have been identified indicating an increase in the average age of prize-winners among men from 1982 to 1999 and among women from 1982 to 1996, which reaches 29-30 years. There is also a forecast for a decrease in this indicator to 26-27 years by 2020, followed by an increase by 2025. The most noticeable changes are observed in middle-distance races for men and long-distance races for women. Until 2022, Russian athletes demonstrated the best results in pursuit races. The obtained research data can be used to improve the training system of ski racers in our country.

Keywords: *ski racing, international competitions, correlation, statistical analysis, nationality, age trends.*

Introduction. Skiing continues to evolve. After sprinting was included in the international competition program in 1996, contact disciplines such as mass starts, pursuit races and skiathlon appeared and continue to change. In recent years, there have been significant changes to the program. In particular, the International Ski Federation has equalized the length of the distances for men and women in the World Cup and World Championships. Next season, in honor of the 20th anniversary of the Tour de Ski, a new race format will be used in the third stage in Toblach (Italy), in which the 20-25 best skiers will compete in separate races over a distance of 5 km. Based on the results of the first race, the next race will be held in a pursuit format [1]. Changes in the sport, the emergence of contact disciplines, and increased speed have led not only to changes in performance factors, but also to a decrease in the peak age of maximum achievements in a long-term retrospective [4]. Studies conducted in 2021 showed that the average peak age was 26.2 years in distance races and 26.0 in sprints. In addition, Norwegian researchers have found a trend towards a decrease in the peak age of athletes born in later years, which could be related to earlier specialization, changes in training or selection criteria.

Other studies have shown that the age of peak performance is positively related to the length of distance in endurance sports [2]. At the same time, there is a lack of research in the field of cross-country skiing that uses data analysis to identify current trends in the sport, areas for development and improvements to the training system.

Objective of the study is to investigate the relationship between the age and nationality of athletes and their performance at various distances in World Cups, World Championships and Olympic Games between 1982 and 2025 in order to identify current trends in the development of the sport.

Methods and structure of the study. The data for analysis was downloaded from the International

Ski and Snowboard Federation website [1], then using the RStudio development environment and the Rvest library, data for the available years – from 1982 to 2025 – was downloaded. The correlationfunnel library [3] was used to binarise the variables, which made it possible to analyze both numerical (age) and categorical (nationality) variables. Next, to identify and visualize trends, the correlation coefficient was calculated for the variable reflecting the top three finishers (1 or 0) and the variables reflecting the nationality and age of the skier at the time of the competition. Pearson's correlation coefficient was used, and only correlations significant at the 0.05 level are presented in the article.

Results of the study and discussion. The performance of athletes of different nationalities in FIS international competitions between 1982 and 2025 in races of various lengths and formats was analyzed. In accordance with the data in the protocols, sprints, middle distances (5-20 km for men, 5-15 km for women), long distances (30-50 km for men and 20-50 km for women) and a separate category of pursuit races were identified.

It was found that in long-distance races for men in different years, athletes from the USA, Canada, Russia, Switzerland, Germany and Norway dominated (Fig. 1). In women's races, significantly fewer statistically significant correlations were found during the study period, and only Norwegian athletes had a decisive advantage in long distances in different years.

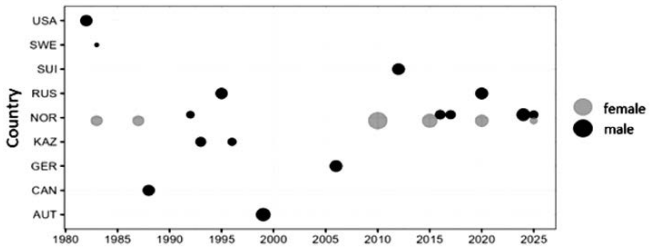

Fig. 1. Correlation between the number of prize places in long-distance events and nationality among men and women

In middle-distance races (Fig. 2), on the contrary, more significant correlations were found among women, showing periods of clear superiority of national teams in different periods. In some cases, this dominance was achieved through the performance of a single athlete, while in others it demonstrated the superiority of the entire team.

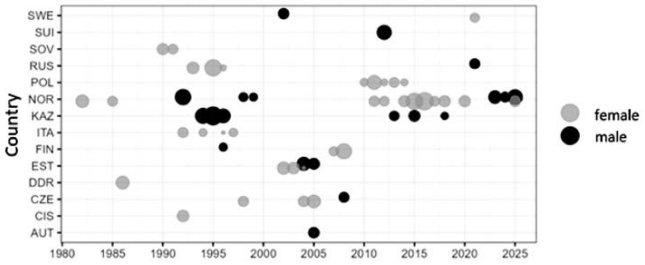

Fig. 2. Correlation between the number of prize places in middle-distance events and nationality among men and women

It should be noted that, despite the successful performances of Alexander Bolshunov and other Russian skiers over the past decade, the Russian men's team only dominated the middle distances in 2021. In sprint races, representatives from a smaller number of countries had a clear advantage during the competitive seasons for both men and women (Fig. 3).

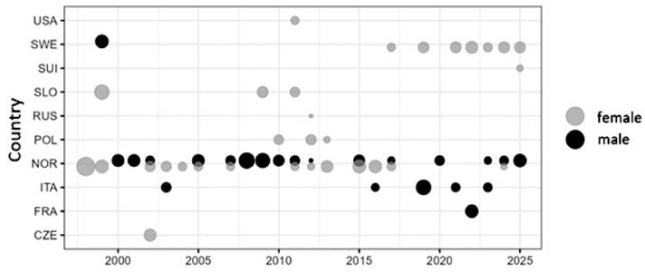

Fig. 3. Correlation between the number of prize places in sprinting and nationality among men and women

Over the years, only the Swedes, Italians and French have been able to pose serious competition to the Norwegians. In the women's group, there is a clear period of Norwegian dominance, which ends in 2017 when Swedish skiers take the lead.

Thus, the analysis revealed periods of dominance by representatives of different countries in ski races of various formats and lengths. The predictable advantage of Norwegian athletes is most pronounced in the men's sprint and women's long-distance races. Russian athletes competed most successfully in pursuit races. After the Russian team was suspended, the Norwegians' advantage increased in all types of races, indicating a real decline in competition on the world stage, despite the fact that the chances of small teams getting into the lead increased.

To assess age trends in cross-country skiing, the average age of medalists in each type of competition from 1982 to 2025 was determined (Fig. 4). Fig. 4 shows that the average age of medalists in men's distance races increased from 25 in 1985 to 30 in 1999, stabilized at approximately this level, and then showed a slight downward trend until 2021. When sprinting first appeared, both young and older athletes became winners in this discipline, but until 2018, sprinters were, as a rule, younger on average than distance runners.

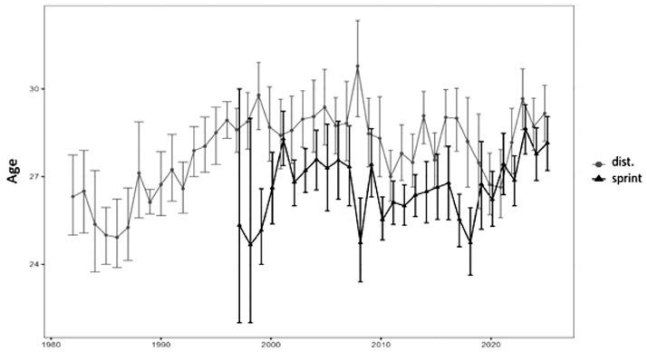

Fig. 4. Average age of male winners of international cross-country skiing competitions (confidence intervals) in distance races (5, 10, 15, 30, 50 km) and in sprints

In women's competitions, there was also an increase in the average age of winners before the advent of sprint races, and some stabilisation of this indicator in long-distance races until 2006. Interestingly, in recent years, there has been another increase in the average age of competition leaders for both men and women in short and long distances. This is probably due to the ageing of individual athletes, and at some point, as a result of generational change, there will be another decline in age indicators, but it should be noted that there is no 'rejuvenation' of the sport.

Conclusions. Analysis of data from international cross-country skiing competitions over the past 43 years has revealed trends in the age of medalists and visualized the relationship between nationality and age with medal positions in races of various formats and lengths.

It was determined that Russian athletes performed best in pursuit races, while Norwegians have had an overwhelming advantage in men's sprints and women's long-distance races for many years. In recent years, competition in cross-country skiing has declined, and the advantage of Norwegian skiers is undeniable in all disciplines.

There is also a trend towards an increase in the average age of male winners (between 1982 and 1999) and female winners (between 1982 and 1996) to 29-30 years, a slight decrease in this indicator by 2020, and a subsequent increase by 2025.

The results of the study can be used to improve the training system for cross-country skiers in our country. The lack of 'rejuvenation' in the sport, including in sprint disciplines, should encourage a focus on long-term planning, retaining talented athletes, and counteracting the forcing of sports training at an early age.

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