

## **Excess economic burden of multimorbidity: a population-based study in Italy**

### ***Eccesso di costo economico della multimorbilità: uno studio di popolazione in Italia***

Chiara Seghieri, Niccolò Borri, Gaia Bertarelli and Sabina Nuti

**Abstract** In Italy the increasing incidence of chronic disease and multimorbidity are major challenges for health systems. When a patient suffers from more than one chronic condition, the conditions can interact causing a significant increase in patients' care needs. Using healthcare administrative databases of Tuscany region to identify cohorts of chronic prevalent patients and their total direct healthcare expenses, in this paper we aim to study the economic burden of multiple chronic conditions and calculate the excess cost when comorbidities occur in order to assess how combinations of chronic conditions in adults affect total direct health expenditure.

**Abstract** *In Italia la multi morbidità è una sfida importante per i sistemi sanitari. Quando un paziente soffre di più di una condizione cronica, le condizioni possono interagire causando un aumento dei costi sanitari del paziente. Tuttavia, resta da determinare la misura in cui le co-morbilità influiscono sui costi. Utilizzando i database amministrativi sanitari della regione Toscana per identificare le coorti di pazienti prevalenti e le loro spese sanitarie dirette totali, in questo lavoro vogliamo studiare l'onere economico a carico del Sistema Sanitario Nazionale di molteplici condizioni croniche e calcolarne l'eccesso di costo quando si verificano co-morbilità al fine di valutare come le combinazioni di condizioni croniche negli adulti incidono sulla spesa sanitaria diretta totale.*

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**Key words:** Health Care Costs, Multimorbidity, Comorbidity, Expenditures, Administrative Data.

## 1 Introduction and background

The Italian National Health System is going through a period of strong criticality and reflection, with reference to its sustainability at an economic-financial level. This occurs for several reasons, including the gradual increase in subjects suffering from Noncommunicable diseases (NCDs) that require adequate continuum of care. NCDs, also known as chronic diseases, are recognised as the leading causes of death and disability worldwide. According to WHO, 70% of the deaths worldwide are due to NCDs. Multimorbidity, which is the presence of two or more chronic conditions in the person, is particularly relevant in Italy where more than 7 million people - 11.7% of the total population - are more than 75 years old and 42.3% of them have multiple chronic conditions (Istat, 2020). As consequence, the increasing of multimorbidity is a major health-related challenge for patients, health professionals, and society more broadly: it is associated with poor health outcomes, including increased mortality (Nunes et al., 2016), worse quality of life (Makovski et al., 2019), functional decline and increasing use of healthcare services (Ryan et al., 2018) thus imposing considerable economic burden on health systems (Wang et al., 2018). Nonetheless, many people with chronic conditions, and in particular those with multiple conditions, are still failing to receive appropriate care. Despite the guidelines that lead to suggesting bringing the patient to the center of the health care process (Starfield, 2009), health care systems are still organised around a single disease model with professionals working in a fragmented way, focusing on the intervention for the treatment of a specific disease rather than on the patient overall. Prevention and treatment services should shift from a single disease focus to a person-centred approach, so that morbidity gains match that of longevity; a health, rather than simply illness, approach to the prevention and care of patients is warranted to protect and promote maintenance of good health and to contribute to the sustainability of the health systems (Pearson-Studdard, 2019).

Knowing the absorption of resources related to the chronic population in charge by the Health System is very important and can help policy and decision makers in the health planning phase, in order to allocate adequate resources with respect to the entire path of diagnosis and treatment of these patients. In this sense, the present study aims at identifying, quantifying, and characterizing in terms of demographic characteristics and direct costs the combinations of chronic disease in a population of multimorbid patients in Tuscany Region (Italy). We will then estimate the economic burden of multiple chronic conditions by identifying selected conditions and calculating the excess costs of the specific condition when other conditions co-occur in order to know more about how combinations of chronic conditions in adults affect total direct health care expenditures and increase awareness among health profes-

sionals on how the healthcare delivery should move to a value-based health service, based on patient perspective and needs.

## 2 Data and Methods

We conducted a population-based study using administrative healthcare data of the Tuscany region at the individual level. This study utilizes a database consisting of all residents enrolled in the Tuscan health care system, aged 16 or more, alive in 2019 and who were classified as affected or not affected by one or more specific chronic diseases according to administrative data algorithms.

The Tuscany healthcare administrative databases contain information on all public and private accredited healthcare providers. The individual-level databases used in the present study include: (i) hospital inpatient data; (ii) emergency care data; (iii) outpatient care data; (iv) drug prescription data (v) exemption data; and (vi) registered person database which contains demographic information on all residents enrolled in the Tuscan health care system including, sex, date of birth and date of death. The different administrative databases were linked at the individual (patient) level through a unique identifier. Aggregate direct care costs of the year 2019 (1 January 2019 and 31 December 2019) were calculated for each selected chronic patient by considering cost information from the following administrative databases: inpatient care (DRG tariffs), drugs (net costs) and outpatient services (outpatient tariffs), emergency department care (tariffs).

In order to conduct our analysis, we selected six non-communicable diseases that contribute to the bulk of deaths, preventable disabilities and morbidity worldwide, namely heart disease, heart failure, stroke, cancer, diabetes, and chronic respiratory disease (World Health Organization, 2020).

Direct care costs for the selected prevalent population were estimated using Generalized Linear Models (GLMs) given the low number of zero costs (1.6%). Three different GMLs were tested, specifying several families (Gamma, Poisson, Inverse Gaussian) and a link log. To decide on the correct specification of the model, we employed the Modified Park test and Pregibon's Link test which indicated that the Poisson-Log link model was adequate compared to other types of distributions. More specifically, we run a log-poisson model separately for each of the six selected pathologies using as independent variables: gender, age classes (16-34, 35-54, 55-69, 70-84 and over 85), the 5 binary chronic disease variables and the interaction of each pathology with each of the other selected pathologies. Additionally, in order to control for the presence of a chronic condition outside of the list of the other 5 selected chronic conditions, we also added a variable for the number of any other chronic condition, and interaction between the number of other chronicities and each of the selected disease. The estimated excess costs of one condition when other co-occur were then estimated through the recycled predictions methods (Glick et al., 2014). The increase in healthcare expenditure attributable to each selected disease

was estimated by subtracting average predicted expenditure for sick people from average predicted expenditure for the individuals with the other disease variables set to 0 or 1 in case of comorbidity for a given disease. This allows us to analyze the excess cost of chronic combinations using all the permutations for every possible couple of diseases. Therefore we were able to simulate the impact of a specific chronic condition on an already existing one among the six considered, and controlling for the presence of any other co-occurring chronic condition. With this method, as an example, we were able to estimate the excess cost attributable to diabetes in a cohort of patients with cancer and vice versa. All considered models were also run separately by gender to analyse potential gender differences in the excess costs for each combination of conditions.

### 3 Preliminary Results

Overall, in 2019, 1,257,413 (approx. 40%) of the 3,203,190 registered residents in Tuscany aged 16 years old or more, had one or more of the 36 chronic diseases identified by the algorithms and were included for analysis. Among these patients, 55% were female and 45% men; as expected, the percentage of patients with at least one chronic condition increased with increasing age (Table 1).

The economic burden of chronicity in 2019 was 30% of the total healthcare expenditures (23,5% only considering the selected six diseases) and, on average, the yearly direct costs per patient with at least one chronic condition were 2436€ (SD 6913€). Multimorbidity affected about half of the chronic patients (39% of all Tuscan population aged 16 years or more having two or more chronic conditions) and the average number of conditions per person was equal to 1.97 (SD 1.28).

The six conditions identified for the study counted for 50.25% of the chronic cases (69% if excluding hypertension and hypercholesterolemia) and 77% of the healthcare expenditures of chronic patients. Of these identified diseases, heart disease accounted for the highest number of cases (21.1%) followed by cancer (15.7%), COPD (7.7%), heart failure (6.7%), diabetes (6.4%) and stroke (6.3%) (Table 2). Among these conditions, the most prevalent combinations, as expected, were heart disease with heart failure (5.1%) followed by diabetes with heart diseases (4.7%). Table 3 shows that for all the six selected conditions, healthcare expenditures increased with each additional chronic condition (each different morbidity counts one for this analysis), with, approximately an exponential trend, except for cancer which is likely to show a linear behaviour on costs as the number of chronic conditions increases.

### 4 Strengths, limitations and future analyzes

The proposed short paper present preliminary results of the analysis of costs of the healthcare system in multichronic patients for residents in Tuscany through adminis-

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	N	%	Mean of chronicities	Std. Dev.
16-34	50884	4.05%	1.14	0.44
35-54	219942	17.49%	1.35	0.74
55-69	368943	29.34%	1.78	1.1
70-84	451184	35.88%	2.3	1.38
85+	166460	13.24%	2.6	1.5
Male	563629	44.8%	2.08	1.35
Female	693784	55.2%	1.88	1.2
1 condition	633066	50.35%		
2 conditions	297368	23.64%		
3 conditions	162302	12.91%		
4 conditions	87960	7.00%		
5 conditions	44077	3.51%		
6 + conditions	32640	2.59%		

**Table 1** Number and percentages of patients with chronicities in patients group according to age, sex and number of chronicities. Percentages sum up to 100 since we considered the share of each class over the total number of chronic and multichronic patients in Tuscany, t-test for gender gives us a significant difference between the two group in the number of chronicities, a oneway ANOVA test is performed for the groups of age range giving again significant difference in the number of chronicities.

	Prevalence rate	Diabetes	Heart failure	Heart disease	Stroke	COPD
Diabetes	16.4%					
Heart failure	21.1%	4.7%				
Heart disease	6.7%	2.0%	5.1%			
Stroke	6.3%	1.5%	3.2%	1.1%		
COPD	7.7%	1.4%	2.8%	1.5%	0.9%	
Cancer	15.7%	2.1%	3.1%	1.0%	1.0%	1.3%

**Table 2** Prevalence of the combination of the six selected index chronic conditions in the study population.

Index disease	One disease	Two diseases	Three diseases	Four diseases	Five diseases	Six or more diseases
Diabetes	995(±29)	1680(±33)	2615(±53)	4030(±90)	5757(±127)	9175(±165)
Heart failure	2434(±308)	2166(±148)	3472(±102)	4805(±126)	6361(±136)	9514(±167)
Heart disease	1254(±47)	2874(±105)	4283(±118)	5692(±141)	7344(±194)	9988(±199)
Stroke	3295(±305)	3763(±169)	4282(±218)	5068(±141)	6110(±168)	8941(±186)
COPD	1700(±59)	2408(±47)	3445(±48)	4744(±77)	6390(±102)	9326(±140)
Cancer	3918(±78)	4720(±88)	5607(±101)	6816(±167)	8159(±210)	10445(±435)

**Table 3** Costs in euros for the six selected index chronic conditions according to the number of comorbidities. Each different morbidity counts one for this analysis.

trative data. Estimates of the excess costs of a specific chronic condition when other chronic conditions co-occur, also stratified by gender, are an ongoing research. There are limitations to this study. It utilizes only administrative data sources, which although widely available at reasonable cost, refer to health problems for which people seek medical care, therefore they might not provide correct prevalence for specific diseases. Additionally, they do not provide information on the gravity of the diseases and socio-economic details of the patients. Moreover, the type of data only allows the identification and estimation of direct medical costs thus underrepresenting the economic burden of the care of multimorbidity. It is also important to underline that in our analysis only 6 chronic diseases are considered and they only concern the 23.5% of healthcare costs in Tuscany, even if they contribute to most of deaths and preventable disabilities (World Health Organization, 2020). As to the strengths, this is a population study covering a large and well-characterized population with chronic conditions, and to the best of our knowledge it is the first study that shows the extent to which combinations of selected conditions contribute to the excess cost burden associated with multicronicity in Italy.

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# Depression-free life expectancy among 50 and older Americans by gender, race/ethnicity and education: the effect of marital disruption

## *Aspettativa di vita libera dalla depressione tra gli americani over 50 per genere, etnia e istruzione: l'effetto della rottura del legame matrimoniale*

Alessandro Feraldi and Cristina Giudici

**Abstract** Depression is a common mental health disorder, positively associated with mortality and morbidity, especially in the elderly. The study examines differences in Depression-Free Life Expectancy by gender, race/ethnicity, education and marital status between 2012 and 2018, using a cohort of 50 and older Americans of the Health and Retirement Study. On average, people not in union anymore could expect to live less years in total as well as less years free of depression than people in union. Women, who were also more likely to be not in union anymore, could expect to live more years with depressive symptoms in late life than men. Estimates of depression-free life expectancies are important as they may contribute to the definition of current and future social and medical service needs and policies.

**Abstract** *La depressione è un disturbo mentale comune, associato positivamente a mortalità e morbilità, soprattutto negli anziani. Lo studio esamina le differenze nell'aspettativa di vita libera da depressione per genere, etnia, istruzione e stato civile tra il 2012 e il 2018, utilizzando una coorte di americani over 50 intervistati attraverso l'indagine Health and Retirement Study. In media, gli individui non più coniugati possono aspettarsi di vivere meno anni in totale e meno anni liberi dalla depressione rispetto a quelli sposati. Le donne, le quali hanno maggiore probabilità di non essere più sposate, possono aspettarsi di vivere più anni con sintomi depressivi in tarda età rispetto agli uomini. Le stime dell'aspettativa di vita libera dalla depressione sono importanti in quanto possono contribuire alla definizione delle esigenze e delle politiche dei servizi sociali e medici attuali e futuri.*

**Key words:** depression-free life expectancy, multistate life tables, marital disruption, ethnic groups, educational differences, gender differences

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## 1. Introduction

Depression is among the most common mental disorder worldwide that can adversely affect both mental and physical health [12]. In 2015, the prevalence of depression and the lifetime prevalence in the global population were 4.4% and 10.0%, respectively [12]. Additionally, it has been observed a positive associations of depression with mortality and morbidity [7, 12]. Although this increased mortality risk may be indirectly caused by chronic conditions and risky behaviours (e.g. excess in alcohol and drug abuse), depression is likely to be responsible for a proportion of the increase in mortality risk [7].

Important studies have shown a higher prevalence of depressive symptoms among women compared to men at various stages of the life-course in the U.S. In their meta-analysis of 24 studies on people aged 75 and older, Luppá and colleagues [10] found that the men-to-women depression prevalence ratio of was 1:1.4–2.2. Yet, several studies have shown that gender differences in life expectancy are partially explained by social and economic status which differ not only by gender but also by education, ethnicity and marital status [1, 10, 11]. For example, low educational attainment is associated with higher depressive symptom burden in older adults [11]. Other evidences in the U.S. suggested that Black older adults have higher depressive symptoms and psychological distress than White, whereas Hispanics have lower lifetime prevalence of major depressive episodes [2].

## 2. Marital disruption and depression

It is generally well recognised that marital status and transitions have important implications for health. On the one hand, marriage can be protective for health and reduce morbidity and mortality: compared to unmarried people, separated, divorced and widowed generally have greater social and financial support, overall healthier behavioural patterns. On the other hand, marital disruption, such as separation, divorce and widowhood, are stressful life events that have been associated with poor health and survival outcomes [5]. Although divorces that occur after age 50 (grey divorce) has doubled between 1990 and 2010, marital disruption in late life mostly occurs through spousal death. Recent marital disruption has been associated with increased alcohol intake and decreased body mass index in men, whereas it has been associated with higher risk of smoking initiation/relapse in women [5]. Some studies found that men are more likely to experience widowhood-related depression than women [8]. In a recent study on a sample of middle-aged and older Australian adults, after adjusting for socio-demographic characteristics, the authors found that people who recently divorced had much higher odds depression (OR = 2.9) and divorce had a much stronger impact on depression in men than women [5]. Finally, to date, there has been limited longitudinal research on how divorce/widowhood affects mental health expectancies

As shown, several studies have provided important estimates of the prevalence of depressive symptoms and major depressive symptoms among older adults in U.S. as well as the factors associated with this condition. However, little is known about the dynamics of length of life with and without depression among recent cohorts of U.S. older adults and the effect of marital disruption, particularly by gender, race/ethnicity, and educational attainment. Although early reports provided estimates of mental ill-health and depression-free life expectancies in the mid-to-late 1990s, studies on this field have slowdown.

The aim of this study is to estimate the life expectancy with depression (DepLE), the depression-free life expectancy (Dep-FLE) as well as the total life expectancy (TLE) by

Depression-free life expectancy among 50 and older Americans: the effect of marital disruption gender in U.S. adults and examine differences in race/ethnicity and education over a 7-year period (2012–2018). Additionally, we investigate differences in Dep-FLE due to distinctive marital status: in union and not in union.

### **3. Data and methods**

#### ***3.1 Sample***

The study uses data from the RAND version of the Health and Retirement Study (HRS), an ongoing nationally representative longitudinal survey of health characteristics of U.S. men and women aged 50 and older, with oversampling of minority ethnic groups [4]. Participants have been interviewed approximately every two years from 1992 to 2018 and several other cohorts have been added at each wave. Data on vital status and month and year of death are obtained through the mortality register and exit interviews. RAND HRS version is a user-friendly longitudinal data file, which is cleaned and compiled by the RAND Corporation [4]. After excluding 533 HRS respondents aged 50 years or older in 2012 who were never married (2.7%), the analytic sample consisted of 19,315 individuals.

#### ***3.2 Measurements***

Depressive symptoms were measured using the eight-item Center for Epidemiologic Studies Depression scale (CESD-8). The eight-item CESD is a commonly-used and validated depressive symptom measure in older adults and it is computed as the sum of eight indicators: depression, everything is an effort, sleep is restless, felt alone, felt sad, could not get going (negative indicators) and felt happy and enjoyed life (positive indicators). A cut-off score of three was used as suggested by previous validation studies to indicate clinically relevant depressive symptoms: in each survey wave, a participant was classified as having a depression if one scored three or above on the CESD-8 in that wave. Information on marital status and race/ethnicity and educational attainment were included in the analysis: marital status was categorized as currently in union (i.e. married/partnered), hereafter “in union”, and not in union anymore (i.e. divorced, separated and widowed), hereafter “not in union”; ethnicity was categorized as “White” and “non-White” (Black, Hispanic and others); education was categorized as “lower educated” (less than high school degree, high school degree or General Education Development, GED) and “higher educated” (some college, and college or more).

#### ***3.3 Statistical analysis***

In order to estimate the age-specific hazard rates of transitions to depression, recovery and death, multistate life tables approach (MSLTs) were used. MSLTs is a Markov modelling of stochastic processes that involves individuals moving between a finite number of states over time, including exit and re-entry into the same state [6]. It allows to incorporate covariates into the models to relate individual characteristics to intensity rates and probabilities to better