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Road cycling and safety in Italy

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Abstract

Background. Bicycles are key elements for local micromobility and sport activity. Several western countries have a long tradition of cycling sport activity, and they must face road safety issues.

Objective. The present study has investigated the safety of competitive road cyclists in Italy, focusing on a seven-year period, comprising the COVID-19 pandemic event.

Material and methods. An anonymous dataset containing 5754 injury events involving competitive athletes (Italian Cycling Federation, FCI) in the period 2017-2023 has been statistically analysed. Starting from public data (National Institute of Statistics) the mortality of FCI athletes has been compared to that of non-FCI cyclists.

Results. In the years from 2017 to 2023 the dataset presented 36 deaths of FCI athletes (7 during races, 29 during training sessions, belonging to the categories "Juniores", "Under 23", "Elite" and "Master"). No deaths involved athletes under 16 years old. Young athletes were characterized by a reduced rate of injuries when compared to Elite and Master cyclists. The data described an inverse correlation between the value of inhabitants per square km and the number of normalized injuries. Mortality of FCI athletes was lower than non-FCI cyclists, especially after the COVID-19 pandemic ($p<0.01$).

Discussion and Conclusions. The presented data showed a safer condition for younger FCI athletes when compared to Elite athletes. The comparison with general population using the bicycle for personal mobility is more complex, but some interesting data show a reduced mortality rate in FCI athletes. It is possible to speculate that specific training of FCI athletes and the regular adoption of protective equipment can play a role in reducing mortality: additional studies are required to clarify this aspect.

Introduction

The bicycle is a widely used economical vehicle. Its use dates to the final part of the industrial revolution, that triggered an intense society reshaping through the availability of new mechanical solutions. It was at the end of the XIX century, that a comfortable bicycle became largely appreciated by the population as a new personal means of transport (1). In the same period, due to the evolution of modern sport as a component of contemporary society, cycling competitions were organized around Europe. These events were supported by newspapers and bicycle industries. Road cycling obtained high

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visibility with the creations of Tour de France (1903) and Giro d'Italia (1909), two large stage races that involved cyclists from different nations (2).

The popularity of cycling was linked to the widespread use of bicycles among the population. At the beginning of the XX century the bicycle was an important element of European mobility but in the same period car industries were leading the modification of urban transport with motor vehicles (3). In a few decades towns were redesigned for cars mobility, and highways were planned for long distance mobility. Nevertheless, cycling activity survived as a local micromobility and sport activity. But the coexistence of such different vehicles imposed new strategic changes in urban environments. Several European cities, such as Amsterdam and Copenhagen, made large efforts in improving bicycle mobility through the building of cycle paths and cycle lanes (4). Unfortunately, the creation of these specific pathways was not uniform through the different countries, with strong differences between towns. As reported in the recent Clean Cities Campaign / Transport & Environment report (2022) the ratio between the km of cycle lanes and number of habitants in Europe is highly variable, ranging from 20.2 km/10K habitants in Gant (Belgium) to 0.3 km/10K habitants in Naples (Italy)(5). Important European capital towns, such as Rome, Paris, London, Warsaw are characterized by a reduced availability of cycle lanes. These differences are present also between towns of the same country: in Italy the largest networks of cycle paths are generally present in medium small town located in the north of the country, with Mantua that in 2020 was characterized by 23.4 km/10K habitants.

The creation of specific paths has been considered crucial but not enough to support a safe bicycle mobility: it is important also to increase safety culture in cyclists and car drivers to guarantee a clean interaction between the two different vehicles (6,7). Cultural changes require time and specific educational programs. Many examples of educational interventions on cycling safety for children can be found all around the world, but it is not easy to understand if they are efficacious (8). Ideally, an educational program should focus on both the development of motor–tactical skills and safety motives (9). These key elements are already part of the teaching programs of cycling schools that support the development of agonist cyclists: epidemiological considerations should be useful for an evaluation of their effectiveness in reducing injuries. At the moment, the majority of safety reports, do not investigate the role of training on cycling, neither the past experience in competitive cycling activity. For example, the recent European Road Safety Observatory reported cyclist fatalities considering age/gender of cyclists, period and location for the injuries, but without considering the cycling experience (10). In addition, cyclist fatalities are generally reported per million inhabitants, without an accurate estimation of which percentage of mobility is performed with bicycle and how many km are travelled. This limit is mainly due to the fact that no national bicycle registers have been implemented in the different countries, and generally cyclists are not required by law to have cycling insurance that compensate (and record) for damages. All these limits can be partly overcome by performing statistical analysis on injuries of cyclists registered with sports federations and combining the results with national mobility data.

Starting from these considerations, the present study has investigated the safety of competitive road cyclists through a statistical descriptive analysis of injuries databases from the Italian Cycling Federation (FCI, Federazione Ciclistica Italiana). The study was focused on a seven-year period, comprising the COVID-19 pandemic event, and including

a comparison between competitive athletes and general population using the bicycle as a means of transport on Italian roads.

Material and methods

Every year the FCI guarantees a series of insurance coverages and services for its members and affiliates (athletes, mechanics, managers, technicians,...). These services do not only concern accidents but also liability towards third parties and legal protection. It was possible to obtain the list of all services provided from insurance companies in the period 2017-2023: these data are protected and are not openly available due to data privacy laws. Authors analysed the data respecting the anonymity of FCI members. The processed anonymous data set (limited to the interest of the study) is, however, available from the authors upon reasonable request. The interest of the study was limited to the accidents involving competitive athletes, including also under 13 athletes (U13, alias "giovanissimi", a category for children approaching competitive sport and under training for the required skills), and for this reason the historical reports of insurance interventions were ordered to identify the events occurred to FCI members of the following categories: U13 ("giovanissimi", under 13); 13-14Y ("esordienti", 13-14 years old); 15-16Y ("allievi",15-16 years old); JUN ("Juniores", 17-18 years old); U23 ("Under 23", 19-22 years old); ELT ("Elite", over 23 for males or over 19 for women); MST ("Master", over 30 or over the end of "Elite" category).

The dataset obtained, created anonymously, was the starting point of the statistical analyses and consisted of 5754 items covering the period 2017-2023. Every item of the dataset was characterized by the following information: date, athlete's category, activity (training or race), type of damage (injury or death). Limited to the year 2023, the insurance company was able to report in a separated list all the towns where injuries occurred. This information was used to relate the events to the demographic density of the different Italian regions obtained from ISTAT, National Institute of Statistics: the events occurred outside Italian territories or not clearly localized were not considered in the analysis.

The anonymous format of the dataset was in accordance with National Privacy Law and European Privacy Regulation, and did not required ethical committee approval for its usage in statistical analysis (11). The total number of FCI athletes for each year was used for data normalization.

The statistical analysis has been performed using percentage values for qualitative variables, average values and standard deviation for quantitative variables. The Student's T Test was used to compare categorical variables between different database subsets.

The mortality data of FCI members were compared with mortality data of non-FCI members obtained from national mobility reports. In the comparison, the deaths occurred during racing competitions were not considered due to big differences in traffic if referred to the usual driving conditions on the streets (closed roads and non-applicability of the normal traffic code). The number of cyclist deaths on Italian streets was obtained from ISTAT, National Institute of Statistics (Istat. Incidenti stradali www.istat.it) while the estimated number of cyclists on Italian streets (estimation of the number of regular users of bicycle as means of transport) was obtained from ISFORT (ISFORT Rapporto sulla mobilità degli italiani, www.isfort.it).

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Results

Injuries of FCI athletes

In the years from 2017 to 2023 a total of athletes 445582 were affiliated to FCI for the seven categories considered for this study, with the preponderance (60%) of MST category (Fig. 1).

The injuries normalized for the number of athletes of each category showed that the category ELT has the highest prevalence of injuries (10.4 %), while the U13 category showed the lowest value (0.61 %) (Fig. 2).

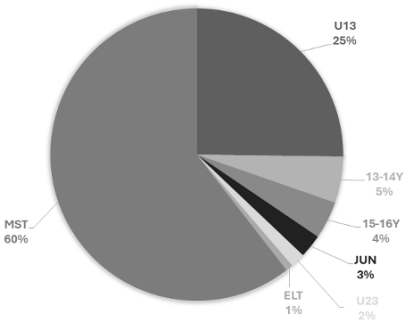

FIG.1. Subdivision of affiliates athletes (year 2017-2023) per

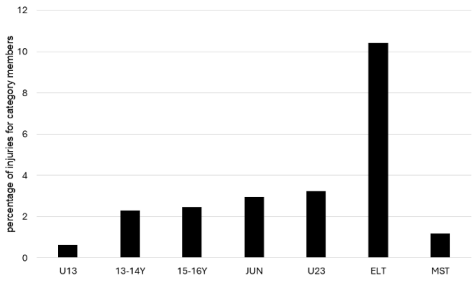

FIG. 2. Injuries normalized for the number of athletes of each category in years 2017-2023: values in percentage.

The distribution of injuries in the different years remained stable in the considered period, with the only exception of year 2020, characterized by a strong reduction of injuries but still with the prevalence of "Elite" category (Fig. 3).

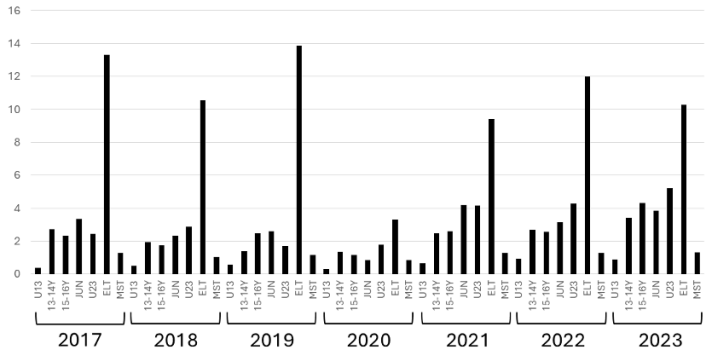

FIG. 3. Annual prevalence injuries in the different athletes' categories: values in percentage.

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Limited to the year 2023 it was possible to localize 985 injuries for the seven categories considered for this study. The raw data showed that the region with the highest number of events was Lombardia. After normalization for the number of FCI affiliates cyclists, Umbria region showed the highest prevalence of injuries and Campania the lowest (Tab. 1).

The value of normalized injuries has been compared with the population density of each region. Figure 4 shows an inverse correlation between the value of inhabitants per square km and the number of normalized injuries: regions with high population density (like Lombardia) were characterized by a lower value of normalized injuries compared to low population density regions (eg Umbria, Trentino Alto Adige and Valle d'Aosta).

Deaths among FCI athletes

In the years from 2017 to 2023 the total number of deaths was 36 (7 during races, 29 during training sessions) and involved the categories "Juniores", "Under 23", "Elite" and "Master". Figure 5 represents the mortality in percentage, normalized for the total number of athletes of each category in the period 2017-2023: the "Elite" category reported the highest value.

Starting from demographic and statistical data for the Italian population it has been possible to compare the mortality of FCI athletes with the mortality of non-FCI cyclists (general population using the bicycle for personal mobility). The aim of the comparison was to understand if in similar conditions an FCI athlete was safer in national roads than a non-FCI cyclist. Considering that during a race the driving conditions are different from those faced by general population in normal viability, the comparison considered only the 29 deaths of FCI athletes occurred during training sessions. Figure 6 shows mortality normalized for the number of affiliates athletes (FCI) or for the estimated number of cyclists on Italian streets (non-FCI).

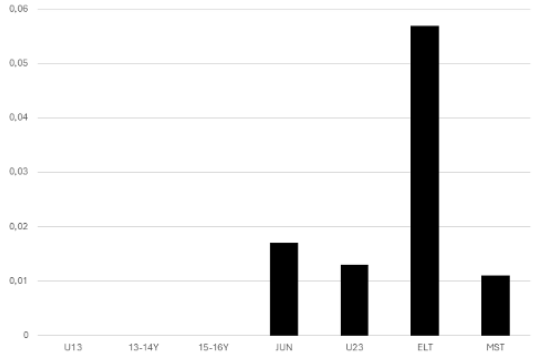

FIG. 5. Normalized mortality (years 2017-2023) for categories U13, 13-14Y 15-16Y, JUN, U23, ELT, MST: values in percentage.

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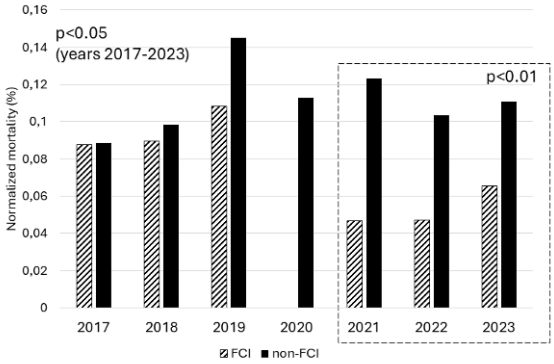

FIG. 6. Comparison between normalized mortality (years 2017-2023) for FCI athletes (excluding race events) and general Italian population using the bicycle for personal mobility (non-FCI): values in percentage. The dotted box shows the period after the COVID-19 lockdown

For the years 2017-2023, the average normalized mortality of FCI members (not in race) was lower than those of not normalized cyclists (non-FCI). At the same time, after the COVID-19 lockdown the difference between the two series become stronger, with a $p<0.01$ for the years 2021-2023.

Discussion

The data analysed in the present paper described safety condition for cyclists on Italian roads in the period between years 2017 and 2023. As far as the authors know, this is the longest (7 years) continuous epidemiological study on cyclists registered with national sport federations. In addition, a comparison with national demographic and statistical data was performed in order to investigate differences between competitive athletes and generic users of the bicycle, like workers or students moving for everyday life activities and not involved in official sport trainings. The comparison with general population posed some technical questions due to the absence of an official registry of cycling mobility on Italian roads. The adoption of data presented in the annual national mobility reports (collected through survey interviews to a randomized sample of the population) allowed authors to overcome the limit. Unfortunately, it was not possible to completely exclude the presence of cyclists with competitive experience (and no longer affiliated with the FCI) among the general population. Nonetheless, it seems unlikely that very active and experienced cyclists were not affiliated with federal structures, even considering the insurance advantages.

It is worth remembering that the period considered for the present study included the COVID-19 pandemic, that was considered an epochal event, impacting totally the human society, with short- and long-term effects not yet completely understood (12). Italy was the first country in the western world to be affected by the COVID-19 pandemic and immediately enacted different strategies and policies to limit the spread of the SARS-CoV-2 virus (13). Mobility and sport activity were modified in year 2020. Cycling activity was considered a safe mode for personal mobility, and outdoor training for athletes was rapidly allowed. In addition, the government supported the purchase of bicycles, and, as happened in other countries, quickly many shops ran out of supplies (14). New bike lanes were planned together with the adjustment of speed limits, with many towns that created

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the 30 km/h car speed limit zones (15). In general, the pandemic event supported personal mobility with the bicycle (rather than the car) as a key element. But three years after the emergency is crucial to investigate which kind of legacy has been obtained by population.

The data collected from FCI showed that the competitive category with highest prevalence of injuries was the "Elite". The data have been normalized for the number of athletes in the category, but it is important to consider that each category is characterized by different values of activity, with the "Elite" cyclists that can cover in a year more than 30,000 km, a distance three times higher than active amateur cyclists, and many times the regular activity of young athletes (16). Unfortunately, the exact value of activity of each category is unknown. Despite this limitation, the data clearly showed stable low levels of injuries in young athletes all over the period. This is even more evident when considering mortality values: in the period 2017-2023 no deaths were reported for U13, 13-14Y, 15-16Y categories. This is probably the result of safety procedures regularly implemented by cycling societies in line with FCI indications, but also differences in the training intensity can explain these differences. In general, young cyclists are trained together with an expert coach, and in many situation they are followed by a service car (flagship). In addition, the youngest athletes have to perform specific exercises to improve riding skills and perceptions of safety, together with continuos check by the coach of road safety and vehicle rules compliance.

The inverse correlation between normalized injuries (year 2023) and population density underlined that injuries are less frequent in Italian regions with high concentration of inhabitants. This datum is probably linked on behavioural adaptations of cyclists and car drivers to high traffic conditions, enhancing risk perception and prudent driving. This phenomenon, called "safety in density", has been described for increased local cyclist spatial density, but additional data for generic traffic conditions are required (17).

Despite the limitations already mentioned, the comparison between FCI athletes and generic cyclists underlined interesting differences. The analysis of normalized mortality showed a safer situation for FCI athletes than general Italian population using the bicycle for personal mobility. Considering that athletes ride their bikes much more than non-athletes, the difference with generic cyclists should have been even more evident if it could be possible to normalize deaths for distance travelled.

It is interesting to consider the effect of pandemic period on cyclists' safety: after the year 2020, normalized mortality of general cyclists was clearly higher than that of FCI athletes. The comprehension of this result is not easy, considering that many effects of the pandemic event on society have not been still fully understood. A recent case study showed some negative effects on cycling safety after COVID-19 pandemic, but without distinguishing between athletes and non-athletes (18). In addition, many new cyclists were people with low individuals' cycling frequency levels before the lockdown and that strongly changed their habits (19). It is possible to speculate that, after COVID-19 pandemic lockdown, there has been an increase in general cyclists, without the implementation of specific training in road safety or on driving skills (20). On the contrary, FCI cyclists continued their specific training, also testing new protocols for the lockdown period, and their mortality remained lower than non-FCI cyclists (21).

On the other hand, the importance of specific training courses as a tool for improving cycling skills has been underlined by some studies (22,23). After the pandemic the need

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for specific training on cycling safety (especially for children and youth) has been clearly underlined, supporting also the adoption of protective helmets and other safety equipment (24). A strong interaction between FCI cycling teams and schools could be useful for the development of cycling skills and safety perception in the general population, supporting a bicycle-based mobility.

Conclusions

The safety of athletes is a key element for all FCI affiliates. Despite the intense activity, FCI athletes showed reduced mortality when compared to non-FCI cyclists. It is always difficult to compare epidemiological data from different databases. Some confounding factors, like exposure time, riding environment, socioeconomic status, road infrastructure, should be better evaluated in future studies. However, the presented data show a positive situation for Italian road cyclists. In particular, high safe conditions emerged from the analysis of young FCI categories. The teaching of advanced riding techniques and the promotion of a safe behaviour (typical activities of youth cycling teams) have been already associated with a smaller number of cycling accidents (9). This finding provides a potential explanation for the observed data. The enhancement of cycling education programs, particularly regarding safety, could be facilitated by strengthening the interaction between school and youth cycling teams. The promotion of active and safe local mobility should be pivotal strategy to support sustainability and a correct lifestyle.

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