Quantifying the Economic Impact of Premature Mortality from Cirrhosis in Spain

Costs of Cirrhosis Premature Mortality in Spain

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ABSTRACT

Objectives: Excessive alcohol consumption is a major contributor to illness and mortality on a global scale. Per-capita alcohol consumption rose from 5.5 litres in 2005 to 6.4 litres in 2016 and is projected to reach 7.6 litres by 2030. In 2019, alcohol was associated with roughly a quarter of all cirrhosis-related deaths worldwide. The aim of this study is to assess the economic impact of premature mortality due to cirrhosis in Spain.

Methods: To estimate the economic impact of premature mortality due to cirrhosis, we utilized the human capital method. This method involved collecting data on mortality rates, average salaries, and unemployment rates. Our objective was to quantify the financial implications of cirrhosis-related deaths, offering valuable insights for policymakers and healthcare professionals.

Results: In 2022, 45% of cirrhosis deaths occurred among individuals of working age. This resulted in the loss of 20,190 years of potential life lost (YPLL), contributing to productivity losses totalling €20.4 billion over a decade. These statistics highlight the significant economic and societal burdens associated with cirrhosis mortality.

Conclusions: Over the past two decades, there has been a global increase in alcohol consumption, a trend expected to persist and possibly escalate through 2030. As a direct consequence, projections indicate a corresponding increase in cirrhosis-related deaths over the coming decade. This anticipated rise underscores the ongoing public health challenge posed by alcohol-related liver diseases worldwide.

KEYWORDS: alcohol-related diseases; cirrhosis; productivity loss; human capital approach

1. INTRODUCTION

Excessive alcohol consumption significantly contributes to illness and death worldwide (1). Global per-capita alcohol consumption increased from 5.5 litres in 2005 to 6.4 litres in 2016 and is expected to reach 7.6 litres by 2030 (1). In 2019, alcohol was linked to approximately 25% of cirrhosis-related deaths globally (1). Due to the increasing prevalence of obesity and higher alcohol consumption, along with advancements in managing hepatitis B and C infections, the epidemiology and burden of cirrhosis are shifting (2). While viral hepatitis continues to be the leading cause of cirrhosis worldwide, the prevalence of non-alcoholic fatty liver disease (NAFLD) and alcohol-associated cirrhosis is increasing in several regions (2). NAFLD encompasses a broad spectrum of conditions, ranging from non-alcoholic fatty liver (NAFL), which is characterized by simple steatosis without inflammation, to metabolic dysfunction-associated steatohepatitis (MASH), marked by liver steatosis accompanied by inflammation and hepatocyte ballooning (3). MASH can progress to advanced fibrosis, cirrhosis, and hepatocellular carcinoma (3). NAFLD is closely associated with metabolic disorders such as obesity, diabetes, hypertension, and dyslipidaemia (4).

Cirrhosis results in more hospitalizations, readmissions, longer stays, and worse outcomes compared to other common chronic diseases (5). In the United States, the burden of cirrhosis and chronic liver disease is estimated to be around $2.5 billion in direct costs, with indirect costs reaching up to $10.6 billion (5). While liver biopsy is the gold standard for staging liver fibrosis and diagnosing cirrhosis, it is invasive, expensive, and has technical limitations, such as sampling error and variability in histological interpretation, making it impractical for routine screening or diagnosis (6). Several non-invasive tests are available for staging liver fibrosis. These include blood-based

biomarkers like Fib-4, and methods that assess liver stiffness, such as vibration-controlled transient elastography and magnetic resonance elastography (6).

The number of deaths from cirrhosis is expected to rise in the coming decade (2). Therefore, enhanced efforts are needed to promote primary prevention, early detection, and treatment of liver disease, as well as to improve access to care (2). This research aimed to evaluate the economic impact of premature deaths caused by cirrhosis in Spain, highlighting the urgent need for timely and effective interventions.

2. MATERIALS AND METHODS

The data for this study was sourced from the Instituto Nacional de Estadística (INE), which provides comprehensive information on cirrhosis-related fatalities through its Death Registry. This comprehensive dataset includes critical details such as the age and gender of the deceased individuals, forming the basis for our analysis (7,8). Employment rates were derived from the Labour Force Survey conducted by INE, and detailed salary data, including monetary and non-monetary compensation, was obtained from the Spanish Structural Wage Survey. The study spans a 10-year period, from 2013 to 2022, to incorporate the most recent and relevant data available.

The methodology used to estimate productivity loss was based on the Human Capital (HC) approach (9,10). This framework measures a person's economic contribution to society by their potential earnings, with premature death representing a loss of future productivity. We employed a simulation model to estimate the productivity losses resulting from premature deaths caused by cirrhosis. This model incorporated the age at death, gender-specific employment rates, and average wages. Our assessment

focused exclusively on losses in labour productivity and did not account for unpaid work or leisure activities.

The analysis consisted of three main steps. First, the years of potential life lost (YPLL) were calculated by determining the total life expectancy lost due to premature deaths, broken down by age and gender. Next, the years of potential labour productive life lost (YPLPLL) were estimated by focusing on deaths that occurred before the legal retirement age of 65. This step considered the working years that would have been completed if the individual had lived until retirement. Finally, labour productivity losses (LPL) were calculated by multiplying the productive years lost by age- and gender-specific wages and adjusting for employment rates (11).

Salary data from 2013 to 2021 was used in the analysis due to the unavailability of 2022 data. An annual discount rate of 3% was applied to future income values to account for the time value money (12), with additional sensitivity analyses using rates of 0% and 6%.

The HC approach provides essential insights into the economic impact of premature mortality, informing resource allocation decisions (13). While this method is widely used, alternative approaches also exist. The friction cost method, for instance, estimates losses based on the time required to replace a worker, offering a more short-term perspective on productivity loss (14). Additionally, the willingness-to-pay approach evaluates intangible costs, such as pain and suffering, by assessing them a monetary value (15).

3. RESULTS

Gender analysis

The results presented in Table 1 and Figure 1 indicate a significant gender disparity in cirrhosis-related fatalities, with the number of male deaths approximately double that

of females. This gender disparity in mortality rates highlight the need for healthcare strategies and interventions tailored to address gender-specific risks and outcomes. Additionally, about half of the males' fatalities occur within the working age population, while only 30% of female fatalities fall into this category.

Age analysis

Figure 1 shows that there is a noticeable concentration of deaths occurring predominantly between the ages of 50 and 80, with a peak observed around the age of 65, which coincides with the typical age of retirement. This age distribution highlights a critical period in which mortality rates are notably elevated, reflecting significant implications for public health and retirement planning. Figure 2 reveals that mortality increases across all age groups up to the 50-54 age group, where it reaches its highest point for both men and women, followed by a gradual decline in older age groups.

In 2013, there were 25,095 YPLL, with nearly one-fifth attributed to women. By 2022, the total YPLL had decreased to16,798, of which 13,173 were attributed to men. A comparison with liver cancer fatalities (Figures 3 and 4) demonstrates that, although liver cancer has a higher mortality rate, productivity losses are greater for cirrhosis. This is because liver cancer predominantly affects individuals beyond retirement age, leading to fewer deaths among the working age population (Figure 5).

Economic analysis

Table 2 translates these mortality figures into monetary terms. Deaths in 2013 resulted in an economic cost of €2,278.46 million, rising to €2,479.11 million by 2021. A sensitivity analysis provided a cost range, estimating the economic impact in 2013 between €2,215.36 million and €2,345.35 million, and in 2021 between €2,410.45 million and

€2,551.89 million. These findings illustrate the increasing financial burden associated with cirrhosis-related deaths over time.

4. DISCUSSION

The results of this study underscore the significant gender, age, and economic disparities in cirrhosis-related mortality and productivity losses. Our findings revealed that male fatalities from cirrhosis were nearly twice as high as those fore females. The age distribution of deaths also presents key insights, with the majority of fatalities occurring between the ages of 50 and 80, peaking around retirement age. Furthermore, the economic analysis demonstrated that the productivity losses associated with cirrhosis-related premature deaths increased from €2,278.46 million in 2013 to €2,479.11 million in 2021. Comparisons with liver cancer mortality data revealed that, while liver cancer has a higher mortality rate, the younger age of individuals affected by cirrhosis leads to greater productivity losses, emphasizing the need for targeted healthcare interventions, early detection, and effective healthcare policies to mitigate the burden of cirrhosis.

A major factor contributing to cirrhosis is the increasing prevalence of alcohol-related liver disease (ALD) and NAFLD. ALD is strongly linked to the growing tendency among younger individuals to abuse alcohol, often in combination with unhealthy dietary habits such as excessive consumption of processed high-calorie foods. These lifestyle trends significantly increase the risk of developing cirrhosis in later years (16). Given this alarming trend, early intervention through alcohol counselling and medication-assisted therapies (MATs) is essential. Psychological disturbances are frequent in ALD patients and addressing these through counselling can improve adherence to sobriety and long-term health outcomes (17). However, despite their proven cost-effectiveness, MATs

remain underused, needing policy interventions to enhance their accessibility and adoption (18).Early detection is crucial in reducing cirrhosis-related mortality, yet diagnosis is challenging, as many individuals with ALD remain asymptomatic until decompensation occurs. Since ALD is potentially reversible with sustained sobriety, regular screening of at-risk populations is vital. This is further emphasized by studies highlighting the importance of early diagnosis through non-invasive methods, which improve patient outcomes and reduce healthcare costs (19). For NAFLD, the economic and health burden is increasing due to the global obesity pandemic, necessitating cost-effective screening strategies (20). Ultrasound has been identified as a simple, affordable, and widely available tool for diagnosing post-NAFLD liver cirrhosis, particularly in individuals with metabolic syndrome (21).

In addition to ultrasound, splenomegaly detection through imaging may serve as a useful marker in assessing liver cirrhosis progression. Studies have emphasized the liver-spleen axis as a critical component in assessing cirrhosis and its evolutive forms (22,23). Incorporating these diagnostic tools into routine screening programs could lead to earlier intervention, ultimately reducing long-term healthcare costs associated to late-stage liver disease.

For patients with advanced cirrhosis, liver transplantation remains the only definitive treatment. However, many patients are ineligible due to organ shortages or comorbidities, needing alternative management strategies. In compensated ALD cases, sustained alcohol abstinence through structured treatment programs has been shown to improve survival rates significantly (17). Despite this, the accessibility and utilization of these interventions remain insufficient, highlighting the need for policy measures to integrate comprehensive addiction treatment into standard hepatology care.

Regarding strengths and limitations of this study, a major strength is its comprehensive analysis of cirrhosis-related mortality and economic burden, providing critical insights into the demographic and financial impact of the disease. The study incorporates a long-term evaluation of productivity losses and healthcare costs, offering valuable evidence for public health interventions. Furthermore, by comparing cirrhosis with liver cancer mortality, this research underscores the unique economic challenges associated with different liver diseases.

However, there are several limitations. First, the study relies on secondary data, which may not capture individual comorbid conditions or the impact of recent medical advancements. Second, our assessment of economic burden focuses primarily on productivity losses and does not account for indirect costs such as caregiving expenses, disability, or quality-of-life reductions. Expanding the economic evaluation to include healthcare expenditures and societal costs would provide a more holistic understanding of cirrhosis-related financial burdens. Additionally, while our analysis extends to 2021, healthcare trends—especially post-pandemic—may have influenced more recent mortality rates and economic impacts, necessitating ongoing monitoring and updated analyses.

5. CONCLUSION

This study underscores the significant economic and health burden that cirrhosis places on the Spanish healthcare system, presenting both challenges and opportunities for healthcare policy and management. With 45% of cirrhosis deaths occurring among the employed and an economic impact of €20.4 billion over the past decade, the profound implications of this disease are clear.

The findings emphasize the need for enhanced public health measures, including widespread screening, early diagnosis, and improved access to alcohol cessation programs. Integrating cost-effective diagnostic tools such as ultrasound and leveraging novel non-invasive assessments could further aid in the timely detection and management of cirrhosis. Moving forward, future research should focus on evaluating the long-term cost-effectiveness of preventive interventions and exploring policy strategies to optimize resource allocation in cirrhosis management. **STATEMENTS AND DECLARATIONS**

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 cirrhosis in Spain and was a major contribution in the intellectual content revision. MA analysed cirrhosis 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

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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	3,657	3,462	3,568	3,426	3,505	3,303	3,269	3,239	3,343	3,294
females	1,371	1,346	1,357	1,253	1,259	1,202	1,195	1,202	1,276	1,186
% Deaths at working age										
males	50.83	48.79	49.50	48.98	46.39	47.35	44.91	46.96	46.96	44.81
females	31.44	29.20	30.58	28.01	32.25	29.03	30.29	32.95	34.48	30.78
YPLL										

males	20,037	18,007	17,858	17,234	16,438	15,152	13,804	14,058	14,445	13,173
females	5,058	4,144	4,335	4,083	4,373	3,787	3,976	3,898	4,415	3,625

Table 2. Productivity losses (in millions €) due to cirrhosis (sensitivity models 0%; 6%)

Year	Premature mortality costs (baseline)	Premature mortality costs (0%)	Premature mortality costs (6%)
2013	2,278.46	2,345.35	2,215.36
2014	2,129.16	2,191.66	2,070.19
2015	2,315.15	2,383.12	2,251.03
2016	2,196.12	2,260.59	2,135.30
2017	2,263.83	2,330.29	2,201.14
2018	2,237.43	2,303.11	2,175.46
2019	2,179.68	2,243.66	2,119.31
2020	2,317.85	2,385.89	2,253.66
2021	2,479.11	2,551.89	2,410.45
Total	20,396.79	20,995.57	19,831.90

FIGURES

Fig.1 Number of deaths per age group in 2022

Fig. 2 Years of potential life lost (YPLL) per each age groups a) Year 2019 b) Year 2020 c) Year 2021 d) Year 2022

Fig. 3 Liver cancer vs Cirrhosis: Total deaths per year

Fig. 4 Liver cancer vs Cirrhosis: YPLL per year

Fig. 5 Liver cancer vs Cirrhosis: YPLL per year: Total deaths per year at employment age