RESEARCH PAPER

Worldwide disease epidemiology in the older persons

Camilla Mattiuzzi[1] · Giuseppe Lippi[2]

Key summary points

Aim To provide an overview on the current worldwide disease epidemiology in older persons.

Findings Ischemic heart disease, stroke and chronic obstructive pulmonary disease are the leading causes of disability and death in older people, whilst dementias have displayed the largest increase during the past 16 years.

Message Cancers and dementias will probably display the highest mortality escalation during the next 40 years.

Abstract

Purpose This article provides an overview on the current worldwide disease epidemiology in older persons, analyzing information contained in the World Health Organization (WHO) health data and statistics database.

Methods Epidemiology data on diseases in older persons (i.e., in subjects aged 60 years or older) were retrieved from the official WHO health data and statistics database.

Results Ischemic heart disease (IHD), stroke and chronic obstructive pulmonary disease (COPD) are the leading causes of disability and death in older people, whilst dementias have displayed the largest increase during the past 16 years. With only few exceptions, significant sex difference can be observed in the majority of diseases causing disability-adjusted life years (DALYs) and deaths in older people. DALYs are mostly caused by IHD, malignancies, COPD and cirrhosis in older men; whilst dementias, hearing loss, falls, hypertensive heart disease, back and neck pain and diarrheal diseases cause larger health loss in older women. Death rate for malignancies (except colorectal cancer), COPD, cirrhosis and tuberculosis is larger in older men; whilst mortality for cardiovascular disorders, dementias and diarrheal diseases is larger in older women. IHD is the leading cause of health loss and deaths in nearly all WHO regions, whilst infectious diseases still cause a substantial epidemiologic burden in Africa.

Conclusions Cancers and dementias will probably display the highest mortality escalation during the next 40 years.

Keywords Geriatric diseases · Aging · Epidemiology · Mortality

Introduction

Aging is an irreversible physiological process, which remarkably contributes to modify many biological pathways, thus increasing the risk of developing a kaleidoscope of age-specific pathological conditions or modifying the epidemiology of other pathologies which are commonplace in younger persons [1, 2]. The last World Health Organization (WHO) statistics indicates that the worldwide population could be estimated at 7461.88 million in 2016, 933.50 of whom (12.5%; 502.14 women and 431.36 men) classified as older (i.e., aged ≥ 60 years) [3]. Although subjects with an identical chronological age often exhibit rather dissimilar trajectories of age-related decline, wherein aging is deeply influenced by several genetic, epigenetic and environmental

✉ Giuseppe Lippi
giuseppe.lippi@univr.it

1 Service of Clinical Governance, Provincial Agency for Social and Sanitary Services, Trento, Italy

2 Section of Clinical Biochemistry, University Hospital of Verona, Piazzale LA Scuro, 37134 Verona, Italy

determinants [1], predicting disease trends at population level is essential for health decision-making, thus enabling to plan and implement appropriate healthcare measures aimed at preventing or limiting the medical, societal and economic burden of senescence and unhealthy aging [4]. This is especially relevant considering that the worldwide number of older people will expectedly increase by 3.25-fold during the next 40 years, approximating 3038.77 million by the year 2060 (29.7% of the entire worldwide population) [5]. Therefore, the aim of this article is to provide an overview on the current worldwide disease epidemiology in older persons.

Methods

Epidemiology data on diseases in older persons (i.e., in subjects aged 60 years or older) were retrieved from the official WHO health data and statistics database, published at the end of the year 2018, and containing information on the period between the years 2000–2016 [5, 6]. Briefly, with the Global Health Estimates, the WHO aims to provide complete and comparable worldwide statistics on health loss due to diseases and injuries (i.e., cause-specific disability-adjusted life years; DALYs) and mortality in WHO Members States with a population > 90,000 inhabitants. Estimates are disaggregated by many epidemiologic variables including sex, age and geographic location.

To establish the impact of different pathologies across different ages, we perform specific searches in the WHO database by selecting a number of informative epidemiologic variables such as "age" (i.e., < 60 years and ≥ 60 years), "measure" (i.e., "DALYs" and "deaths"), "year" (i.e., "2000" AND "2016"), "sex" (i.e., "female" and "male") and "Location" ("WHO Regions"). The data retrieved from the different searches were imported into Excel files, and then analyzed with Microsoft Excel (Microsoft, Redmond, WA, US), Analyse-it (Analyse-it Software Ltd, Leeds, UK) and MedCalc statistical software (MedCalc Software, Ostend, Belgium). The study was performed in accordance with the Declaration of Helsinki and under the terms of relevant local legislation. Ethics board approval is unnecessary at the local institution (University of Verona) for articles based on free scientific databases searches.

Results

Cause-specific disability-adjusted life year in older people

In the year 2016, the value of DALYs was 2668.47 million (1429.69 million in men and 1238.78 million in women) in the entire worldwide population and 831.42 million

(427.53 million in men and 403.89 million in women) in people aged ≥ 60 years, respectively. Therefore, DALYs in older persons account for 31.2% of all DALYs [29.9% in men and 32.6% in women; odds ratio (OR) men versus women, 0.88; 95% confidence interval (95% CI), 0.75–1.04; $p = 0.137$]. The 20 leading causes of DALYs in older people are summarized in Table 1. The first two of such conditions, ischaemic heart disease (IHD) and stroke, are also the leading causes of DALYs in the entire world population. Notably, the burden of chronic obstructive pulmonary disease (COPD), dementias and lung cancers, which cause 6.6%, 3.9% and 3.2% of all DALYs in older people, is much higher than in the entire worldwide population, where they only appear as 7th, 23rd and 17th causes of DALYs. Compared to the year 2000, dementias displayed the largest increment (+108.8%), followed by kidney diseases (+68.8%) and falls (+59.9%), whereas the burden of tuberculosis declined by 18.6%. Unlike all other conditions, the burden of stomach cancer and diarrhoeal diseases also declined during the last 16 years. The sex distribution of DALYs in older people is shown in Table 2. With few exceptions, the burden of the leading causes of DALYs is different between sexes, with health loss caused by IHD, malignancies, COPD and cirrhosis being larger in older men than in older women; whilst dementias, hearing loss, falls, hypertensive heart disease, back and neck pain, diarrheal diseases and uncorrected refractive errors cause larger DALYs in older women than in older men. The geographical distribution of DALYs in older people is shown in Table 3. IHD is the leading cause in all WHO Regions except Western Pacific, where stroke is the first cause. Infectious diseases pose a larger burden in Africa than in other WHO regions.

Causes of death in older people

In the year 2016, the number of deaths was 56.88 million (30.35 in men and 26.53 in women) in the entire worldwide population and 36.32 million (18.29 million in men and 18.03 million in women) in people aged ≥ 60 years, respectively. Therefore, mortality in older people accounts for 63.9% of global deaths (60.3% in men and 68.0% in women; OR men vs. women, 0.72; 95% CI, 0.69–0.74; $p < 0.001$). This actually implies that the risk of dying in older persons is nearly 30% higher in women than in men. The 20 leading diseases causes of death are summarized in Table 4. The first four of such conditions (i.e., IHD, stroke, COPD, and dementias) are also the leading causes of death in the entire worldwide population. Compared to the year 2000, falls displayed the largest increment (+212.1%), followed by dementias (+149.6%) and kidney diseases (+78.3%), whereas, the burden of tuberculosis has declined by 16.5%. The sex distribution of DALYs in older people is shown in Supplementary Table 1. With few exceptions, mortality is

Table 1 List of the 20 leading diseases causing disability-adjusted life year (DALYs) in the older people

Disease	Year 2016				Year 2000		
	Value†	%	Rank all ages	Variation from 2000 (%)	Value†	%	Rank
All DALYs	831.42	100	–	30.7	635.97	100	–
Ischemic heart disease	133.65	16.1	1	31.2	101.85	16.0	1
Stroke	94.31	11.3	2	13.4	83.19	13.1	2
Chronic obstructive pulmonary disease	54.52	6.6	7	4.3	52.26	8.2	3
Dementias	32.74	3.9	23	108.8	15.68	2.5	8
Trachea, bronchus, lung cancers	26.64	3.2	17	35.4	19.68	3.1	4
Lower respiratory infections	25.25	3.0	3	40.7	17.94	2.8	5
Hearing loss	24.23	2.9	13	51.6	15.99	2.5	6
Kidney diseases	19.32	2.3	18	68.8	11.44	1.8	11
Other circulatory diseases	18.82	2.3	26	27.8	14.73	2.3	9
Falls	14.94	1.8	20	59.9	9.34	1.5	15
Cirrhosis of the liver	13.87	1.7	14	34.0	10.35	1.6	13
Hypertensive heart disease	13.26	1.6	41	38.9	9.55	1.5	14
Back and neck pain	13.10	1.6	12	43.9	9.10	1.4	16
Tuberculosis	12.86	1.5	11	− 18.6	15.80	2.5	7
Colon and rectum cancers	11.48	1.4	40	29.9	8.84	1.4	17
Stomach cancer	11.21	1.3	43	− 2.4	11.49	1.8	10
Liver cancer	10.96	1.3	33	38.7	7.90	1.2	18
Diarrheal diseases	10.90	1.3	6	− 2.7	11.20	1.8	12
Uncorrected refractive errors	10.50	1.3	28	44.1	7.29	1.1	20
Road injury	9.88	1.2	5	55.7	6.35	1.0	22

†Million

different between sexes, with death rate for malignancies (except colorectal cancer), COPD, cirrhosis and tuberculosis larger in older men than in older women, whilst mortality for all cardiovascular disorders, dementias as well as for diarrheal diseases is larger in older women than in older men. The geographical distribution of deaths in older people is shown in Supplementary Table 2. IHD is the leading cause of mortality in all WHO Regions. Likewise for DALYS, the mortality for infectious diseases in Africa is much larger than in all the other WHO regions.

The WHO projections of worldwide mortality for the leading diseases in subjects aged 70 years or older (this WHO database does not provide separate statistics in the age range between 60 and 69 years) are finally shown in Supplementary Table 3. The all-cause mortality after the age of 70 years will expectedly increase by approximately 2.7-fold by the year 2060, much more than the all-cause deaths at all ages, which will only display a ~ 1.8 growth. During the next 40 years, the number of deaths in older people is hence predicted to grow (by ~ 2.7), but at a lower extent than the increase of the older population (~ 3.2), and with highly disease-specific trends. The highest increase of mortality (i.e., ≥ 3-fold) will be probably recorded for many types of cancer (especially prostate, esophagus, liver, breast, stomach

and colorectal malignancies), as well as for dementias. Mortality in older persons for kidney diseases, falls, liver cirrhosis, lower respiratory infections, COPD and diarrheal diseases will also probably rise by around threefold, whilst mortality for tuberculosis will only increase by 7%. Notably, the number of deaths for cardiovascular disease in older people will also increase, but the overall growth of these conditions will be predictably lower than the demographic increase of older persons.

Discussion

Several lines of evidence confirm that the sustainability of worldwide healthcare systems, and of public finances on the whole, can only be safeguarded when the impact of possible challenges, including the expected strains of demographic changes, is accurately predicted and controlled. The analysis of the current epidemiologic scenario, along with that of recent evolution and future trends of disease burden in the general population, is a mainstay for fostering population-level improvements in public health [7]. This concept becomes especially relevant in older people [8], whereby the number of older persons (i.e., aged 60 years or older)

Table 2 Sex differences in the leading diseases causing disability-adjusted life year (DALYs) in the older people

Disease	Men		Women		Odds ratio (95% confidence interval)
	Value[†]	%	Value[†]	%	
All causes	427.53	100	403.89	100	0.88 (95% CI, 0.75–1.04; $p = 0.137$)
Ischemic heart disease	71.11	16.6	62.53	15.5	1.09 (95% CI, 1.05–1.13; $p < 0.001$)
Stroke	48.07	11.2	46.24	11.4	0.98 (95% CI, 0.94–1.02; $p = 0.351$)
Chronic obstructive pulmonary disease	30.75	7.2	23.77	5.9	1.24 (95% CI, 1.17–1.31; $p < 0.001$)
Dementias	12.17	2.8	20.57	5.1	0.55 (95% CI, 0.51–0.59; $p < 0.001$)
Trachea, bronchus, lung cancers	18.68	4.4	7.96	2.0	2.27 (95% CI, 2.09–2.47; $p < 0.001$)
Lower respiratory infections	12.89	3.0	12.36	3.1	0.98 (95% CI, 0.91–1.07; $p = 0.704$)
Hearing loss	11.60	2.7	12.63	3.1	0.86 (95% CI, 0.80–0.94; $p < 0.001$)
Kidney diseases	10.02	2.3	9.30	2.3	1.02 (95% CI, 0.93–1.11; $p = 0.694$)
Other circulatory diseases	9.03	2.1	9.79	2.4	0.87 (95% CI, 0.79–0.95; $p = 0.002$)
Falls	7.14	1.7	7.80	1.9	0.86 (95% CI, 0.78–0.96; $p = 0.005$)
Cirrhosis of the liver	8.72	2.0	5.15	1.3	1.61 (95% CI, 1.44–1.80; $p < 0.001$)
Hypertensive heart disease	5.84	1.4	7.42	1.8	0.74 (95% CI, 0.66–0.83; $p < 0.001$)
Back and neck pain	5.33	1.2	7.77	1.9	0.64 (95% CI, 0.58–0.72; $p < 0.001$)
Tuberculosis	8.19	1.9	4.67	1.2	1.67 (95% CI, 1.49–1.87; $p < 0.001$)
Colon and rectum cancers	6.46	1.5	5.02	1.2	1.22 (95% CI, 1.08–1.37; $p = 0.001$)
Stomach cancer	7.56	1.8	3.65	0.9	1.97 (95% CI, 1.74–2.24; $p < 0.001$)
Liver cancer	7.59	1.8	3.37	0.8	2.15 (95% CI, 1.89–2.44; $p < 0.001$)
Diarrheal diseases	4.80	1.1	6.10	1.5	0.74 (95% CI, 0.66–0.84; $p < 0.001$)
Uncorrected refractive errors	4.65	1.1	5.85	1.4	0.75 (95% CI, 0.66–0.85; $p < 0.001$)
Road injury	6.36	1.5	3.53	0.9	1.72 (95% CI, 1.50–1.95; $p < 0.001$)
Breast cancer	0.06	0.0	6.50	1.6	0.01 (95% CI, 0.004–0.019; $p < 0.001$)
Prostate cancer	5.85	1.4	0.00	–	N/A

[†]Million

is expected to increase by over threefold during the next 40 years, thus urgently needing to design and implement specific healthcare interventions aimed at reducing the overall impact of unhealthy aging.

The results of our analysis on the WHO databases may have some important public health implications. Although we first found that IHD, stroke and COPD are the leading causes of disability and death in the older population, dementias displayed the largest increase in the past 16 years, comprised between 2.1- and 2.5-fold, thus nearly doubling that of the other three conditions, with a very marked prevalence (i.e., approximately double) in the female sex. Even more importantly, this trend is not expected to reverse soon, since the mortality for dementias will probably display an escalation ~twofold larger than that for IHD, stroke and COPD. This prediction is in keeping with the data previously published by Mayeux and Stern, who hypothesized that the burden of dementia is predicted to double every 20 years [9]. As regards the geographical distribution, the burden of dementias seems higher in the Americas, Western Pacific and Europe.

Unlike DALYs, where the list of leading causes in subjects aged ≥ 60 years do not substantially overlap with those of younger people (Table 1), the mortality causes in older people more closely reflect those of the entire population (Table 4), and this is probably due to the fact that the number of deaths in older persons accounts for nearly three-fourth of all deaths.

The information garnered on cardiovascular diseases also deserves some discussion. Circulatory diseases account for nearly one-third of all DALYs (i.e., 31.3%) and deaths (i.e., 39.7%) in older people. The epidemiologic impact of hypertensive heart disease (+26% DALYs and +29% deaths) and other circulatory diseases (+13% DALYs and +25% deaths) is significantly higher in older women than in older men. IHD causes more DALYs in older men than in older women, but more deaths in older women than in older men. The health loss for stroke is then comparable between sexes, but the mortality is again ~8% higher in older women than in older men. Regarding the geographic distribution, the burden of cardiovascular diseases in older persons is lower in Americas (23.9%) and Africa (25.9%) and higher in Eastern Mediterranean (38.9%) and Western Pacific (34.9%). Mortality data are nearly overlapping, whereby the number of older deaths for cardiovascular diseases is again lower in Americas (31.6%) and Africa (31.8%), but is exceptionally

Table 3 Geographical distribution (Regions of the World Health Organization; WHO) of the leading diseases causing disability-adjusted life year (DALYs) in older people

Disease	Africa (%)	Americas (%)	South-East Asia (%)	Europe (%)	Eastern Mediterranean (%)	Western Pacific (%)
Ischemic heart disease	12.3	13.2	16.1	20.0	24.9	14.2
Stroke	8.8	5.9	10.0	9.6	10.3	16.9
Chronic obstructive pulmonary disease	3.3	5.5	10.4	3.4	4.2	7.2
Dementias	2.5	4.8	2.4	4.6	3.6	4.8
Trachea, bronchus, lung cancers	0.4	3.7	1.3	4.3	1.0	4.9
Lower respiratory infections	7.8	3.1	4.1	1.6	2.1	2.1
Other hearing loss	2.5	3.2	2.7	3.3	2.6	2.9
Kidney diseases	1.9	2.8	2.8	1.5	3.4	2.1
Other circulatory diseases	3.1	3.4	1.0	3.7	2.0	1.8
Falls	1.5	2.1	2.3	2.3	0.9	1.2
Cirrhosis of the liver	2.6	1.6	1.8	1.3	3.3	1.2
Hypertensive heart disease	1.7	1.4	1.4	1.4	1.7	2.0
Back and neck pain	1.3	1.9	1.1	2.3	1.5	1.5
Tuberculosis	4.7	0.2	3.6	0.1	1.5	0.7
Colon and rectum cancers	0.5	1.7	0.6	2.6	0.6	1.5
Stomach cancer	0.4	0.9	0.6	1.3	0.6	2.6
Liver cancer	5.5	0.4	3.0	0.2	1.1	0.1
Diarrheal diseases	0.6	0.9	0.6	0.8	0.9	2.7
Uncorrected refractive errors	1.0	1.0	1.5	1.1	1.2	1.4
Road injury	1.8	1.0	1.2	0.7	1.3	1.4
Breast cancer	0.7	1.2	0.5	1.4	0.8	0.4
Prostate cancer	1.3	1.4	0.2	1.2	0.5	0.3

Values are shown as percent value of all DALYs within the same WHO Region

high in Eastern Mediterranean (49.7%) and Europe (45.9%), where IHD accounts for 32.3% and 28.0% of all deaths in older people. This evidence reinforces previous data based on US statistics in the years 2005 and 2013 [10, 11].

Some interesting considerations can also be made on cancer, falls and infectious diseases epidemiology in older people. As regards malignancies, the current epidemiologic data and the WHO projections are alarming. Although the leading cancers cause altogether only 7.2% of all DALYs and 11.2% of all deaths, respectively, their future epidemiologic burden is expected to considerably increase, with mortality rising by > 2.7-fold for all these malignancies (except lung cancers). A worldwide strategy shall, hence, be planned, entailing enhanced investment on screening and treating malignancies, as already highlighted for the general, non-older population [12].

As regards falls, although they only contribute for 1.3% of all DALYs and 1.8% of all deaths in the older people, fall-related mortality is expected to raise by over threefold during the next 40 years (Supplementary Table 3). There is now solid evidence that falls can be efficiently prevented in older people [13, 14]. A recent analysis published by Steven and Lee showed that implementation of some relatively inexpensive and effortless measures (i.e., home modification by occupational therapists or daily vitamin D supplement) could be highly effective for preventing a vast number of medically treated falls and their consequent economic burden on the health care system [15].

Concerning infectious diseases, lower respiratory infections, tuberculosis and diarrheal disorders altogether account for 5.8% of all DALYs and 7.6% of all deaths, respectively. Their mortality is expected to increase during the next 40 years, but with a trend that will be probably lower than the predicted growth of older people (i.e., < 3.2-fold). Nevertheless, the burden of these conditions remains particularly high in Africa (accounting for 13.1% of all DALYs and 22.1% of all deaths in that region, respectively), which would actually call for additional efforts for developing public health infrastructures targeting permanent, emerging and re-emerging infectious diseases in this continent [16, 17].

As concerns possible preventive measures for major diseases leading to disability and death in older people, some potential strategies have been proposed. For example, the important clinical, societal and economic burden of cardiovascular disease in older people may be reduced by reinforced primary prevention and geriatric

Table 4 List of the 20 leading causes of death in the older people

Disease	Year 2016				Year 2000		
	Value[†]	%	Rank all ages	Variation from 2000 (%)	Value[†]	%	Rank
All deaths	36.31	100	–	32.4	27.44	100	–
Ischemic heart disease	7.86	21.6	1	35.4	5.80	21.1	1
Stroke	4.89	13.5	2	12.0	4.36	15.9	2
Chronic obstructive pulmonary disease	2.80	7.7	3	4.7	2.67	9.7	3
Dementias	1.96	5.4	4	149.6	0.79	2.9	6
Lower respiratory infections	1.65	4.5	6	46.5	1.12	4.1	4
Trachea, bronchus, lung cancers	1.35	3.7	5	42.2	0.95	3.5	5
Other circulatory diseases	0.92	2.5	7	32.5	0.69	2.5	8
Kidney diseases	0.87	2.4	13	78.3	0.49	1.8	12
Hypertensive heart disease	0.77	2.1	12	49.6	0.52	1.9	11
Cirrhosis of the liver	0.63	1.7	16	36.5	0.46	1.7	14
Colon and rectum cancers	0.62	1.7	11	34.7	0.46	1.7	13
Tuberculosis	0.60	1.6	18	− 16.5	0.72	2.6	7
Stomach cancer	0.58	1.6	10	1.8	0.57	2.1	9
Diarrheal diseases	0.56	1.5	20	− 0.6	0.56	2.0	10
Liver cancer	0.54	1.5	9	42.6	0.38	1.4	15
Falls	0.46	1.3	17	212.1	0.15	0.5	28
Prostate cancer	0.34	0.9	22	41.5	0.24	0.9	18
Esophagus cancer	0.32	0.9	35	8.9	0.30	1.1	17
Other digestive diseases	0.32	0.9	28	38.9	0.23	0.8	21
Breast cancer	0.32	0.9	30	33.2	0.24	0.9	20

[†]Million

rehabilitation, by promoting healthy lifestyle changes and strict adherence to ongoing therapeutic measures based on hypocholesterolemic, antihypertensive or antiplatelets medications [18, 19]. Doherty et al. [20] recently highlighted that mortality and disability from lower respiratory infections and COPD in aging populations may be considerably lowered by establishing a higher vaccination coverage among older people. Some potentially effective multifactorial interventions have also been suggested for preventing dementia, including healthy diet, engagement in regular physical activity, management of the major recognized cardiovascular risk factors, stress and depression [21]. Finally, it is also worthwhile mentioning here the top five list of "Choosing Wisely" recommendations suggested for the managed care of geriatric patients in Austria, which encompass enhanced use of urinary catheters in older people, administration of antimicrobials for treating asymptomatic bacteriuria, use of percutaneous feeding tubes and administration of antipsychotic drugs in older persons with advanced dementia, along with early screening for the more frequent forms of cancer in older people (i.e., lung, colorectal, breast and prostate malignancies) [22].

In conclusion, we hope that epidemiologic information conveyed in this article will provide a useful contribution for defining specific healthcare policies aimed at fostering healthier aging around the globe.

Compliance with ethical standards

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