Ann Ist Super Sanità 2015 | Vol. 51, No. 4: 291-297
DOI: 10.4415/ANN_15_04_08

A population-based study of the years of life lost in the Friuli Venezia Giulia region, Italy

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Abstract

Background. The number of years of life lost (YLL) in a population depends not only on the number of deaths but also on the age at which the deaths have occurred, and, as a measure of the burden of premature mortality, is an important piece of information for public health professionals.

Methods. We calculated YLL in the population of Friuli Venezia Giulia, a 1 200 000 inhabitant Italian region, in 2013 and the trend in the past 14 years, through a population-based study using the regional mortality database as the source of information. The same projected life expectancy estimates for 2050 were used for calculating YLL both in males and females, for each calendar year.

Results. In 2013, we counted 14 080 deaths and estimated 220 961 YLL. Malignant neoplasms and cardiovascular diseases accounted for the greatest number of YLL. Injuries had the highest number of YLL per death. Overall, YLL decreased from 2000 to 2013, but differences were observed for different causes of death. Cancers, cardiovascular diseases, and unintentional injuries showed a decreasing trend, whereas infectious diseases resulted increasing over time.

Conclusion. This study, estimating the relative impact of different conditions on the society though the YLL, is a relevant input for the regional public health agenda.

Key words

- years of life lost
- premature mortality
- causes of death
- Italy

INTRODUCTION

Mortality data have been used for decades to assess the health status of countries and for epidemiological research [1, 2]. In addition to the occurrence of deaths alone, however, a knowledge of the age at death is also important to quantify the burden of premature mortality, *i.e.*, the years that a person would have lived if he or she had not died prematurely. Recently, the years of life lost (YLL) have been given great emphasis especially thanks to the Global Burden of Disease Study [3-5]. The YLL is one of the two components of the disability adjusted life year (DALY), a measure of the lost years of healthy life, which combines information on mortality and healthy years lost because of disability and which has been largely used as a summary measure of population health, at global, national, and local levels [6-9].

At a population level, the YLL may be more useful than the simple number of deaths when programming prevention interventions or when allocating public health resources, because they give different emphasis to deaths occurring at different life stages. In addition, monitoring changes in the burden of premature mortality over time may help assessing the effectiveness of prevention and care programs. For a certain disease or condition, YLL may change over time due to different factors: on one side, changes in the incidence of that disease (primary prevention, changes in lifestyle and in environmental exposures); on the other side, changes in the effectiveness of treatment (secondary and tertiary prevention, innovative drugs and treatment strategies); finally, changes in mortality from competing causes.

Friuli Venezia Giulia (FVG) is a Northeastern Italian region with approximately 1 200 000 inhabitants and a special status allowing some autonomy in the health policy. To provide some basis for the preparation of the next regional prevention health plan for the years 2014-2018, we analyzed the burden of premature mortality, as the YLL due to different causes, in 2013 and the trend of premature mortality from 2000 to 2013 in FVG.

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METHODS

For this study, we analyzed mortality data from the regional mortality database of FVG which covers the entire regional population. In the region, the causes of the residents' deaths, reported on the death certificates by the medical examiners, are coded by personnel of the local health agencies according to the 9th revision of the International Classification of Diseases (ICD-9). Later, copies of the death certificates are sent to the National Institute of Statistics (Istat) which assigns codes according to the 10th revision of the International Classification of Diseases (ICD-10) to the causes of death, regardless of the codes assigned at the regional level. Therefore, causes of death coded at the regional and national level might differ, either due to differences in the ICD versions used or to different interpretations of the causes reported in the death certificates.

Since individual death records coded at the national level by Istat are not routinely available to local researchers, we analyzed data from the regional mortality database for the years 2000 to 2013. Death records are anonymous and include information on the causes of death (ICD-9 codes for diseases an injuries 001-999), on the external causes of injuries an poisoning (ICD-9 codes E800-E999) where applicable, on the deceased sex and date of birth, and on the date of death.

The years of life lost YLL were calculated as:

$\sum_i$ (number of deaths at age$_i$) × (the potential life expectancy at age$_i$).

No social values (*e.g.*, time discounting and age weights) were incorporated in the calculation.

For potential life expectancy, we used the frontier life expectancy projected for the year 2050 by the World Population Prospects 2012 provided by the United Nations [10], as suggested by the World Health Organization [11], based on the fact that it may not be appropriate to set the normative loss of years of life in terms of currently observed death rates, since even for the lowest observed death rates some deaths can be prevented. In addition, since the observed death rates in a population change over time, the use of a unique frontier life expectancy allowed us to calculate YLL in the same way for different years. The United Nations' standard life expectancy is set at 91.9 years at age 0 and is the same for males and females.

Causes of death were classified based on the ICD-9 codes following the Global Burden of Disease 2000 project [12] into three broad groups: communicable, maternal, perinatal and nutritional conditions (group I, CMPN); noncommunicable diseases (group II, NCD); and injuries (group III, INJURY). In addition, we allowed for a fourth group for ill-defined conditions (ILLDEF). Deaths were also classified according to a second-level grouping (21 categories plus 2 for ill-defined conditions) as in the Global Burden of Disease 2000 project [12]: I-A. Infectious and parasitic diseases; I-B. Respiratory infections; I-C. Maternal conditions; I-D. Conditions arising during the perinatal period; I-E. Nutritional deficiencies; II-A. Malignant neoplasms; II-B. Other neoplasms; II-C. Diabetes mellitus; II-D. Endocrine disorders; II-E. Neuro-psychiatric conditions; II-F. Sense organ diseases; II-G. Cardiovascular diseases; II-H. respiratory diseases; II-I. Digestive diseases; II-J. Genito-urinary diseases; II-K. Skin diseases; II-L. Musculo-skeletal diseases; II-M. Congenital anomalies; II-N. Oral conditions; III-A. Unintentional injuries; II-B. Intentional injuries; U1. Ill-defined diseases; U2. Ill-defined injuries/accidents.

For the year 2013, we calculated the YLL and the average YLL (AYLL, *i.e.*, the total cause-specific YLL divided by the total cause-specific deaths). Also, the death and YLL rates for each cause were calculated by dividing the total cause-specific deaths or YLL by the annual regional population. We also calculated death rates directly standardized by age category (0-14, 15-64. 65-74, ≥75 years) using the total regional population as the standard. The deaths, and AYLL for each cause were calculated for each year from 2000 to 2013. Time trends were tested through the nonparametric Mann-Kendall test. All analyses presented for males and females separately.

The analyses were conducted using SAS Enterprise Guide v7.1 (SAS Institute Inc. Cary, NC, USA). Trends were tested through XLStat 2015 (Addinsoft).

RESULTS

In 2013, 14 080 deaths were recorded in the regional mortality database of Friuli Venezia Giulia among the residents of the region, which determined 220 961 YLL. The deaths, YLL, rates, and AYLL for each broad group of causes is shown in *Table 1*. The absolute number of deaths and the crude mortality rate are greater among women than men, for all groups of causes except injuries. However, the age-standardized death rate, the AYLL and the number of YLL are greater among men. In both sexes, the relative weight of injuries is almost double when considering YLL instead of deaths.

Figure 1 shows the YLL and the AYLL for each of the 23 second-level cause of death groups in 2013. Malignant neoplasms and cardiovascular diseases accounted for the greatest number of YLL in both sexes (respectively 46 466 in males and 38 857 in females, and 31 139 in males and 27 878 in females). The proportion of YLL from malignant neoplasms (39% in males and 38% in females) was greater than the proportion of deaths (35% and 26%, respectively), whereas the proportion of YLL from cardiovascular diseases (26% in males and 27% in females) was smaller than the proportion of deaths (30% and 37%, respectively), as shown in *Figure 2*, which highlights conditions with a different relative frequency for deaths and YLL. For both intentional (1.4% of deaths and 2.8% of YLL in males; 0.4% of deaths and 1.8% of YLL in females) and unintentional injuries (2.4% of deaths and 4.0% of YLL in males; 1.3% of deaths and 1.8% of YLL in females), the percentage of deaths was smaller than the percentage of YLL. On the contrary, for respiratory infections and respiratory diseases in both sexes and neuro-psychiatric conditions among females, the proportion of deaths was greater than that of YLL.

Among males, the annual number of deaths has decreased from 2000 (N = 6921) to 2013 (N = 6539). Among females, on the other hand, deaths have remained steady (from 7599 in 2000 to 7541 in 2013).

Table 1
Years of life lost by sex and broad group of death causes in Friuli Venezia Giulia, Italy, 2013

Cause	Males							Females						
	Deaths	Deaths %	YLL	YLL %	Deaths/ 10 000 Crude (standardized)	YLL/ 10000	AYLL	Deaths	Deaths %	YLL	YLL %	Deaths/10 000 Crude (standardized)	YLL /10 000	AYLL
I-CMPN	477	7.3	7648	6.4	8.0 (10.0)	128.6	16.0	571	7.6	6838	6.7	9.0 (7.6)	107.7	12.0
II-NCD	5598	85.6	99547	83.2	94.1 (112.9)	1673.9	17.8	6513	86.4	87556	86.4	102.6 (87.6)	1379.4	13.4
III-INJURY	247	3.8	8142	6.8	4.2 (4.5)	136.9	33.0	130	1.7	3423	3.4	2.0 (1.9)	53.9	26.3
U-ILLDEF	217	3.3	4307	3.6	3.6 (4.3)	72.4	19.8	327	4.3	3499	3.5	5.2 (4.3)	55.1	10.7
Total	6539	100	119644	100	110.0 (131.8)	2011.8		7541	100	101317	100	118.8 (101.3)	1596.2	

CMPN: communicable, maternal, perinatal and nutritional conditions; NCD: noncommunicable diseases; INJURY: injuries; ILLDEF: ill-defined conditions; YLL: years of life lost; AYLL: average years of life lost per death.

Nonetheless, YLL have decreased in both sexes: from 149 559 to 119 644 in males, and from 116 144 to 101 317 in females. *Table 2* illustrates, for each second-level cause of death, the changes in deaths, YLL, and AYLL from 2000 to 2013. For both males and females, both the deaths and YLL due to infectious diseases and respiratory infections increased during the study period. Among females, we also observed an increase in the deaths from neuro-psychiatric conditions and in deaths from genito-urinary diseases. In males, we noticed an increased in deaths from respiratory diseases. Deaths and YLL due to cardiovascular diseases, digestive diseases, and unintentional injuries decreased during the study period in both males and females. In both sexes, YLL due to malignant neoplasms also decreased, despite the number of deaths did not. AYLL decreased for many conditions: malignant neoplasms, cardiovascular diseases, digestive diseases, genito-urinary diseases, and unintentional injuries in both sexes; in females, AYLL due to neuro-psychiatric diseases also decreased.

DISCUSSION

With this study, we estimated the burden of premature mortality in Friuli Venezia Giulia, based on the calculation of the YLL. For this estimate, we used the new projections of standard life expectancy for 2050 developed by the United Nations [10]. On one side, this had the disadvantage to overestimate the YLL as compared with previous studies, because the projected life expectancy is a sort of maximum average duration achievable by humans, greater than the values actually estimated for the population of this region [13]. On the other side, however, this had several advantages. First, the projected life expectancy is not influenced by preventable deaths which currently occur in the population, as is observed mortality. Second, if we assume that such a projection is a theoretical maximum life expectancy, we can apply it to both males and females and to populations of different years, thus allowing comparisons against the same standard.

Consistently with other older population-based studies conducted in Europe in contexts comparable to our region (a Spanish study reporting data from 2008 [14] and a Serbian one with data from 2000 [15]), noncommunicable diseases accounted for the largest amount of deaths and YLL in our region (over 80% of YLL), in particular malignant neoplasms and cardiovascular diseases, whose relative frequency with respect to YLL from all causes of death was even higher than in Spain [14], On the contrary, the relative burden of premature mortality due to unintentional injuries in our region was approximately half than in Spain [14]. Overall, in both genders the relative frequency of YLL from injuries in our population was also much lower than in Serbia [15]. However, this comparison deserves caution because the Serbian data are 13 years older than ours. Despite reporting a lower relative importance of cancers and a higher importance of cardiovascular diseases than in our study, an Italian article with mortality data from 1998 [16] also indicated cancers and cardiovascular diseases as the leading causes of death and of YLL, and described the same phenomenon that we observed, *i.e.*, the proportion of YLL from cancers being greater than the proportion of deaths, and the proportion of YLL from cardiovascular diseases being smaller than the proportion of deaths.

Overall, despite females experienced more deaths than males, the YLL were fewer and, in fact, the AYLL were smaller among females. This indicates either that diseases and conditions are incident at younger ages in males, or that in males those diseases are more quickly fatal. Intentional injuries were an exception: for this condition, non-negligible in terms of YLL in this regions, AYLL were greater for females (almost 50 years) than for males (less than 40), indicating that efforts to prevent violence are greatly needed and should be mainly targeted toward girls and young women.

Injuries, intentional and unintentional, were responsible for an amount of YLL certainly smaller than cancers and cardiovascular diseases. Nonetheless, the AYLL were the greatest, if we exclude perinatal and congenital condition, which obviously affect infancy and childhood, and maternal conditions which regard young women. This means that, although deaths from

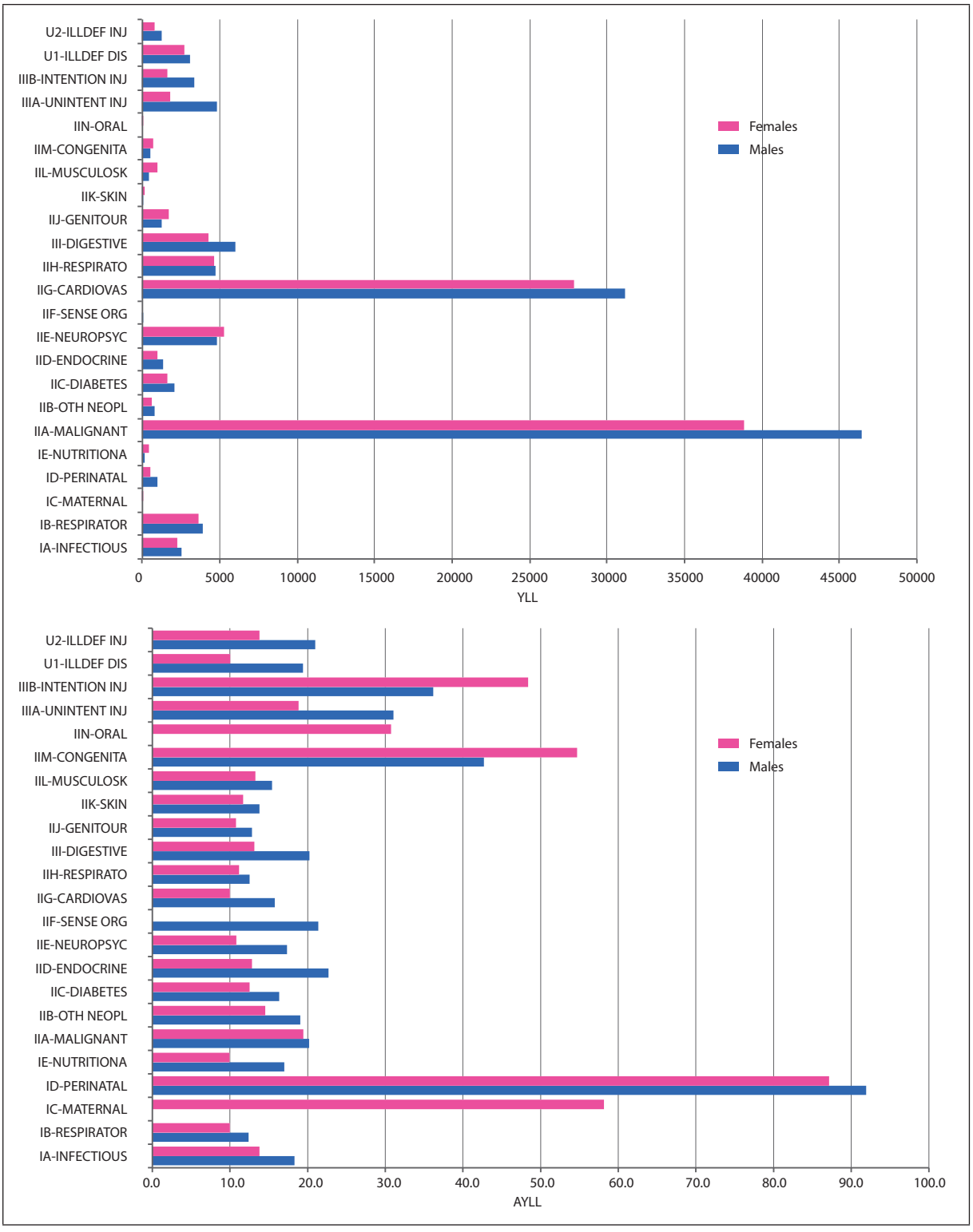

Figure 1
Years of life lost (YLL) and average of years of life lost (AYLL) for each second-level cause of death group, by sex, Friuli Venezia Giulia, Italy, 2013.

injuries are relatively rare in our region, they occur among young people and this should be taken into account when planning the preventive interventions. Similarly to what happens for injuries, the relative importance of YLL due to malignant neoplasms was greater than the relative frequency of deaths. This means that, compared with other conditions, such as cardiovascular and respiratory diseases, the age at death is younger.

Despite the number of deaths did not show a substantial decreasing trend from 2000 to 2013, YLL seem

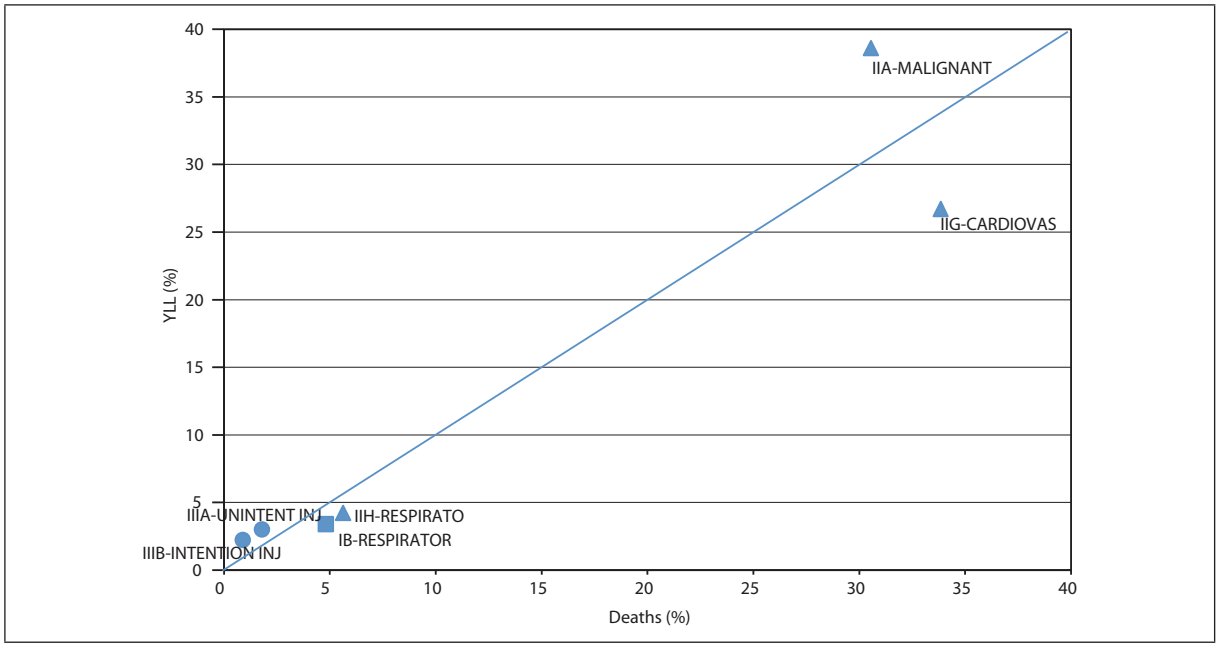

Figure 2
Percentage of years of life lost (YLL) due to specific causes of death and percentage of deaths due to the same causes, Friuli Venezia Giulia, Italy, 2013. Only categories with a difference in the percentages of deaths and YLL of at least 1 percent point are labelled in the graph.

to have decreased in both sexes: mortality has been somewhat postponed, either by reducing deaths or by increasing the age at which death occurred. Looking at specific causes of death, however, we observed that only for certain conditions the YLL decreased over time. For some of them, (*e.g.*, malignant neoplasms) the reduction was only associated with a reduction in AYLL, whereas for others (*e.g.*, cardiovascular diseases and unintentional injuries), it was due to a decrease of both the number of deaths and of the AYLL. In the first case, we may argue that the improvement was due to the disease treatment (*e.g.*, new chemotherapy for cancers which prolong survival) or to secondary prevention (*e.g.*, screening which allowed the detection of cancer at earlier stages, responding better to treatment), whereas in the second both treatment and primary prevention might have had a role. Premature mortality over time should be monitored and any significant changes should be further investigated. In fact, they could reflect the effectiveness of public health policies in the region (or the lack thereof). Infectious diseases and respiratory infections, although not representing leading causes of premature mortality in our population, showed an increasing trend over time, both in terms of deaths and of YLL: increased frequency of travels and mass migrations, favoring the spread of pathogens [17-19], ageing of the population [19], or increased antimicrobial resistance due to improper drug use [19, 20] may be hypothesized as possible causes. Even high-income regions and countries nowadays face challenges related to communicable diseases and should not drop their guard. Antimicrobial use policy, vaccinations, travel medicine, and health promotion among the more susceptible elderly and chronically ill persons are warranted.

The validity of our results is strictly dependent on the validity of the source of mortality data. In the regional database, the ICD-9 codes for the causes of death, imputed by six local coders based on the causes reported by the medical examiners on the death certificates, may differ from the ultimate official ICD-10 codes assigned by the central coders of the national institute of statistics. However, since analyzed broad groups of causes instead of specific codes, it is unlikely that coding errors were macroscopic at the point that our estimates were biased.

The results of this study only depict part of the burden of diseases and injuries in our population. Measures of the years of life lost because of disability and of the quality of life of individuals living with chronic conditions would help characterizing the population and prioritizing public health interventions. However, estimating measures such as the disability adjusted life years (DALY) or the quality adjusted life years (QALY) at a population level is difficult since administrative social and health-related databases lack details on the life of prevalent cases. Ad hoc research on specific conditions is needed to provide a better picture of the health gaps in the population and to improve priority setting and resource allocation. Nonetheless, through the analysis of individual-level mortality data of the entire regional population, we could calculate the burden of premature mortality in FVG and provide public health professionals and policy-makers with accurate information on the impact of different conditions on society. The main results of this analysis will be part of the epidemiological basis of the new regional prevention health plan of FVG, confirming the importance of primary and secondary prevention of cancers and cardiovascular diseases, which determine la largest proportion of YLL, and stressing the need for effective preventive interventions directed at unintentional and intentional injuries, which affect individuals at younger ages.

Table 2
Deaths, years of life lost (YLL), and average years of life lost (AYLL) for different causes of death by sex and calendar year, Friuli Venezia Giulia, Italy*

	Males								Females							
	Deaths				AYLL				Deaths				AYLL			
Cause	2000	2013	Trends	p	2000	2013	Trends	p	2000	2013	Trends	p	2000	2013	Trends	p
I. CMPN																
IA-INFECT	43	138		<0.01	22.3	18.3		<0.01	58	166		<0.01	18.8	13.8		0.01
IB-RESP	207	317		<0.01	13.8	12.4		0.05	205	360		<0.01	10.6	10.0		<0.01
IC-MAT	0	0			-	-			0	1		1.00	-	58.1		0.82
ID-PERINAT	8	11		0.35	84.7	91.9		0.22	13	6		0.13	89.6	87.1		0.25
IE-NUTR	18	11		0.32	15.5	17.0		0.83	28	38		0.02	12.6	9.9		0.01
I. NCD																
IIA-MALIGN	2435	2302		0.04	22.6	20.2		<0.01	1970	1999		0.07	20.9	19.4		<0.01
IIB-OTH NEO	20	39		<0.01	20.6	19.0		0.28	21	42		0.01	19.5	14.5		0.03
IIC-DIAB	119	127		0.10	18.1	16.3		0.13	162	130		0.41	12.8	12.5		0.10
IID-ENDOCR	41	58		0.04	25.0	22.7		0.16	49	75		<0.01	18.6	12.8		<0.01
IIE-NEUROPS	223	276		0.02	19.0	17.3		0.04	372	488		<0.01	14.1	10.8		<0.01
IIF-SENSE	0	2		0.70	-	21.4		0.52	1	0		0.05	40.4	-		0.08
IIG-CARD	2434	1978		<0.01	18.5	15.7		<0.01	3470	2787		<0.01	11.8	10.0		<0.01
IIH-RESP	250	378		<0.01	17.7	12.5		<0.01	191	414		<0.01	12.2	11.2		<0.01
III-DIGEST	380	296		<0.01	24.1	20.2		<0.01	356	323		0.15	17.3	13.2		<0.01
IIJ-GENIT	76	96		<0.01	18.3	12.8		<0.01	68	158		<0.01	16.6	10.8		<0.01
IIK-SKIN	5	6		1.00	13.3	13.8		0.39	15	14		0.03	15.0	11.7		0.39
IIL-MUSC	19	28		0.03	22.2	15.4		0.19	57	70		0.04	12.1	13.3		0.13
IIM-CONGEN	9	12		0.24	48.8	42.7		0.91	12	12		0.78	36.9	54.7		0.33
IIN-ORAL	1	0		0.62	22.2	-		0.27	1	1		0.41	17.8	30.7		0.91
III. INJURY																
IIIA-UNINT	336	155		<0.01	39.1	31.1		<0.01	198	97		<0.01	23.2	18.8		0.01
IIIB-INT	114	92		0.09	39.7	36.2		0.45	50	33		0.03	33.2	48.4		0.59

*Decreasing trends over the 14 years were highlighted in dark grey; increasing trends in light grey.

Author's contribution statement

Francesca Valent conceived the study, conducted the statistical analyses and wrote the manuscript. Loris Zanier conceived the study and critically reviewed the results and the manuscript.

Conflicts of interest statement

None declared.

Received on 7 January 2015.
Accepted on 15 June 2015.

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