Accidents Analysis Across Italy

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1 Introduction

This Report presents a set of main statistical findings and analysis in relation to indicators concerning accidents at work across Italy, the statistics presented in this report have been conducted using the software R, the data which represents Six-monthly incidents grouped by "region", and the data concerning the number of employers are collected from INAIL website. First step, data is collected by region from INAIL website and then it is merged into one dataset. Second step a package is created in R to contain the dataset (`accidentr`).

The dataset about incidents contains 25 variables and 3052056 observations, and the variables are grouped into 7 types as the following:

A - temporal location of the injury:

1. detection date: it is the date of extraction of the data (recorded and validated) from the archives; temporally qualifies the information base;
2. protocol date (of the case): it is the protocol date of the case;
3. date of occurrence: is the date on which the accident occurred;
4. date of definition: is the date of the prevailing administrative definition;
5. date of death: is the date of death of the injured party following an accident;

B - geographical location of the accident:

6. place of occurrence: is the ISTAT code of the province where the accident occurred;

C - characteristics of the injured person:

7. identification of the injured person: internal code (for longitudinal analysis);
8. gender: is the gender of the injured person;
9. age: the age of the injured party on the `date of occurrence`, expressed in years of age;
10. place of birth: cadastral code of the injured party's place of birth;

D - method of injury:

E - administrative characteristics of the injury:

F - medico-legal characteristics of the accident:

G - characteristics of the employer:

An accident at work is defined as a discrete occurrence during the course of work which leads to physical or mental harm. Fatal accidents at work are those that lead to the death of the victim

11. modality of occurrence: code of the modality (if `during work`, `in itinere`);
12. with / without means of transport (involved): mode code (if `with` or `without`);

13. case identifier: internal code (for longitudinal analyzes);
14. administrative definition: code that characterizes the administrative situation of the accident case (if `positive` or `negative`) or the `exempt` outcome or the `preliminary investigation` situation;
15. administrative definition of the fatal outcome: code that characterizes the administrative situation of the case of an accident with a fatal outcome (if `positive` or `negative`) or the situation `in investigation`;
16. indemnity: code of the type of indemnity (if `temporary`, `capital`, `direct annuity`, `survivors' annuity`);
17. cause of negativity for the fatal outcome: code of the cause for which the case of an accident with a fatal outcome is defined as negative (if "activity not protected", for "lack of valid documentation", if for "lack of itinere", for" lack of condition during work ", if for" fatal outcome not attributable to the event ", if" unprotected person ", if for" other causes of negativity ");

18. degree of impairment: overall degree of impairment of the psychophysical integrity of the injured person;
19. days indemnified: number of days indemnified;

20. employer: internal identification code of the employer (for longitudinal analyzes);
21. territorial insurance position: internal code;
22. sector of economic activity: this is the primary ATECO code of the insurer;
23. management: if `agriculture`, `industry and services`, `on behalf of the state`;
24. tariff management: if `industry`, `crafts`, `tertiary`, `other activities`;
25. large tariff group: code of the large tariff group (whether `agricultural processing and food`,`chemical, paper and leather`, `construction and plant`, `energy and communications`, `wood and similar`, `metals and machinery`;`rock and glass mining`,`textiles and packaging`, `transport and warehouses`,`other activities`).

within one year of the accident taking place. Non-fatal accidents at work are defined as those that result at least four full calendar days of absence from work (they are sometimes also called 'serious accidents at work'). Non-fatal accidents at work may result in a considerable number of working days being lost and often involve considerable harm for the workers concerned and their families. They have the potential to force people, for example, to live with a permanent disability, to leave the labour market, or to change job.

The rest of the report is organized in the following, section two is the discussion of the number of accidents, section three is containing incidence index, section four analyses of impairment, indemnity, indemnified days and to the definition of total and permanent disability according to the degree of impairment.

Required Libraries

- library(accidentr)
- library(ggplot2)
- library(plotly)
- library(dplyr)
- library(scales)
- library(tidyr)
- library(treemapify)
- library(reactable)
- library(ltm)
- library(readxl)
- library(rnaturalearth)
- library(mapview)
- library(tmap)

2 Number of accidents

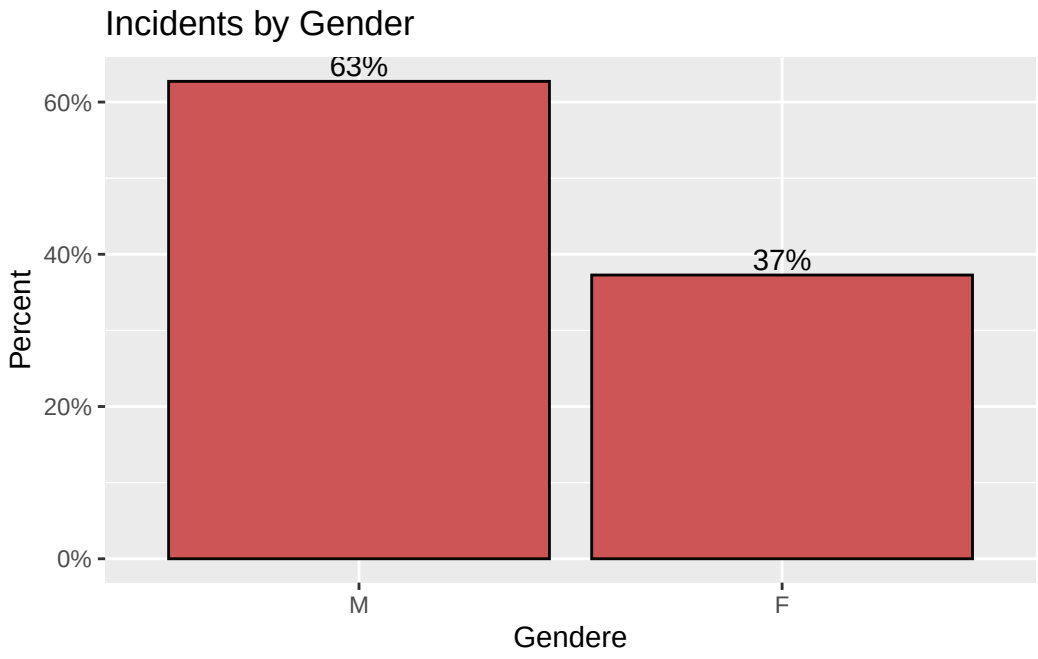
2.1 Number of incidents by years

Years	Female Incidects	Male Incidents	Total of Incident
2017	231865	411203	643068
2018	228571	411161	639732
2019	229569	410680	640249
2020	243448	325233	568681
2021	204278	356048	560326

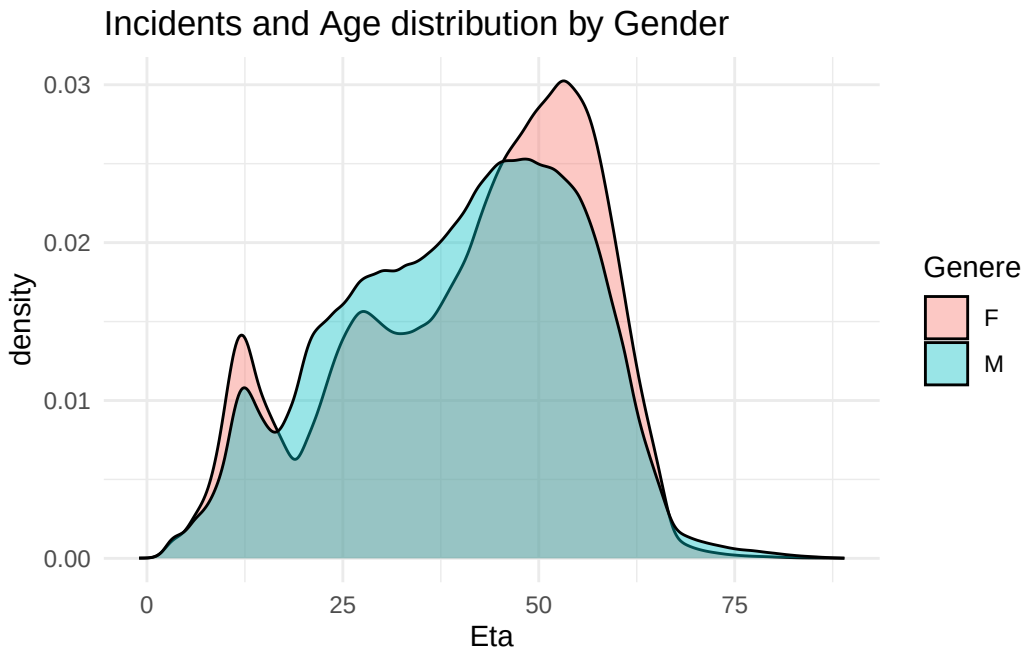
Figure 1: Number of accidents (Male & Female)

In 2017, there were 643.1 thousand accidents at work across all Italy, which is the highest number of accidents with respect to the other years while 2021 has the lowest number of accidents. Overall, there were a decrease of -12.87 in the total number of accidents at work between 2017 and 2021. However, men were considerably more likely than women to have an accident at work. In 2021 more than two out of every three (63.5 %) of accidents at work in Italy involved men. Factors that influence these statistics are: the proportion of men and women who are in employment; the different types of work that men and women carry out; the activities in which they work. For example, there are far more accidents in the demolition and preparation of the building site, manufacturing or construction sectors, which tend to be male-dominated.

The figure below confirms that the number of incidents among male population is about two out of every three (63 %) with respect to incidents among the female population.



2.2 Age distribution



From the figure above, we can see that injuries among female workers is at the highest rate around the ages 30, 40 and 50, while the age with most frequent injuries among male workers is around the ages 40, 50 and 60. However, at ages from 20 -30 the frequency of injuries for the female workers is higher than male, while at the ages lower than 20 the injuries rate is higher among male workers with respect to female workers. For ages greater than 40 till 60 the injuries is higher for male compared to female.

2.3 Number of incidents by months

The figure illustrates the indices of accidents during the different years (2017 - 2021) for all months, analysing the years 2017 - 2019 we can see that the number of incidents at work follows more or less the same pattern during the months. The pattern shows three peeks; around March, May and October. The lowest number of incidents is registered in August, we observe as well that months with lower frequency of incidents are January, April and December. However, for the years 2020 - 2021 `the years of pandemic` we observe different behavior of the frequency of incidents at work with respect to the years 2017 - 2019. For the year 2020, May has the lowest number of incidents (30368) while November has the highest frequency of incidents (72483) compared to all years. In 2021, we see that the frequency of incidents follow the pattern of the years 2017 - 2019 but with considerably lower frequency of incidents.

Month	NameMonth	2017	2018	2019	2020	2021
01	Jan	53258	50569	53825	51899	48111
02	Feb	52040	51532	52264	51077	42470
03	Mar	62724	57007	57926	50232	44772
04	Apr	47456	51765	50018	32046	42680
05	May	63075	63475	60091	30358	47712
06	Jun	54823	53668	53423	35486	45239

Month	NameMonth	2017	2018	2019	2020	2021
06	Jun	54823	53668	53423	35486	45239
07	Jul	51436	53110	53175	42785	46122
08	Aug	40138	39355	37843	33300	35152
09	Sep	51698	52767	52877	44544	47683
10	Oct	61259	63083	64412	67168	52659
11	Nov	58799	57081	56953	72483	53978
12	Dec	46362	46320	47442	57303	53748

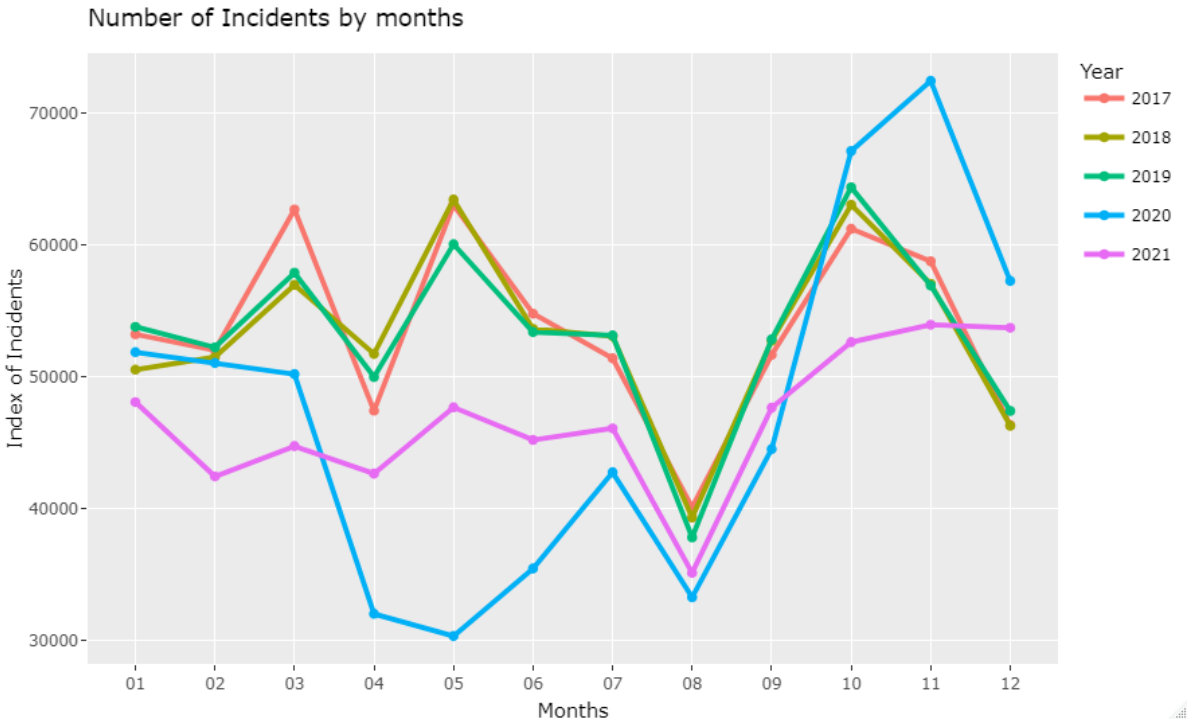


Figure 2: Number of accidents by months

2.4 Analysis of fetal incidents

2.4.1 Number of fetal incidents by economic activity and gender

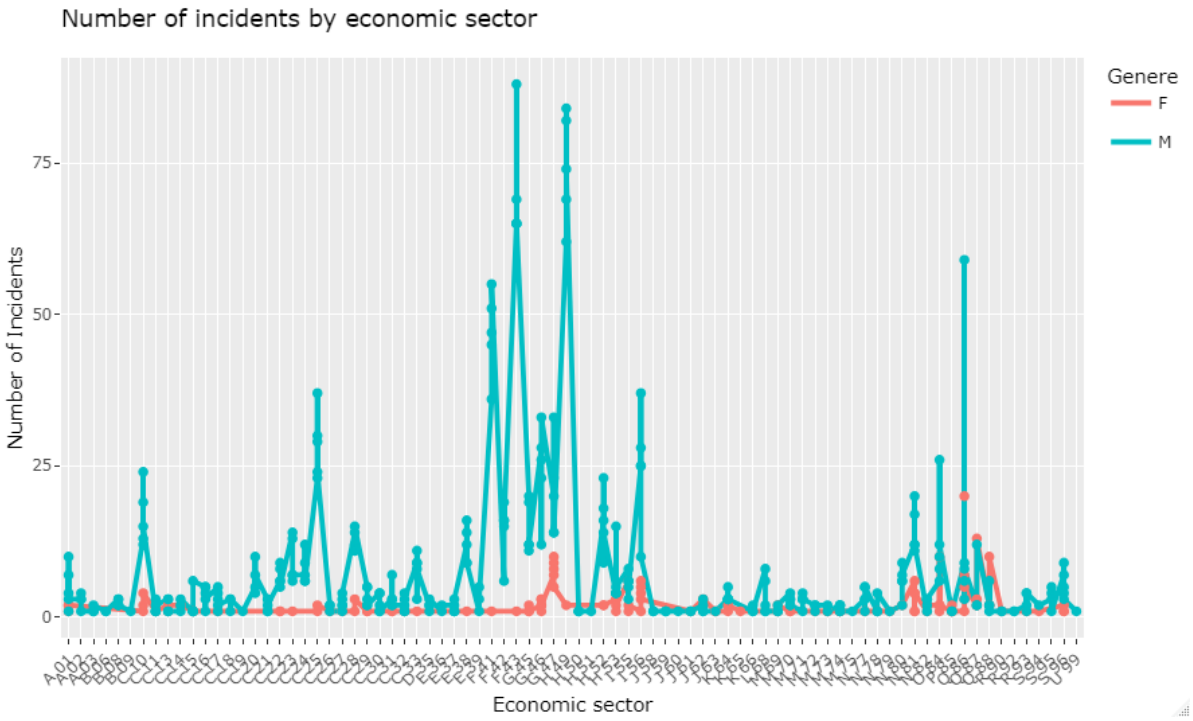


Figure 3: Number of accidents by gender

The figure above shows information about the proportion of men and women who are in employment and the different types of work that male and female carry out.

2.4.2 Number of fetal incidents by economic activity

The figure below presents the number of fatal accidents according to the economic activity between the year 2017 and 2021. Within the economic sector,`F43` Demolition and preparation of the building site, `H49` Line transport and pipeline transport, `F41` Construction of buildings, `I56` Restaurant service activities and `C25` Manufacture of metal products (except machinery and equipment) sectors are considered to be the sectors with greatly high frequency of accidents for the past years. In 2020, `Q86` Health care witnessed a boom in the frequency of accidents and this number is influenced by the pandemic period `Covid 19`.

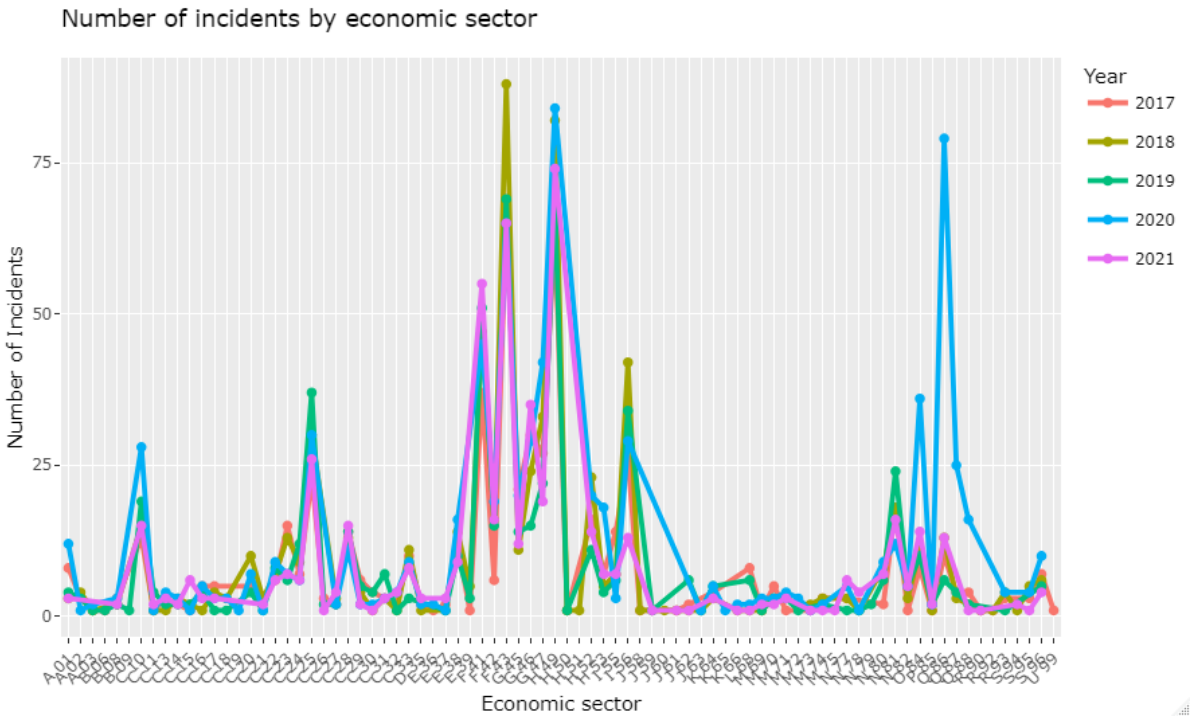


Figure 4: Number of fetal incidents by economic activity

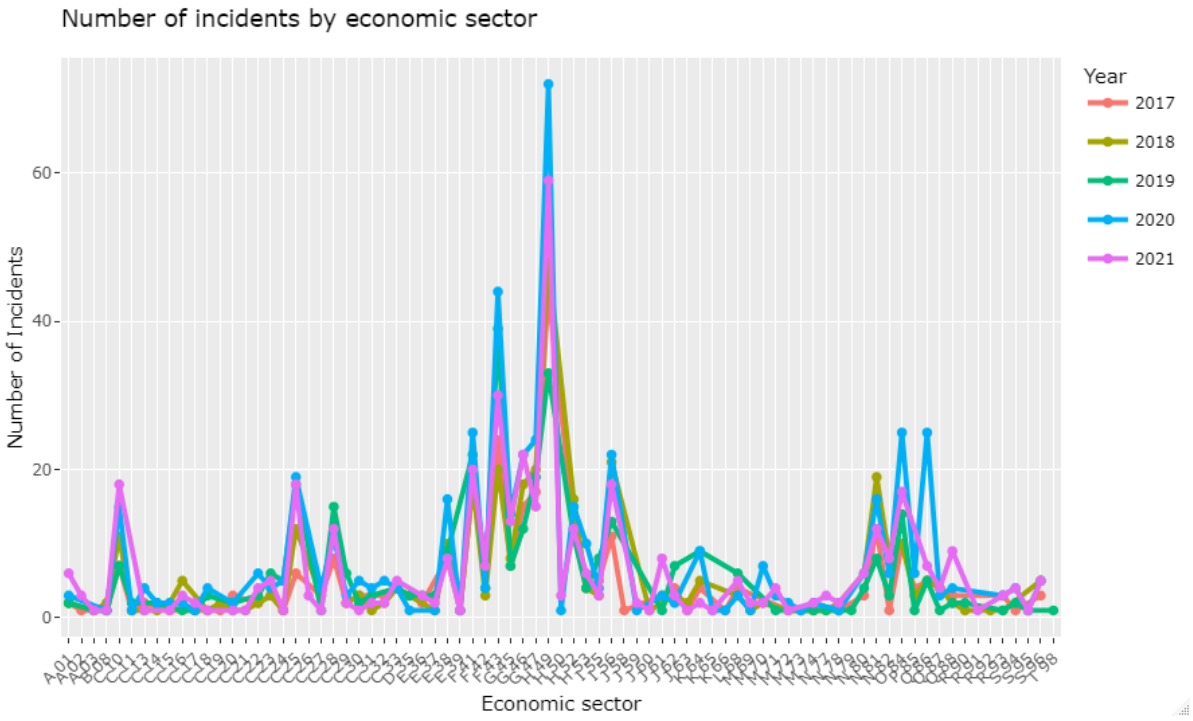


Figure 5: Number of non-fetal incidents by economic activity

2.4.3 Number of Non-Fetal incidents by economic activity

The figure above illustrates the number of Non-fatal accidents according to the economic activity between the year 2017 and 2021. Within the economic sector, `H49` Line transport and pipeline transport,`F43` Demolition and preparation of the building site, `F41` Construction of buildings, `I56` Restaurant service activities and `C25` Manufacture of metal products (except machinery and equipment) sectors are considered to be the sectors with greatly high frequency of accidents for the past years. In 2020, `Q86` Health care and witnessed aN INCREASE in the frequency of accidents and this number is influenced by the pandemic period `Covid 19`.

2.4.4 Number of fetal incidents by gender

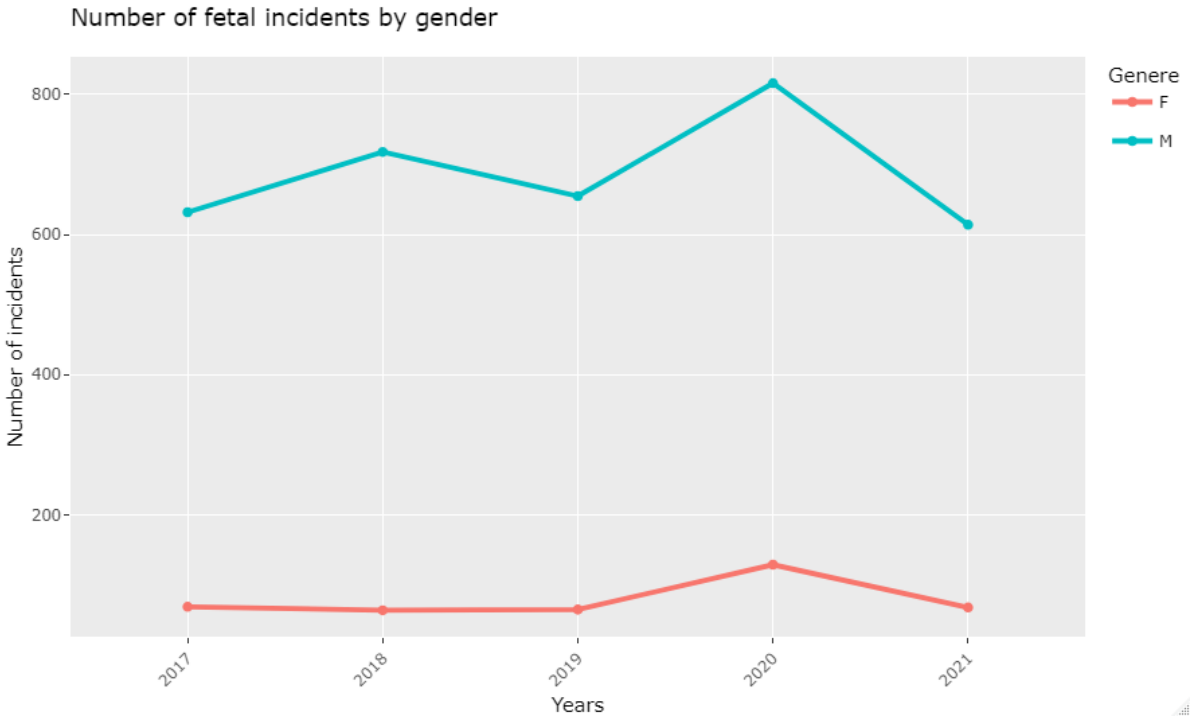


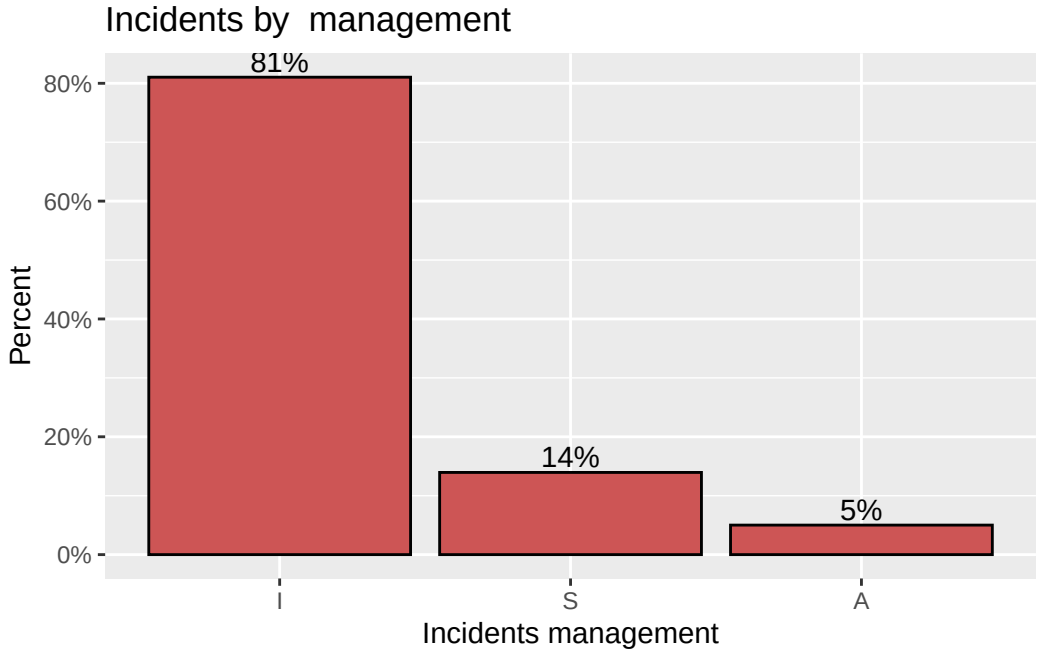
Figure 6: Number of fetal incidents by gender

The graph illustrates the number of fetal incidents among male and female population. Men were considerably more likely than women to have incidents at work. As noted above, one of the main reason why the number of incidents is higher for men population (than women population) is related to the economic activities where they are more likely to work. Indeed, the number of accidents at work varies greatly depending upon the economic activity and is positively skwed in relation to male-dominated activities. In 2020 the number of fetal incidents

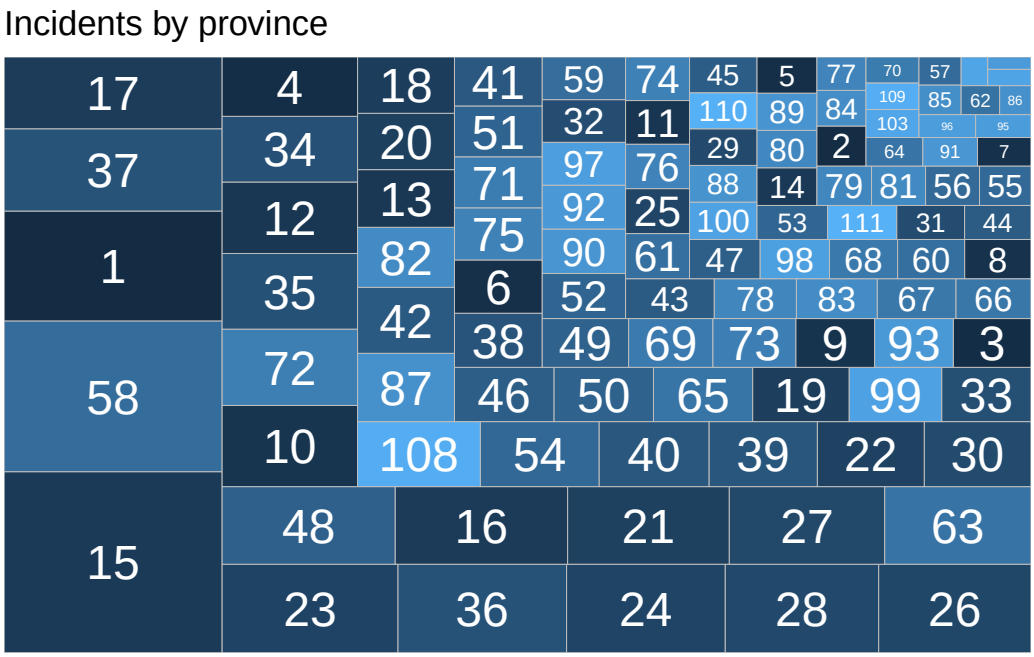
in Italy were higher compared to other years, one of the factor that influenced this number is the pandemic `Covid 19`.

2.5 Number of incidents according to management

From the graph below we can see that, the first bin (`I`) which represents incidents in the industry and services sector which has the highest proportion of accidents 81% with respect to accidents in the other sectors, while incidents in the agricultural sector (`A`) shows the lowest frequency which is about 5% only. For the the incidents in working on behalf of the state (`S`) sector represent 14% of the accidents across Italy.



2.6 Number of Incidents by province



The graph illustrate the proportions of accidents by province, we can see that 0.065 of accidents are occurring from (15) `province of Milan` which is the highest proportion of accidents compared to the other provinces, the second highest proportion of accidents are occurred in (58) `Rome` with a proportion of accidents equals to 0.054, the third province with high proportion of accidents is (1) `Turin`, while the province with the lowest proportion of accidents is (94) `Isernia` which is about 0.00086, the second lowest proportion of accidents is occurred in (101) `Crotone` with proportion of accidents equals to 0.00115 and the third lowest frequent of accidents is occurring in (102) `Vibo Valentia` with about 0.00124. However, the three province with the lowest frequency of accidents are located in south Italy while the province with high frequency of accidents are in the south and center of Italy.

2.7 Location of the incidents (Map)

2.7.1 Number of accidents by province

The map illustrates the number of accidents distributed across all Italian provinces, and as noted above the provinces with highest number of accidents are; Milan, Roma and Turin, while the provinces with lowest number of accidents are; Isernia, Crotone and Vibo Valentia. The map confirmed that provinces with the highest number of accidents are located in northren and center Italy and the lowest number of accidents are located in southern Italy.

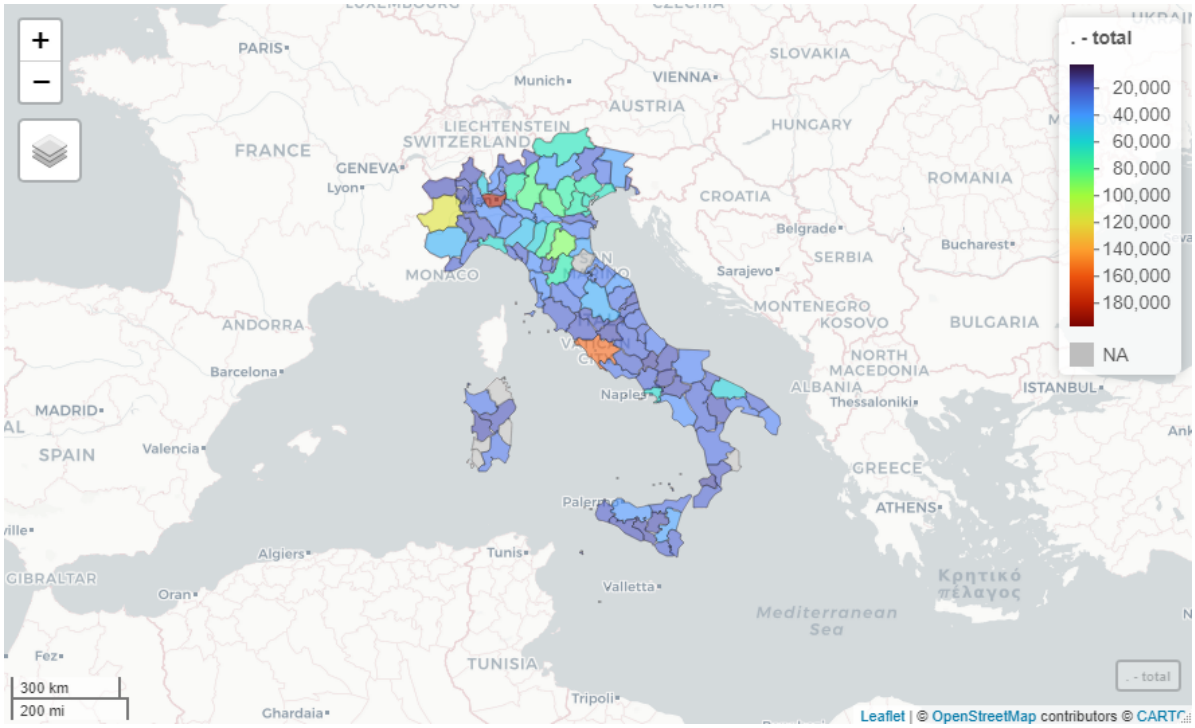


Figure 7: Map of incidents by province

2.7.2 Number of accidents by region

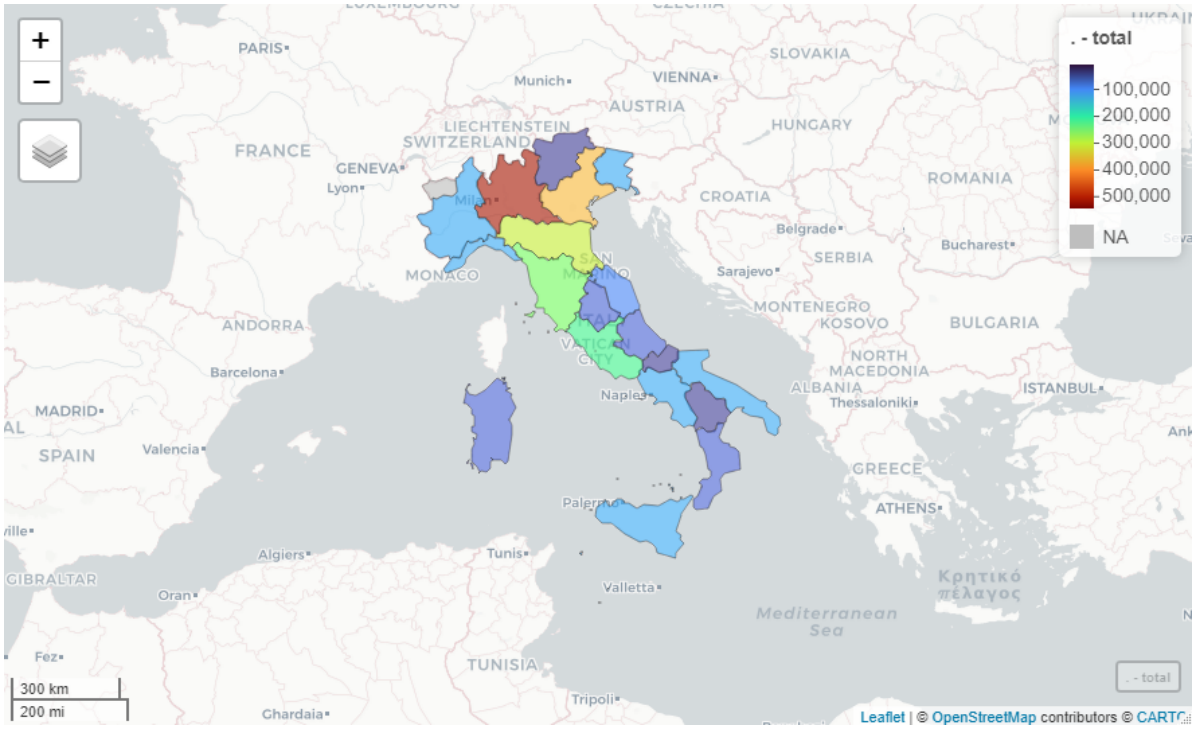


Figure 8: Map of incidents by region

An alternative way to analyse the data is by aggregating the data by region. From the map, the region with high number of incidents at work is Lombardy and the second region with high number of incidents is Veneto and the third region with considerable number of incidents is Emeglia-Romagna. However, regions with low frequent of accidents are Trentino-Alto-Adge, Molise and Basilicata.

3 Incidents Rates

3.1 Index by year

An alternative way to analyse the information on accidents at work is to express the number of accidents in relation to the number of persons employed; this produces a ratio referred to as the incidence rate or incedent index. In the Figure below, simple incidence rates are shown relating the number of accidents to the overall number of persons employed. For any given year, these statistics give an indication of the likelihood that someone had an accident. In the years 2017 to 2021, the number of accidents per 100 employed persons ranged from less

Years	Total of Incidents	Number of workers	Incidents Index (100)
2017	643068	16518031	3.8931
2018	639732	16911409	3.7828
2019	640249	17336533	3.6931
2020	568681	15960796	3.563
2021	560326	17146622	3.2679

Figure 9: Index of accidents from 2017 - 2021

than 3.26 in 2021 to 3.89 accidents per 100 persons employed in 2017. The highest incidence rates among this years were recorded in 2017 and 2018, with 3.89 and 3.78 accidents per 100 persons employed respectively.

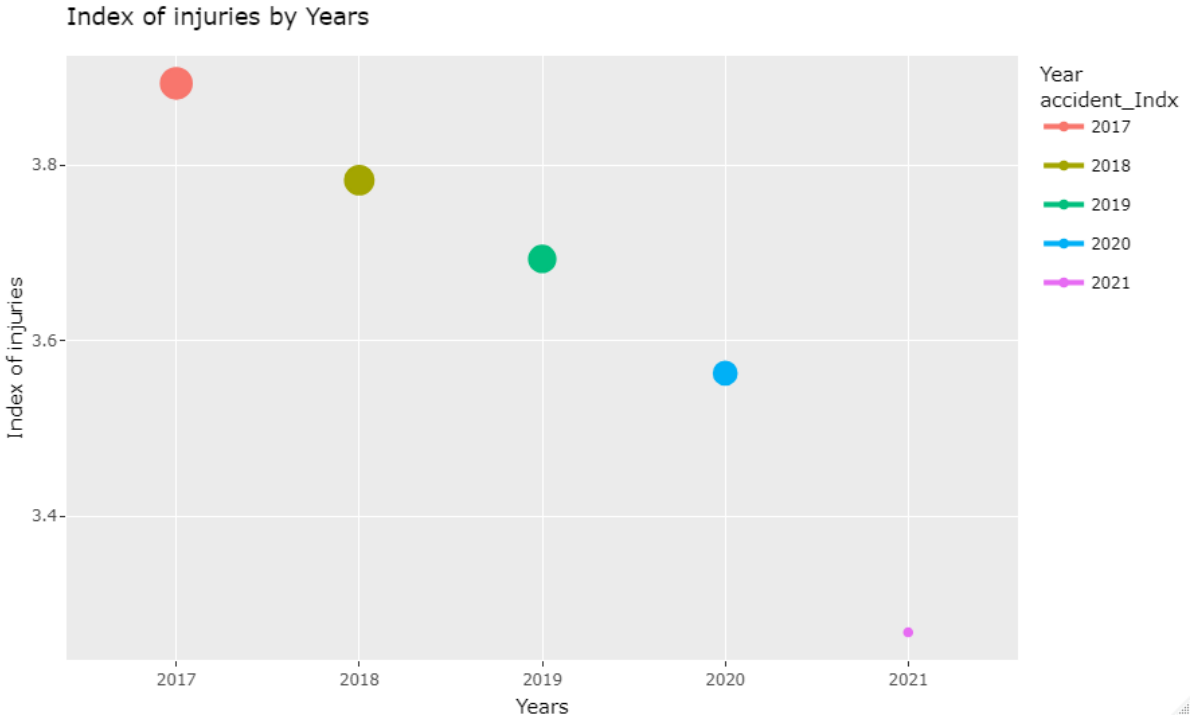


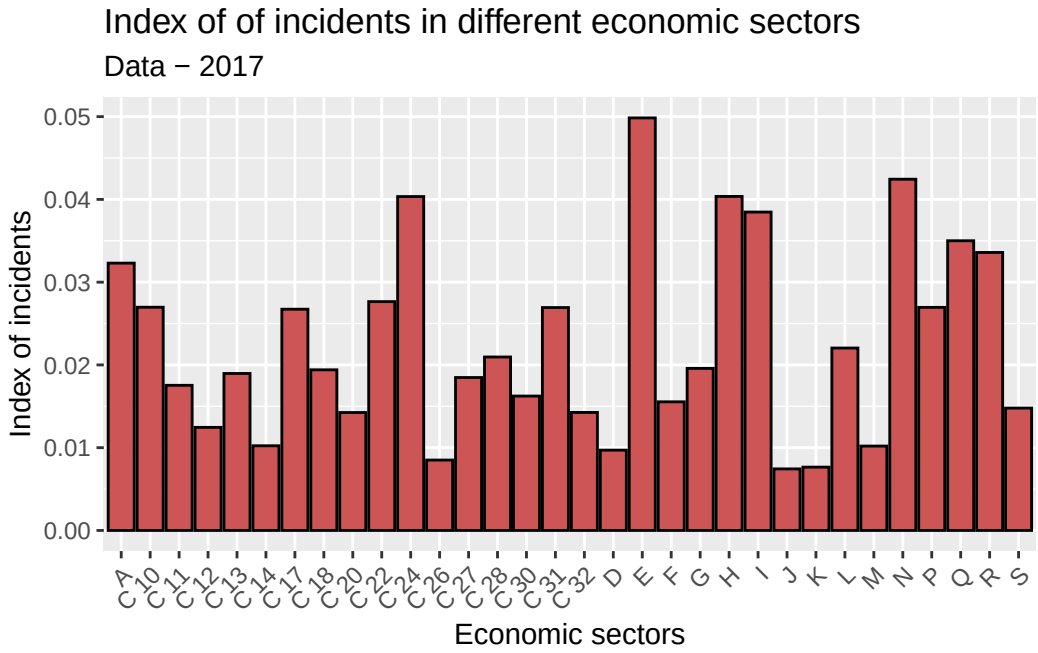
Figure 10: Index of accidents from 2017 - 2021

From the figure we can tell that, 2017 has the highest rate of incidents while 2021 has the lowest rate of incidents. However, the frequency of incidents has decreased dramatically by -11.18% from 2019 to 2020 and this is quit reasonable due to the pandemic (Covid 19), and the frequent of incidents has declined from 2020 to 2021 by -1.47%. In general, the frequency of incidents is showing a declining trend over the past 5 years period except the year 2019,

there was an increase by 0.081% from the year 2018 to 2019.

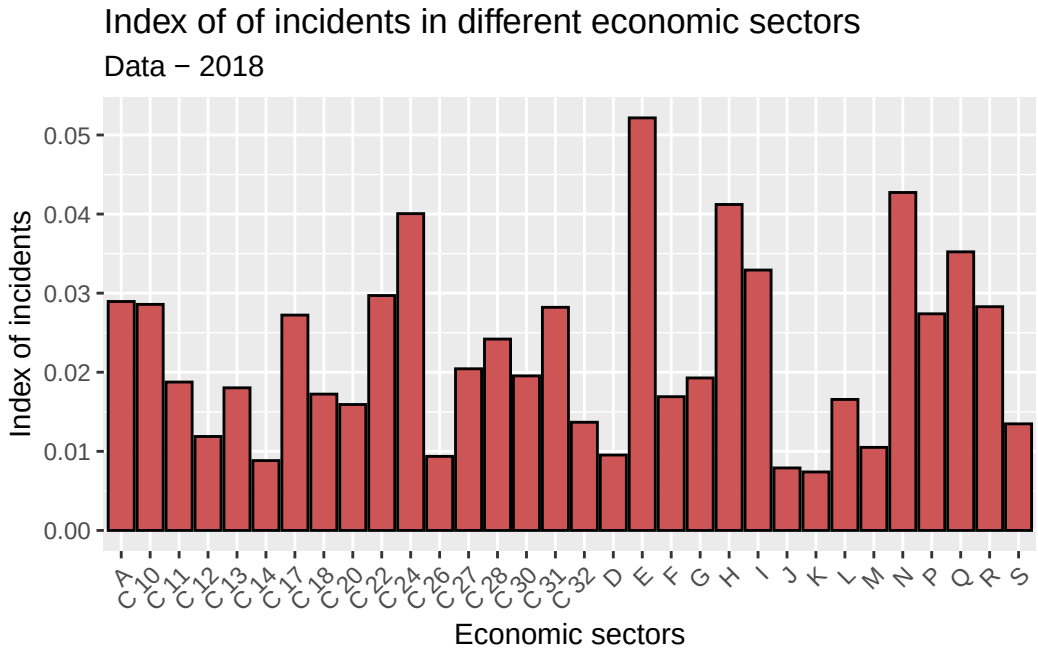
3.2 Index of accidents by economic sector

3.2.1 Rates of incidents in 2017



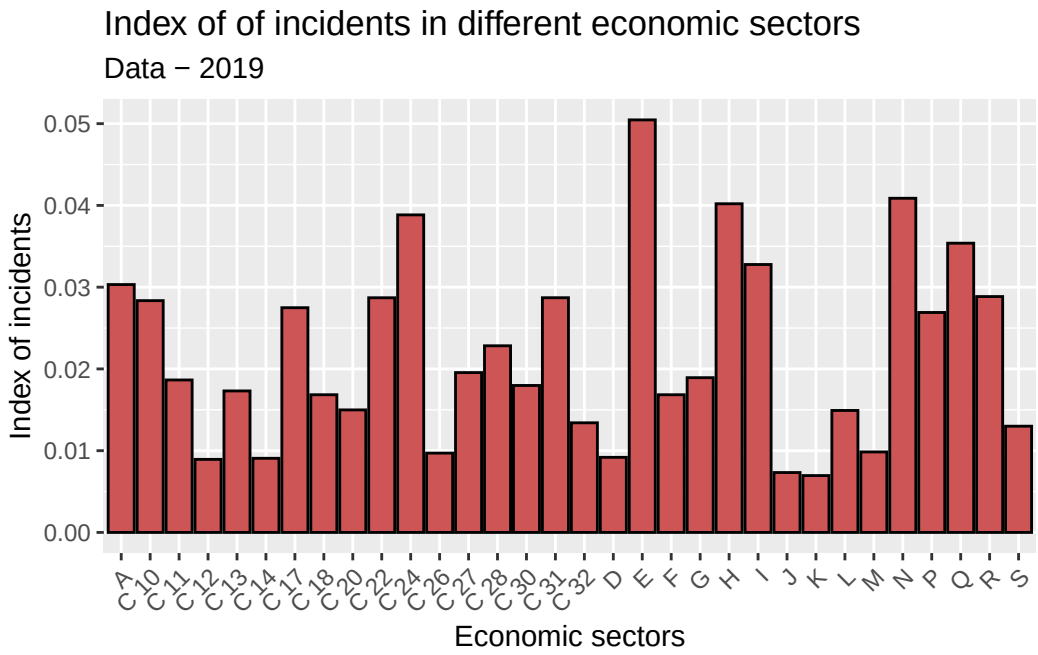
Within the economic sectors,`E` water supply; sewerage, waste management and remediation activities, `N` rental,travel agencies, business support services, `H` transportation and storage, `C24` Steel industry and `I` Accommodation and catering service activities sectors are characterized as sectors with high incidents rate compared to all accidents at works in 2017. More than (4.98 %) of all accidents at work in Italy took place within the water supply; sewerage, waste management and remediation activities sector, while the rental,travel agencies, business support services (4.24 %) had the next highest share. Transportation and storage sector (4.06 %), Steel industry with index of (4.03 %), Accommodation and catering service activities (3.85 %). The sectors with low frequent of accidents are; `J` Information and communication services (0.74%), `K` Financial and insurance activities (0.745), `C26` Manufacturing of telecommunications equipment (0.85%) and `D` Supply of electricity, gas, steam and air conditioning (0.97%).

3.2.2 Rates of incidents in 2018



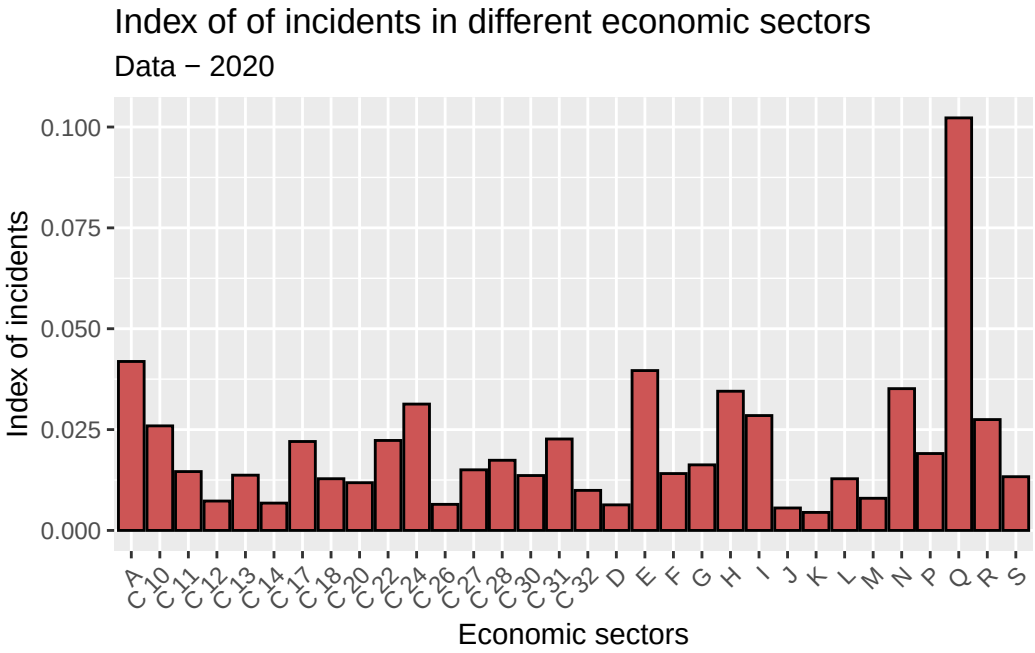
For the years 2018, the economic sectors,`E` water supply; sewerage, waste management and remediation activities (5.22%), `N` rental,travel agencies, business support services (4.27%), `H` transportation and storage (4.12%), `C24`Steel industry and (4.01%) `Q` Health and social assistance (3.52%). Comparing these result to 2017 the order of the top rated sectors with high incidents index remain the same except `I` Accommodation and catering service activities is replaced with `Q` Health and social assistance in 2018, furthermore there is a slight increase of (0.24%) in water supply; sewerage, waste management and remediation activities sector in 2018 with respect to 2017. The sectors with low frequent of accidents are; `K` Financial and insurance activities (0.74%),`J` Information and communication services (0.79%), `C14` Making of clothing items (except Fur clothing) (0.88%), `C26` Manufacturing of telecommunications equipment (0.94%) and `D` Supply of electricity, gas, steam and air conditioning (0.95%). Here as well we see some changing in orders with respect to 2017.

3.2.3 Rates of incidents in 2019



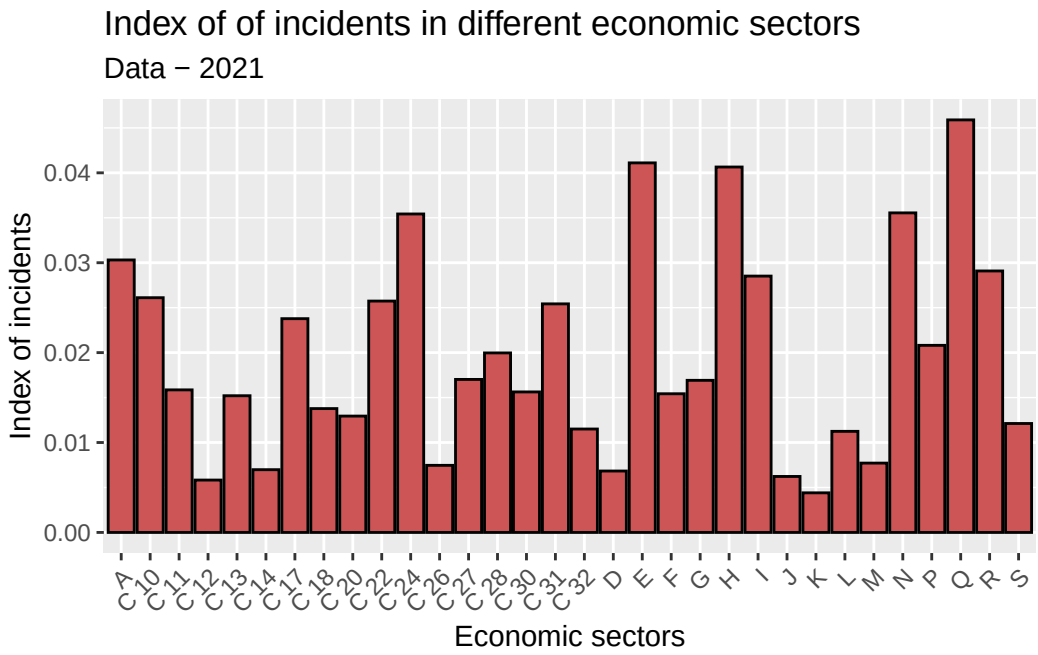
For the years 2019, the economic sectors,`E` water supply; sewerage, waste management and remediation activities (5.05%), `N` rental,travel agencies, business support services (4.09%), `H` transportation and storage (4.02%), `C24`Steel industry and (3.88%) `Q` Health and social assistance (3.54%). Comparing these result to 2018 the order of the top rated sectors with high incidents index remain the same, furthermore there is a slight increase of these index compared to 2018. The sectors with low frequent of accidents are; `K` Financial and insurance activities (0.69%),`J` Information and communication services (0.73%), `C14` Making of clothing items (except Fur clothing) (0.91%), `C26` Manufacturing of telecommunications equipment 0.91% and `D` Supply of electricity, gas, steam and air conditioning (0.97%). Here as well we see some changing in orders with respect to 2017.

3.2.4 Rates of incidents in 2020



In the year 2020 there is a dramatic increase in the index of incidents for Health and social assistance sector and one of the main factor behind this phenomenon is the pandemic `Covid 19`, `Q` Health and social assistance sector is characterized with highest incident index (10.22%) compared to the past years, and this is reasonable due to the pandemic and how hospitals were operating during this period. However, `A` Agriculture, forestry and fishing as well witnessed an increase (4.19%) with respect to the past years. The flowing economic sectors showed a considerable declined `E` water supply; sewerage, waste management and remediation activities (3.96%), `N` rental,travel agencies, business support services (3.52%), `H` transportation and storage (3.45%), `C24`Steel industry and (3.31%). For the sectors with low incident of accidents we observed a considerable decline with respect to the past years, `K` Financial and insurance activities (0.45%),`J` Information and communication services (0.56%), `C14` Making of clothing items (except Fur clothing) (0.68%), `C26` Manufacturing of telecommunications equipment (0.65%) and `D` Supply of electricity, gas, steam and air conditioning (0.63%).

3.2.5 Rates of incidents in 2021



Analysing the Incidents rates foe the year 2021, there is a dramatic decline (-5.63%) in the index of incidents for Health and social assistance sector compared to 2021, although `Q` Health and social assistance sector is still characterized with highest incident index (4.59%) in 2021. `E` water supply; sewerage, waste management and remediation activities (4.24 %) had the next highest share, then `H` transportation and storage (3.45%), `C24`Steel industry and (4.06%), `N` rental,travel agencies, business support services (3.55%). For the sectors with low incident of accidents we observed a more or less a similar behaviour with respect to the past year 2020, `K` Financial and insurance activities (0.44%),`J` Information and communication services (0.62%), `C14` Making of clothing items (except Fur clothing) (0.70%), `C26` Manufacturing of telecommunications equipment (0.75%) and `D` Supply of electricity, gas, steam and air conditioning (0.68%).

3.3 Index of incidents by large tariff group (Tariff Inail)

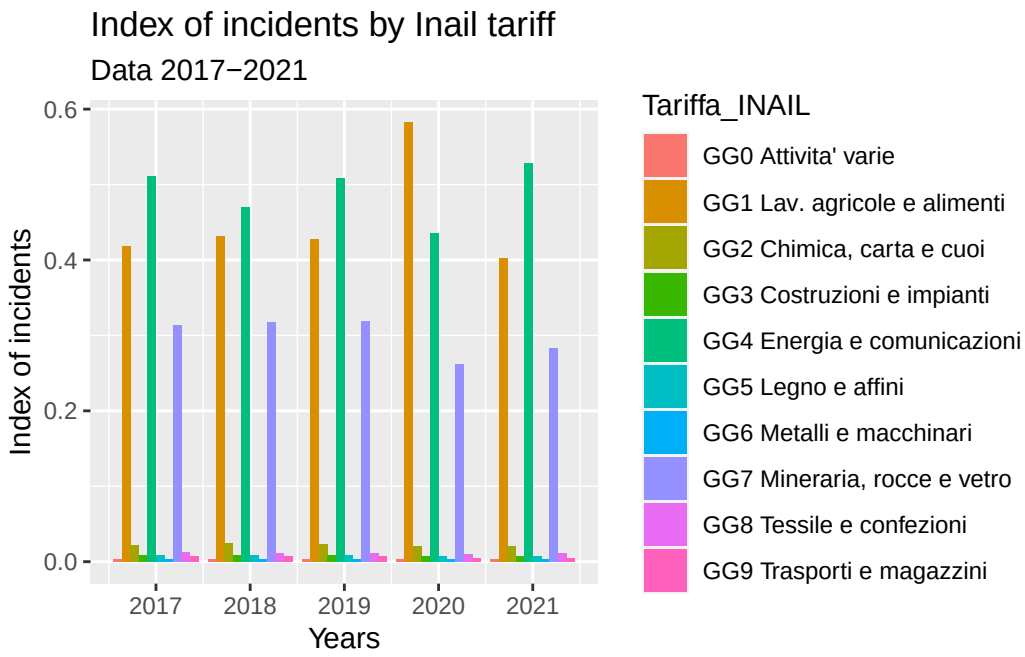


Figure above presents an analysis of data according to large tariff group across the years 2017 to 2021, the groups that are characterized with high frequency of incidents are `GG1` agricultural processing and food, `GG4` energy and communications and `GG7` rock and glass mining.

The figure above shows that years between 2017 - 2018 were characterized generally with highest incident rates. As noted before the groups with relatively high index of incidents are `GG1` agricultural processing and food, `GG4` energy and communications and `GG7` rock and glass mining. In 2020 the highest index of incidents is recorded by agricultural processing and food and it was about 58.22%. For the energy and communications, the highest record of incidents is registered in 2021 which is about 52.88%. Considering rock and glass mining, it hits the highest record in 2019 with an index of 31.83%. The rest of the groups have a relatively low incident indices ranging from 2.255 recorded from `GG2` chemical, paper and leather group to 0.32% recorded from `GG0` other activities.

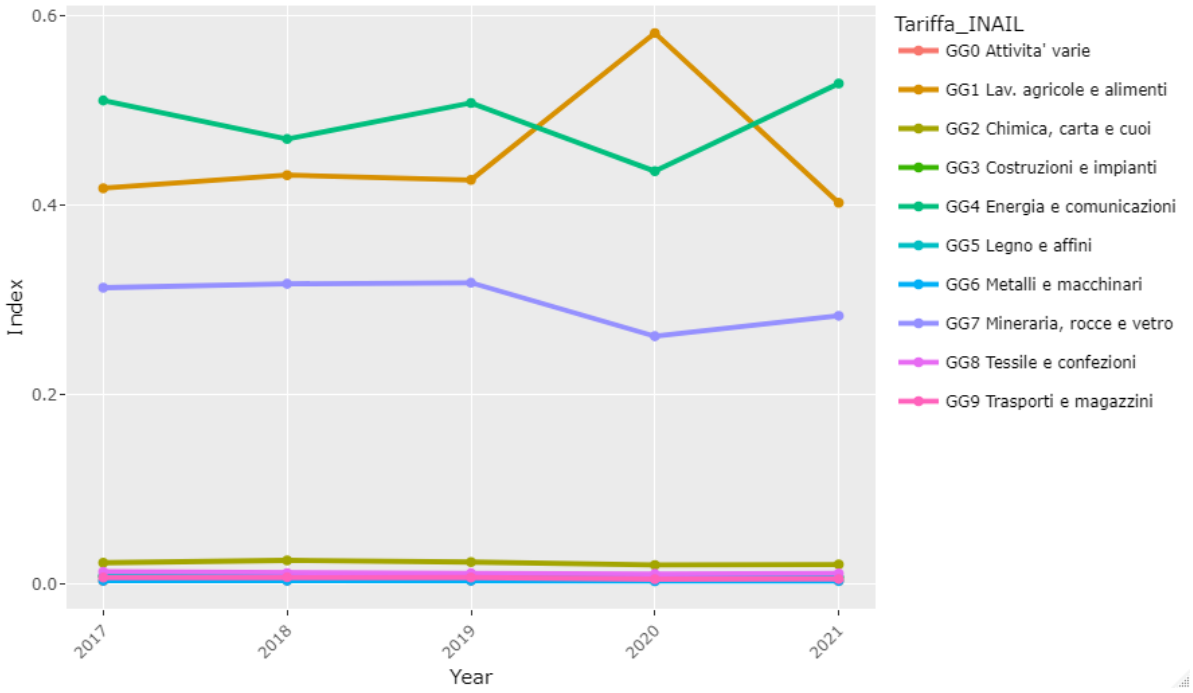


Figure 11: Index of incidents by large tariff group (Tariff Inail)

3.4 Index of incidents by management tariff

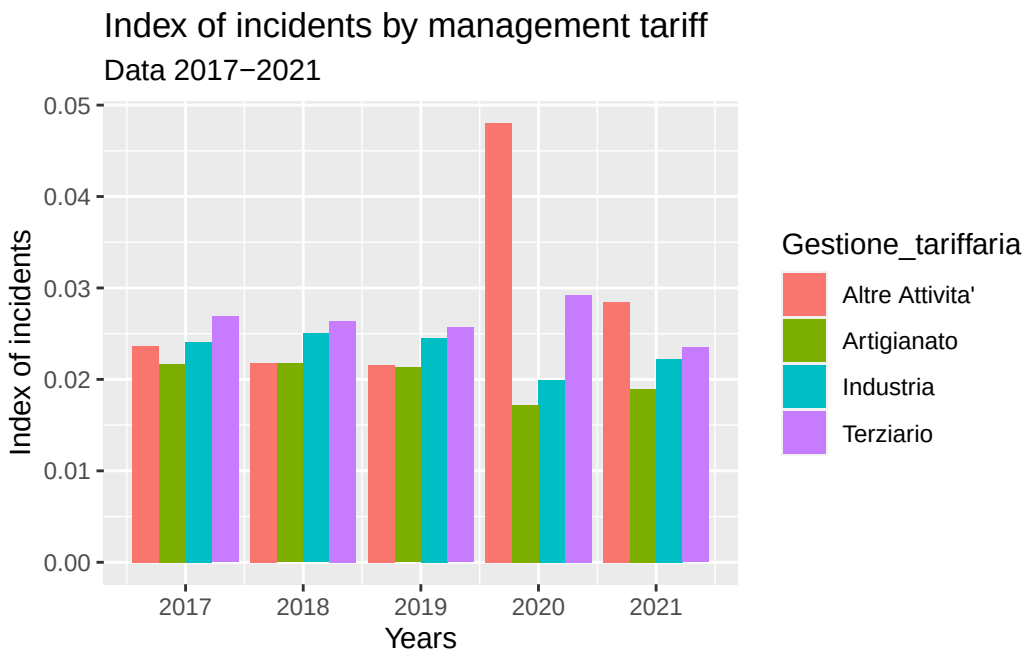


Figure above presents an analysis of data according to management tariff across the years 2017 to 2021, the activities that are characterized with high frequency of incidents are industry and tertiary, except in the year 2020 other activities has the highest incident rate with respect to all years.

Analysing the figure above, Industry, crafts and tertiary follow the same patterns of the incidents index between the years 2017 - 2021 except for the year 2020 tertiary showed an increase in the number of incidents (2.92%), while industry and crafts showed a decline (1.99%) and (1.72%) respectively. For the other activities, the incident index increased dramatically (4.8%) and this is the highest index recorded between 2017 and 2021.

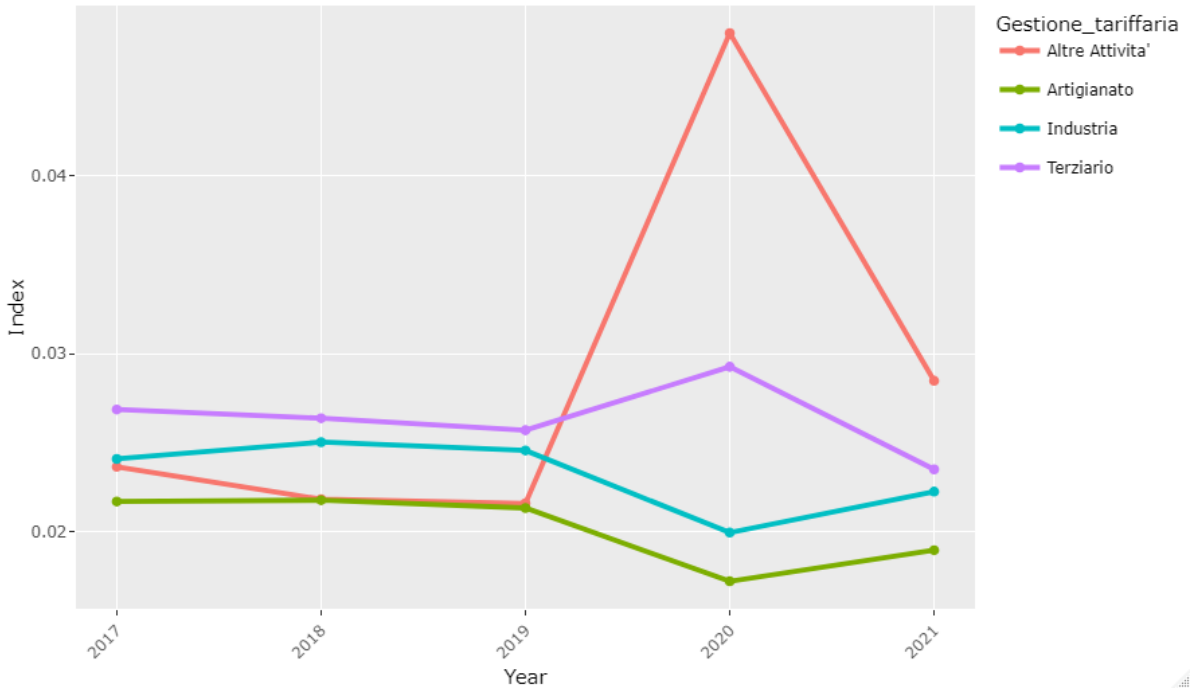
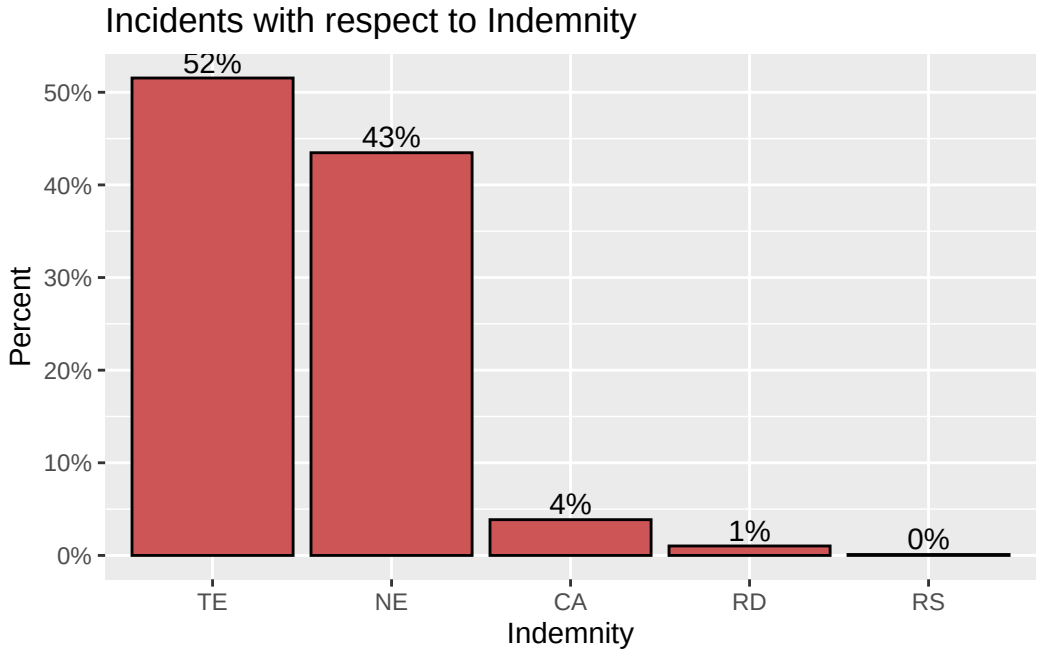


Figure 12: Index of incidents by management tariff

4 Analyses of impairment, indemnity, indemnified days

4.1 Analyse of Indemnity



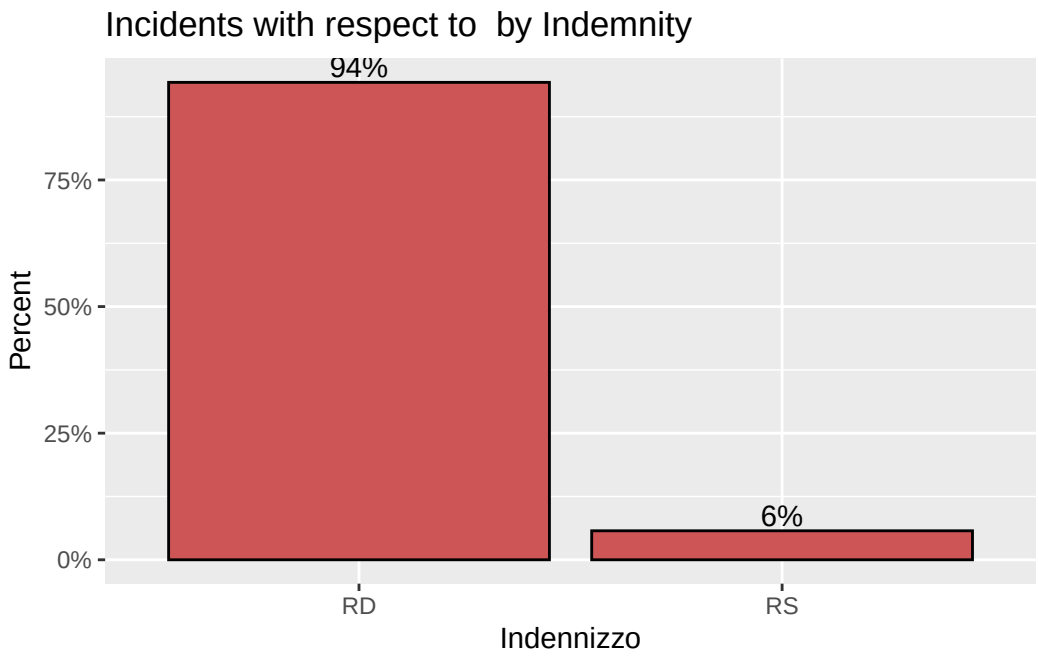

```
        TE          NE          CA          RD          RS
0.515423046 0.434740057 0.038614953 0.010215081 0.001006862
```

The figure above illustrates the types of indemnity resulting from accidents, which are `temporary`, `capital`, `direct annuity`and `survivors' annuity`. From the graph we can see that 52% of indemnified incidents are considered to be `TE` temporary, while 4% is considered as capital `CA` and 1% is direct annuity `RD` and about 0.1% are survivors' annuity `rs`.

4.2 Total and permanent disability

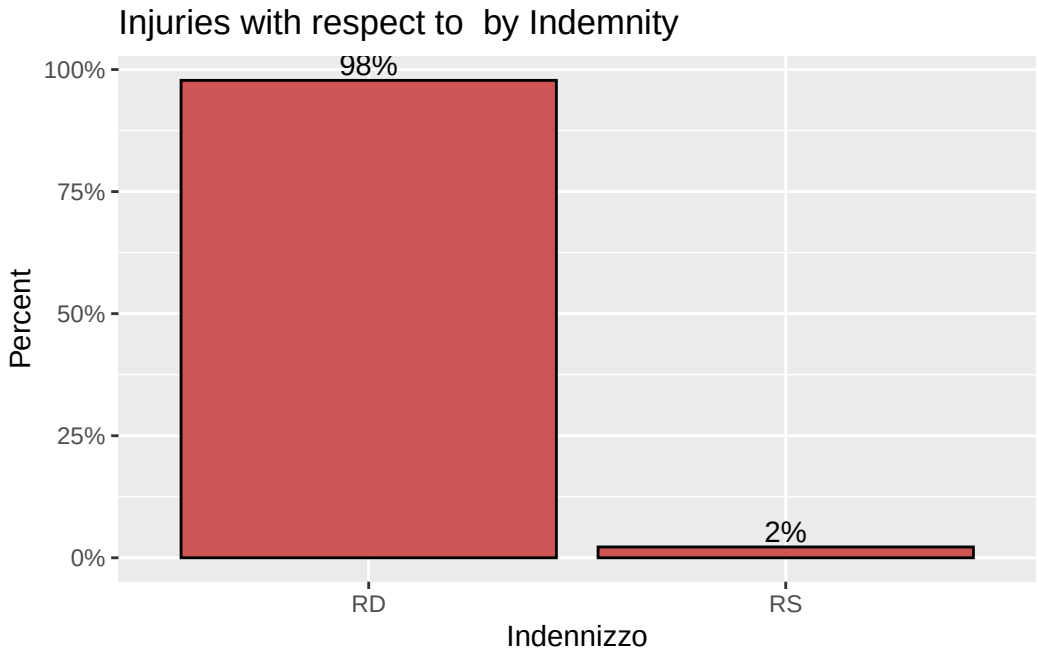
Total permanent disability (TPD) is a condition in which an individual is no longer able to work due to injuries. Total permanent disability, also called permanent total disability, applies to cases in which the individual may never be able to work again.

4.2.1 Degree of impairment $>$ 60



The analysis of the degree of impairment is crucial in defining the total and permanent disability, here if the insurance company based on this dataset decide to identify a person with degree of impairment greater than 60 as TPA, then from the figure above we can see that 94% of the workers with degree of impairment greater than 60 are categorized as immediate annuity `RD` beneficiaries, and in this case the insurance comapny offers an immediate income to the annuitant, and 6% are categorized as survivors' annuity `DS` beneficiaries, which allows the annuitant to ensure after death, a continuous lifetime annuity for their dependents.

4.2.2 Degree of impairment $>$ 40



The analysis of degree of impairment is crucial in defining the total and permanent disability, here if the insurance company based on this dataset decide to identify a person with degree of impairment greater than 40 as TPA, then from the figure above we can see that 98% of the workers with degree of impairment greater than 40 are categorized as immediate annuity `RD`beneficiaries, which offers an immediate income to the annuitant, and 2% are categorized as survivors' annuity `DS`beneficiaries, which allows the annuitant to ensure after death, a continuous lifetime annuity for their dependents. However, when the insurance company decrease the threshold of the degree of impairment to 40, the number of persons defined as TPD is 2349, and when the threshold of the degree of impairment is 60, the number of persons defined as TPD is 856.