Gastric Cancer in Spain: Evaluating Productivity Loss and Economic Impact

Productivity Loss of Gastric Cancer in Spain

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ABSTRACT

Introduction: In 2018, gastric cancer (GC) was estimated to account for over 1.03 million new cases globally, making it one of the most frequently diagnosed malignancies. In Spain, about 6,913 new cases were diagnosed in 2022. GC is an aggressive cancer originating in the stomach and ranks fifth in cancer incidence and third in cancer-related deaths worldwide. Despite treatment, only 25% of patients survive more than 5 years after diagnosis.

Methods: To estimate the economic impact of premature mortality due to GC, the human capital method was employed. This approach involved collecting data on mortality rates, average salaries, and unemployment rates. The study spanned a 10-year period, from 2013 to 2022, to integrate the latest and most pertinent data for analysis. The goal was to quantify the economic consequences GC-related deaths, providing valuable information for policy makers and healthcare professionals.

Results: GC caused 51,814 deaths over the study period with a slight annual decline, predominantly affecting men. Approximately 23% of deaths occurred among people of working age, amounting to a total of 122,632 YPLL. In economic terms, GC deaths accounted for costs of €1,239.34 million in 2013, rising to €1,242.04 million by 2021, for a total of €11,469.07 million over the study period.

Conclusions: The incidence of gastrointestinal cancers has decline in some types, but they remain a substantial public health challenge. These findings underline the significant health and economic challenges posed by GC, highlighting the need for targeted interventions to mitigate its impact on both individuals and healthcare systems.

KEYWORDS: gastric cancer; productivity loss; human capital approach; economic impact; YPLL

1. INTRODUCTION

Cancers located in the main gastrointestinal tract include oesophageal cancer, gastric cancer (GC), colon cancer, rectal cancer, liver cancer, and pancreatic cancer [1]. In 2018, these tumours accounted for 26.3% of all cancer cases and were responsible for 35.4% of cancer deaths globally [1]. With over 1.03 million estimated new cases in 2018, GC is among the most commonly diagnosed malignancies worldwide, with the vast majority of cases occurring in Asia, accounting for more than 70% of the global case burden [2]. Most of these cancers are closely linked to dietary habits [3]. Recent studies indicate that more than half of gastrointestinal cancers are attributable to modifiable risk factors [4]. These include alcohol consumption, smoking, infections, diet and obesity [4]. GC is an aggressive malignant neoplasm that develops in the stomach and is one of the leading causes of death globally [5]. It ranks fifth in cancer incidence and third in cancer-related deaths [5]. After treatment, only 25% of patients survive more than 5 years [6]. In Spain, about 6,913 new cases were diagnosed during the year 2022 [7].

According to a study, the estimated annual financial burden of GC for Europe (including France, Germany, Italy, Spain, and the UK), Asia (including Iran, Japan, and China), North America (Canada and the US), and Australia totalled 20.6 billion USD in 2017 (5). In Spain, the annual cost of GC and gastroesophageal junction cancer was 1,171 million USD in 2017 [5].

Evaluating productivity loss is crucial for making informed decisions on resource allocation. Several methods can be used to assess productivity loss [8], with the human capital (HC) approach being the most widely used. This method calculates losses based on the decline in individuals' productivity due to illness or death up to retirement age [9]. Another method, known as the friction cost approach, considers the losses associated with the time required to replace a worker [10]. Additionally, there are less common methods, such as the willingness-to-pay approach, which assigns monetary values to intangible costs such as suffering and discomfort [11].

Cancer-related productivity losses are a crucial proxy indicator of the societal burden of cancer and can influence informed policy decisions. A 2020 study reported that productivity losses due to premature mortality from cancer amounted to €50 billion across Europe [12]. In Spain, the total value of lost productivity due to cancer-related premature mortality in 2018 was estimated at €7.75 billion [12], but no information regarding GC is not available. This research aimed to assess the economic impact of premature deaths caused by GC in Spain, highlighting the urgent need for timely and effective interventions. By quantifying the economic burden associated with these deaths, the study highlights the critical importance of early detection, improved treatment options, and preventative measures. The findings provide valuable insights for policy makers and healthcare providers, emphasizing the need for targeted strategies to reduce the incidence and mortality of GC, ultimately alleviating its economic impact on society. The aim of this study is to provide updated data on productivity losses due to premature mortality from GC in Spain.

2. MATERIALS AND METHODS

2.1 Model and methodology

The theoretical framework used in this study was based on the HC approach [13,14]. According to this perspective, an individual's labour productivity can be measured by his or her earnings. The theory suggests that the premature cessation of an individual's labour activity due to death or disability represents a loss to society because of the future production that person would have contributed. Based on the HC theory, we used a simulation model to forecast the current and potential loss of labour production resulting from premature deaths caused by GC. This estimation considered factors such as the age at which each person died, as well as sex- and age-specific employment rates and wages. It is important to note that our assessment focuses exclusively on labour productivity losses and does not account for the impact of unpaid work or leisure time.

The methodology involved multiplying the number of deaths in each age group by the average remaining life expectancy for that group. This calculation determined the Years of Potential Life Lost (YPLL) due to the premature deaths of "n" individuals. The formula used is as follows, where "L" represents the average remaining life expectancy for a specific age and gender group:

$$YPLL = \sum_{i=1}^{n} L_i$$

After calculating YPLL, the assessment continued to determine the number of years of potential labour productive life lost (YPLPLL). This calculation specifically considered deaths occurring before the age of 65, the legal retirement age. YPLPLL was computed by multiplying the number of deaths in each age group by the anticipated remaining productive years of life (up to the retirement age) for that group. The formula for calculating YPLPLL is as follows, where "Wu" represents the upper limit of working age (65 years), and "Wl" represents the age at death:

$$YPLPLL = \sum_{i=1}^{n} Wu_i - Wl_i$$

Finally, the calculated YPLPLL was multiplied by wages specific to gender and age, adjusted by the employment rate from the age of death to the retirement age. This computation facilitated the estimation of labour productivity losses (LPL), expressed as follows, where "S" represents the wage adjusted for gender and age, and "e" denotes the employment rate adjusted for gender and age:

$$LPL = \sum_{i=1}^{n} YPPLL_i * S_i * e_i$$

1.2 Datasets

The data for this study was obtained from the National Statistical Institute (INE for its acronym in Spanish), which collects information on GC-related deaths through the Death Registry. This dataset is comprehensive and includes crucial details such as the age and gender of the deceased individuals, forming a solid foundation for our analysis [15,16]. In addition to the Death Registry, the study leveraged the Labour Force Survey conducted by INE to understand employment rates. Furthermore, data from the Spanish Structural Wage Survey offered comprehensive insights into remuneration, encompassing both monetary compensation and non-monetary benefits. The study spanned a 10-year period, from 2013 to 2022, to integrate the latest and most pertinent data for analysis.

2.3 Output

To estimate the costs of premature mortality, annual salaries specific to gender and age were applied from the age of death up to the retirement age [15]. However, because 2022 salary data was not available, calculations relied on data from the period between 2013 and 2021. An annual discount rate of 3% was applied to future income values, and a sensitivity analysis was conducted using alternative discount rates of 0% and 6%.

Assessing productivity loss provides crucial data for making informed decisions about resource allocation. Various methods exist for evaluating productivity loss, with the HC approach being the most employed. This approach quantifies losses by considering individuals' potential productivity until retirement age, which may be affected by illness or premature death [16]. Another alternative method that could have been used is the friction cost method, which calculates losses based on the time needed to replace a worker. This approach aims to offer a more realistic estimation but requires a standardized measure of replacement time [17]. Lastly, there are other methods that emphasize different factors. For instance, the willingness-to-pay method assesses intangible costs such as suffering and discomfort by assigning them a monetary value [18].

3. RESULTS

Throughout the study period, GC caused 51,814 deaths. The Table 1 reveals a slight annual decline in these deaths, with a higher incidence in men than in women. Notably, 23% of the deceased were of working age. This has resulted in a total of 122,632 YPLL over the entire period, averaging 12,263 YPLL per year. Regarding the YPLL, it is evident that, like the annual number of deaths, YPLL also decrease over time. Figure 1 shows that YPLL are relatively similar between men and women up until the age of 45. Beyond this age, however, the YPLL for men increase significantly compared to women, resulting in men having a substantially higher total YPLL. This indicates that GC impacts men more severely in terms of potential years of life lost, especially in the middle-aged and older populations.

As illustrated in Figure 2, there is a significant rise in the mortality rate from GC beginning at age 50. The age group experiencing the highest mortality rate is between 75 and 79 years. Interestingly, from the age of 90 onwards, the trend reverses, with women exhibiting a higher mortality rate than men. This shift can be attributed to the fact that, on average, women have a longer life expectancy compared to men. Consequently, a larger proportion of elderly women are present in the population, which may lead to a higher observed mortality rate among women in this age group.

GC accounts for 4.60% of all cancer-related deaths. As illustrated in Figure 3, out of the 393,839 deaths due to digestive tumours over the entire study period, 13.16% were attributed to GC. This places GC as the third leading cause of digestive cancer deaths, following colon cancer, which caused 114,465 (29.06%) deaths, and pancreatic cancer, responsible for 69,885 (17.74%) deaths. This data underscores the significant impact of GC within the broader category of digestive tumours.

As detailed in Table 2, translating these figures into monetary terms reveals that deaths in 2013 incurred a cost of €1,239.34 million, rising to €1,242.04 million by 2021, with a total of €11,469.07 million throughout the entire study period. A sensitivity analysis estimated the economic impact for 2013 to be between €1,205.01 million and €1,275.72 million, and for 2021 to be between €1,304.87 million and €1,381.44 million. This analysis highlights the increasing financial burden of GC-related deaths over time.

4. DISCUSSION

This study is the first published information assessing the economic consequences of premature deaths due to GC. This study found that GC caused a more than 50.000 deaths over the study period. In addition, there was higher incidence in men and more than the 20% of those who die were of working age. Productivity losses accounted for a total of 122,632 YPLL over the study period, resulting in a cumulative economic burden of 11,469.07 million euros. The economic impact ranged between €1,205.01 million and €1,304.87 million.

As seen before, this study showed that the risk of GC is higher in males than in females. This higher risk in male may be due to their higher likelihood of alcohol and tobacco use [3], which are two of the main risk factors for suffering GC. Additionally, it has been observed that elderly patients of both sexes are more likely to develop cancer, possibly due to weakened immunity in the elderly, making them less able to resist the development of cancer [3]. Although gastric cancer is not among the top 10 malignancies in terms of incidence or mortality, it remains the second most common cause of cancer death worldwide [17]. Therefore, advances in the treatment of gastric cancer, even in countries with low incidence rates, can have a major global impact [17].

Over the past two decades, there has been a steady decline in global GC incidence and mortality rates in both developed and developing countries, although this trend varies significantly across different regions [5,18]. In Western countries, possible reasons for this decline include increased availability of fresh fruits and vegetables, reduced consumption of preserved foods, and lower smoking rates [5]. A diet poor in fruit and vegetables has been identified as an important risk factor for the development of GC [23].

Furthermore, the strong association between Helicobacter pylori infection and GC suggests that the widespread use of antibiotics may have contributed to the decrease in incidence [5]. But overall, the burden of cancer incidence and mortality is increasing rapidly worldwide [24]. Globally, the number of new cancer cases is expected to reach approximately 28.4 million in 2040, a significant increase of 47% from the estimated 19.3 million cases in 2020 [24]. This dramatic rise highlights the growing burden of cancer and underlines the urgent need for improved cancer prevention, early detection, and treatment strategies to effectively manage this anticipated increase [24]. This trend reflects the population aging and growth, as well as changes in the prevalence and distribution of major cancer risk factors, many of which are linked to socioeconomic development [24].

Regarding costs, this study revealed an annual cost of between 1,239.34 million euros and 1,242.04 million euros due to the premature death of gastric cancer patients in Spain. Similar costs were reported by Digestive Cancers Europe [25], which reported 2.1 billion euros in terms of indirect costs caused by premature mortality. These costs were assessed based on potential years of working life lost combined with average wages and employment rates per country. And by using the costs calculated using the HC method.

In terms of the limitations of this study, indirect costs such as caregiver burden, transport and non-medical expenses were not included, so this study can potentially the total economic impact of gastric cancer. These data were not included because there were no reliable data available to assess indirect costs. In addition, this study used the HC approach as it is one of the most widely used methods to assess productivity losses. But, as other methods, it has some limitations as assuming that all individuals contribute equally to productivity until retirement age.

5. CONCLUSION

This study highlights the significant economic and health burden of GC on the Spanish healthcare system, which presents both challenges and opportunities for healthcare policy and management. With 23% of GC deaths occurring among workers and an economic impact of €11,469.07 million in the last decade, the profound implications of this disease are evident. Although the incidence of certain gastrointestinal cancer types has decreased, these neoplasms continue to pose major public health challenges. Effective primary and secondary prevention measures are crucial to control these cancers. Key strategies include reducing tobacco and alcohol consumption, controlling obesity, immunizing the population against hepatitis B virus infection and implementing screening programs for colorectal cancer. As life expectancy rises, so does the lifetime risk of developing cancer. In Spain, a significant proportion of cancers are diagnosed in older adults, which means that the ageing of the population translates into an increase in the absolute number of cancer cases. This data should therefore inspire efforts to improve GC prevention, detection and treatment in Spain, with the ultimate goal of improving public health outcomes and economic productivity.

TRANSPARENCY

Ethics approval and consent to participate

Ethics committee approval and patient consent were not required for this study.

Consent for publication

Not applicable.

Availability of data and material

The data that support the findings of this study are available from the Spanish national statistics institute at http://www.ine.es.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable.

Authors' contributions

JD contributed to the investigation by interpreting the productivity loss regarding premature deaths caused by gastric cancer in Spain and was a major contribution in the intellectual content revision. AA and MA analysed the gastric cancer situation in Spain, analysed and interpreted the statistical data, and were a major contributor in writing the manuscript. All authors have read and approved the final manuscript.

Acknowledgements

Not applicable

REFERENCES

1. Lu L, Mullins CS, Schafmayer C, Zeißig S, Linnebacher M. A global assessment of recent trends in gastrointestinal cancer and lifestyle-associated risk factors. Cancer Commun (Lond). (2021). https://doi.org/10.1002/cac2.12220
2. Arnold M, Ferlay J, van Berge Henegouwen MI, Soerjomataram I. Global burden of oesophageal and gastric cancer by histology and subsite in 2018. Gut. (2020). https://doi.org/10.1136/gutjnl-2020-321600
3. Jiang Q, Shu Y, Jiang Z, Zhang Y, Pan S, Jiang W, et al. Burdens of stomach and esophageal cancer from 1990 to 2019 and projection to 2030 in China: Findings from the 2019 Global Burden of Disease Study. J Glob Health. (2024). https://doi.org/10.7189/jogh.14.04025
4. Arnold M, Abnet CC, Neale RE, Vignat J, Giovannucci EL, McGlynn KA, Bray F. Global Burden of 5 Major Types of Gastrointestinal Cancer. Gastroenterology. (2020). https://doi.org/10.1053/j.gastro.2020.02.068
5. Casamayor M, Morlock R, Maeda H, Ajani J. Targeted literature review of the global burden of gastric cancer. Ecancermedicalscience. (2018). https://doi.org/10.3332/ecancer.2018.883
6. Manzanedo I, Pereira F, Serrano Á, Pérez-Viejo E. Review of management and treatment of peritoneal metastases from gastric cancer origin. J Gastrointest Oncol. (2021). https://doi.org/10.21037/jgo-20-232
7. Grávalos C, Fernández Montes A. Gastric Cancer [Cáncer Gástrico]. Sociedad Española de Oncología Médica (SEOM). 2022. https://seom.org/info-sobre-el-cancer/estomago?showall=1&showall=1 Accessed August 2024.

8. Krol M, Brouwer W. How to estimate productivity costs in economic evaluations. Pharmacoeconomics. (2014). https://doi.org/10.1007/s40273-014-0132-3

9. Zhang W, Bansback N, Anis AH. Measuring and valuing productivity loss due to poor health: A critical review. Soc Sci Med. (2011). https://doi.org/10.1016/j.socscimed.2010.10.026

10. van den Hout WB. The value of productivity: human-capital versus friction-cost method. Ann Rheum Dis. (2010). https://doi.org/10.1016/10.1136/ard.2009.117150

11. Yabroff KR, Bradley CJ, Mariotto AB, Brown ML, Feuer EJ. Estimates and projections of value of life lost from cancer deaths in the United States. J Natl Cancer Inst. (2008). https://doi.org/10.1093/jnci/djn383

12. Spanish Statistical Office. Death statistics according to cause of death. [Instituto Nacional de Estadística (INE). Estadística de defunciones según la causa de muerte]. http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176780&menu=resultados&idp=1254735573175 Accessed July 2023.

13. Grossman, M. The human capital model of the demand for health. Handbook of health economics. Amster- dam: North-Holland-Springer (2000). https://doi.org/10.3386/w7078

14. Grossman, M. The Demand for Health: A Theoretical and Empirical Investigation. Columbia University Press. (1972). https://doi.org/10.7312/gros17900

15. Spanish Statistical Office. Death statistics according to cause of death. [Instituto Nacional de Estadística (INE). Estadística de defunciones según la causa de muerte]. http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176780&menu=resultados&idp=1254735573175 Accessed July 2023.

16. Spanish Statistical Office. Wage structure survey [Instituto Nacional de Estadística (INE). Encuesta de estructura salarial]. http://www.ine.es/dyngs/INEbase/es/categoria.htm?c=Estadistica_P&cid=1254735976594 Accessed July 2023.

17. Instituto Nacional de Estadística (INE). Encuesta de población activa. http://www.ine.es/dyngs/INEbase/es/categoria.htm?c=Estadistica_P&cid=1254735976594 Accessed July 2023.

18. Zhang W, Bansback N, Anis AH. Measuring and valuing productivity loss due to poor health: A critical review. Soc Sci Med. (2011). https://doi.org/10.1016/j.socscimed.2010.10.026

19. Kigozi J, Jowett S, Lewis M, Barton P, Coast J. Estimating productivity costs using the friction cost approach in practice: a systematic review. Eur J Health Econ. (2016). https://doi.org/10.1007/s10198-014-0652-y

20. Yabroff KR, Bradley CJ, Mariotto AB, Brown ML, Feuer EJ. Estimates and projections of value of life lost from cancer deaths in the United States. J Natl Cancer Inst. (2008). https://doi.org/10.1093/jnci/djn383

21. Joshi SS, Badgwell BD. Current treatment and recent progress in gastric cancer. CA Cancer J Clin. (2021). https://doi.org/10.3322/caac.21657

22. Zhang Z, Wang J, Song N, Shi L, Du J. The global, regional, and national burden of stomach cancer among adolescents and young adults in 204 countries and territories, 1990-2019: A population-based study. Front Public Health. (2023). https://doi.org/10.3389/fpubh.2023.1079248

23. Ferro A, Costa AR, Morais S, Bertuccio P, Rota M, Pelucchi C, et al. Fruits and vegetables intake and gastric cancer risk: A pooled analysis within the Stomach cancer Pooling Project. Int J Cancer. (2020). https://doi.org/10.1002/ijc.33134

24. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. (2021). https://doi.org/10.3322/caac.21660

25. The costs of oesophageal and gastric cancer. Digestive Cancers Europe. 2021. https://digestivecancers.eu/wp-content/uploads/2021/03/DiCE_Oesophegeal_Gastric_Cancer_Factsheet_20210322_FINAL.0.pdf Accessed August 2024.

TABLES

Table 1. Measures of deaths and years of potential life lost (YPLL)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Number of deaths										
males	3,443	3,334	3,331	3,311	3,213	3,084	3,008	2,946	2,959	2,854
females	2,183	2,200	2,175	2,107	1,941	1,969	2,003	1,971	1,879	1,903
% Deaths at working age										
males	25.76	25.46	24.59	24.13	23.87	24.64	24.27	24.17	24.74	23.58
females	19.42	18.41	20.74	19.27	21.48	20.82	21.87	20.90	21.66	21.60
% GC vs all tumours										
males	5.08	4.96	4.92	4.83	4.69	4.52	4.43	4.38	4.36	4.20
females	5.04	5.12	4.98	4.75	4.34	4.43	4.44	4.33	4.10	4.06
YPLL										
males	8,801	8,447	7,952	7,682	7,631	7,355	6,845	6,971	7,271	6,329
females	4,847	4,715	5,138	4,833	4,541	4,660	5,014	4,571	4,471	4,558

Table 2 Productivity losses (in millions €) due to GC (annual costs discount rates)

Year	Premature mortality costs (baseline)	Premature mortality costs (0%)	Premature mortality costs (6%)
2013	1,239.34	1,275.72	1,205.01
2014	1,226.21	1,262.21	1,192.25
2015	1,275.09	1,312.52	1,239.78
2016	1,230.87	1,267.01	1,196.78
2017	1,252.91	1,289.69	1,218.21
2018	1,290.79	1,328.68	1,255.04
2019	1,320.14	1,358.89	1,283.58
2020	1,291.68	1,329.60	1,255.91
2021	1,342.04	1,381.44	1,304.87
Total	11,469.07	11,805.76	11,151.53

FIGURES

Figure. 1 Years of potential life lost (YPLL) per each age groups a) Year 2019 b) Year 2020 c) Year 2021 d) Year 2022

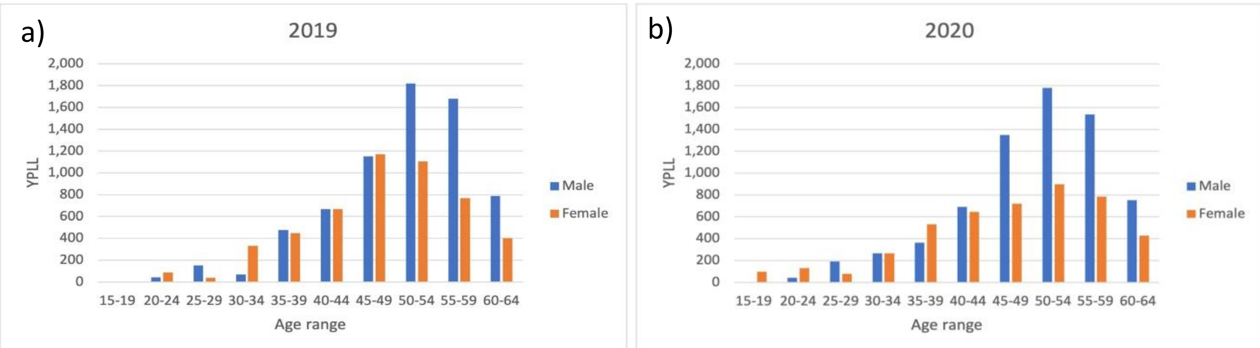


Figure 2. Number of deaths per age group in 2022

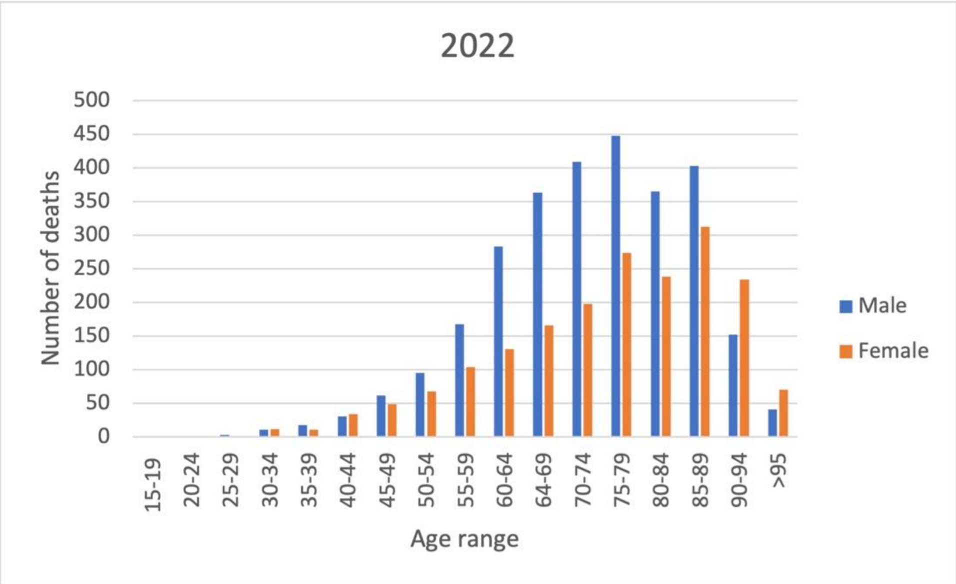
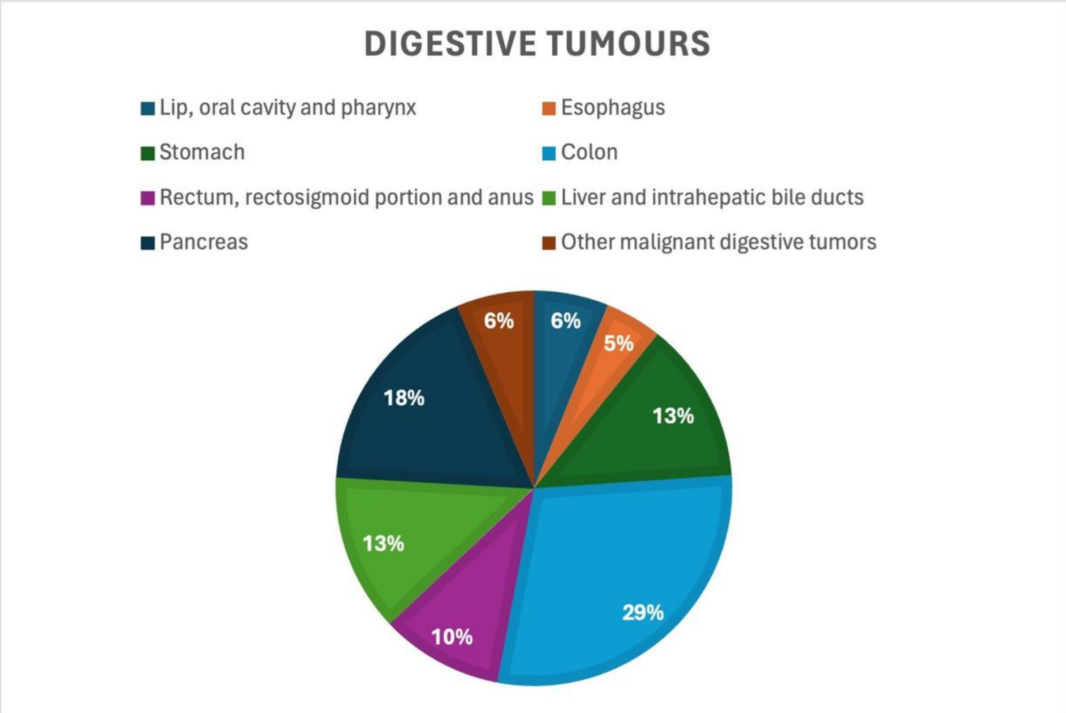


Figure 3. Digestive tumours distribution


DIGESTIVE TUMOURS
Lip, oral cavity and pharynx
Esophagus
Stomach
Colon
Rectum, rectosigmoid portion and anus
Liver and intrahepatic bile ducts
Pancreas
Other malignant digestive tumors
6%
5%
13%
29%
10%
13%
18%
6%