

Burden of non-communicable diseases in Cyprus, 1990 - 2017: findings from the Global Burden of Disease 2017 study

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Abstract

Background: Non-communicable diseases (NCDs) accounted for over 90% of all deaths in the Cypriot population, in 2018. However, a detailed and comprehensive overview of the impact of NCDs on population health of Cyprus over the period of 1990 to 2017, expressed in disability-adjusted life years (DALYs) is currently not available. Knowledge about the drivers of changes in NCD DALYs over time is paramount to identify priorities for the prevention of NCDs in Cyprus and guide evidence-based decision making. The objectives of this paper were to: 1) assess the burden of NCDs in terms of years of life lost (YLLs), years lived with disability (YLDs), and DALYs in Cyprus in 2017, and 2) identify changes in the burden of NCDs in Cyprus over the 28-year period and assess the main drivers of these changes.

Methods: We performed a secondary database descriptive study using the Global Burden of Disease (GBD) 2017 results on NCDs for Cyprus from 1990 to 2017. We calculated the percentage of change of age-standardized DALY rates between 1990 and 2017 and decomposed these time trends to assess the causes of death and disability that were the main drivers of change.

Results: In Cyprus in 2017, 83% (15,129 DALYs per 100,000; 12,809 to 17,707 95%UI) of total DALYs were due to NCDs. The major contributors to NCD DALYs were cardiovascular diseases (16.5%), neoplasms (16.3%), and musculoskeletal disorders (15.6%). Between 1990 and 2017, age-standardized NCD DALY rates decreased by 23%. For both males and females, the largest decreases in DALY rates were observed in ischemic heart disease and stroke. For Cypriot males, the largest increases in DALY rates were observed for pancreatic cancer, drug use disorders, and acne vulgaris, whereas for Cypriot females these were for acne vulgaris, psoriasis and eating disorders.

Conclusion: Despite a decrease in the burden of NCDs over the period from 1990 to 2017, NCDs are still a major public health challenge. Implementation of interventions and early detection screening programmes of modifiable NCD risk factors are needed to reduce occurrence and exacerbation of leading causes of NCDs in the Cypriot population.

Background

Non-communicable diseases (NCDs) are a major cause of death and disability worldwide [1]. The four major groups of NCDs, namely cardiovascular diseases (CVDs), neoplasms, chronic respiratory diseases, and diabetes, cause over 70% of global mortality each year [1]. In Cyprus, a high-income country and a member state of the European Union (EU), NCDs have posed an even greater burden on population health. A 2018 World Health Organization (WHO) report revealed that NCDs accounted for over 90% of all deaths in the Cypriot population [1]. Markedly, neoplasms accounted for 19% of all deaths in Cyprus [2]. Moreover, the prevalence of diabetes in the Cypriot population was estimated to be 10% which is slightly higher compared to the prevalence of diabetes in other EU countries [3]. WHO member states have endorsed a menu of policy options and cost-effective NCD interventions that can be used to tackle the burden of NCDs [4]. Furthermore, population ageing is causing an increase in the burden of specific health conditions; WHO's Global Strategy and Action Plan on Ageing and Health 2016–2020 [5] urges countries to establish intervention policies on healthy population ageing. Understanding at which ages the NCD burden starts to accumulate may shed light on how to introduce better policies and hence, how to reduce the projected NCD burden. However, resources are limited and it is therefore important for policy makers to have up to date quantifications of the impact of NCDs on the population health of Cyprus and the relative attributes of modifiable risk factors to guide priority setting.

The impact of NCDs on population health can be quantified using mortality or incidence and prevalence. However, NCDs are characterized by heterogeneity in health outcomes, with great variety in severity, duration and mortality rates [6]. Moreover, with increasing life span, information on disability has become more important. Summary measures of population health (SMPH) combine mortality, morbidity and disability into on single index [7, 8]. This allows for comparison between distinct health outcomes, and subsequently, comparison of the population health impact of a range of diseases and risk factors. SMPHs are therefore vital tools for priority setting purposes [7, 8]. A widely used SMPH is the Disability-Adjusted Life Year (DALY) [6]. The DALY integrates premature mortality in years of life lost (YLLs) and non-fatal consequences in years lived with disability (YLDs) [7, 8]. The DALY has been used in the landmark Global Burden of Disease (GBD) studies which aim to assess up to date country-specific incidence, prevalence, mortality, YLLs, YLDs, and DALYs for over 300 diseases and injuries in 195 countries and territories using a systematic analysis [9–11]. The approach that is used by the GBD researchers ensures that the calculated incidence, prevalence, mortality, YLLs, YLDs, and DALYs are comparable and internally consistent across years and regions.

Annually, updated methods and results of the GBD study are published. However, a detailed and comprehensive overview of the burden of disease of NCDs in Cyprus is currently not available. Investigation of time trends and decomposition of these time trends can pinpoint the diseases that contributed most to the change in burden of disease of NCD. Knowledge about the main drivers of changes in NCD YLDs, YLLs, and DALYs over time is imperative for health professionals and policy makers to identify priorities for the prevention of NCDs in Cyprus and guide evidence-based decision making. Until recently, the health authorities in Cyprus lacked knowledge about the population's state of health and health policies have not been targeted. In fact, it was shown that the biomedical research funded on the island does not correspond to the DALYs of the Cypriot population [2]. Therefore, assessing the burden of NCDs in Cyprus is an important topic for public health policy planning for primary health interventions and prioritizing NCD prevention policies.

Here, we have sought to provide a comprehensive overview of the age-standardized YLLs, YLDs and DALYs of NCDs in Cyprus in 2017, to investigate rates of change over the period from 1990 to 2017, and to identify the NCDs that were main drivers of these changes. Comparison of NCD-related DALYs between age-specific and age-standardized rates was also made.

Methods

Overview

We performed a secondary database descriptive study using the GBD 2017 results. The GBD 2017 study analyzed the impact of 359 diseases and injuries across 23 age groups and both sexes, and 195 countries and territories between 1990 and 2017 [11]. Detailed descriptions on the GBD study methodology, data and analysis have been previously described [11, 12]. In this study we restricted our analysis to YLLs, YLDs, and DALYs due to NCDs in the Cypriot population from 1990 to 2017.

Cyprus has been divided into two parts; the northern part which is under Turkish occupation and the southern or government-controlled part which consists of five districts, namely Nicosia, Ammochostos, Larnaca, Limassol, and Paphos. The total population in the government-controlled area is estimated at 875,900 in 2018 [13]. All districts of Cyprus will be referred to as a whole in the rest of the manuscript.

The NCD categories (at level 2 of the cause hierarchy) featured in the GBD 2017 study were neoplasms, cardiovascular diseases, chronic respiratory diseases, digestive diseases, neurological disorders, mental disorders, substance use disorders (SUDs), diabetes and chronic kidney disease (CKD), skin and subcutaneous diseases, sense organ diseases, musculoskeletal disorders, and other NCDs.

Source of data and presentation

In our study, we analyzed and reported levels and trends of age-standardized YLL, YLD, and DALY rates. An age-standardized rate is a weighted average of the age-specific rates per 100,000 of population, where the weights are the proportions of the standard population in the corresponding age groups. YLLs, YLDs, and DALYs were provided by the visualisation “*GBD Results*” tool (Institute for Health Metrics and Evaluation (IHME), 2017; available online at: <http://ghdx.healthdata.org/gbd-results-tool>).

The diseases studied by the GBD are arranged in standard hierarchical categories of four levels. Level 1 causes consist of three categories, namely: communicable, maternal, neonatal, and nutritional diseases (Group I); NCD (Group II); and injuries (Group III). Each Level can be broken into a further classification which provides more details about it. For example, Group II can be broken down into 12 different diseases at Level 2. If the interest is for DALYs on CVDs, for example, then these causes can be further broken down into 10 sub-diseases (Level 3) and more details (Level 4). The GBD 2017 levels can be found elsewhere [14]. For the present analysis, we report all Level 2 and Level 3 NCD (sub-)causes.

Age-standardized DALY rates, and its components YLL and YLD, related to all NCDs in Cyprus from 1990 to 2017, were analyzed for both genders at Levels 2 and 3. We, first, calculated the proportion of the top five Level 2 and Level 3 NCDs that contributed most to the burden of NCD DALYs, YLLs, and YLDs in Cyprus in 2017 using the cross-multiplication method, known as ‘*rule of three*’ [15]. For changes over time, we presented the percentage of change as the percent difference, for each age-standardized YLL, YLD and DALY rate in 1990 and 2017. A positive percentage change indicates an increase, whereas a negative change a decrease from 1990 to 2017. Additionally, we decomposed differences in the DALY-related NCDs over the period from 1990 to 2017 to assess the main drivers of change in DALY, YLL and YLD rates of NCDs. Finally, we have examined the age distribution of NCD DALYs and we reported the NCD DALY rates for the elderly (70+ years) category over the 28-year study period.

Uncertainty

Uncertainty distribution for each NCD outcome variable (YLL, YLD, and DALY) was captured and propagated by 1,000 bootstrap draws from the posterior distributions. The results for each variable of interest were derived from the mean of 1,000 draws and the 95% uncertainty intervals (UIs) were derived from the 2.5th and 97.5th percentiles of the corresponding draws of the sampled YLL, YLD, and DALY variables [16, 17].

Results

Burden of disease of NCDs, in Cyprus in 2017

In Cyprus in 2017, the total burden of disease was 18,287 DALYs (15,607 to 21,322 95%UI) per 100,000 of which 83% (15,129 DALYs per 100,000; 12,809 to 17,707 95%UI) were due to NCDs.

The top three Level 2 causes of NCDs in Cyprus in terms of DALYs were CVDs, neoplasms, and musculoskeletal disorders. CVDs accounted for 16.5% (2,497 DALYs per 100,000; 2,276 to 2,729 95%UI), neoplasms for 16.3% (2,469 DALYs per 100,000; 2,277 to 2,681 95%UI), and musculoskeletal conditions for 15.6% (2,365 DALYs per 100,000; 1,719 to 3,177 95%UI) of NCDs DALYs. Mental disorders and neurological disorders were also major causes of the NCD DALYs in 2017 in Cyprus; mental disorders were responsible for 11.4% of NCD DALYs (1,732 DALYs per 100,000; 1,284 to 2,239 95%UI), and neurological disorders for 9.9% (1,503 DALYs per 100,000; 1,136 to 1,932 95%UI). Together, the afore-mentioned NCD health conditions contributed approximately two-thirds of the NCD DALYs in Cyprus. The leading Level 3 NCD causes due to DALYs were low back pain (9.3%; 1,405 DALYs per 100,000; 1,001 to 1,902 95%UI) and ischemic heart disease (IHD; 9.0%; 1,376 DALYs per 100,000; 1,241 to 1,538 95%UI). Headache disorders were responsible for 6.0% (909 DALYs per 100,000; 600.4 to 1,294 95%UI) and 5% of total NCD DALYs was due to diabetes (756 DALYs per 100,000; 601.8 to 943.7 95%UI).

In 2017, YLLs were responsible for 42% of the NCD DALYs (6345 YLLs per 100,000; 5,892 to 6,856 95%UI). The leading Level 2 causes of NCD YLLs were neoplasms (36.7%; 2,327 YLLs per 100,000; 2,150 to 2,523 95%UI) and CVDs (34.2%; 2,171 YLLs per 100,000; 1,981 to 2,389 95%UI). 7.2% of the fatal NCD burden came from diabetes and CKD (460.2 YLLs per 100,000; 417.4 to 505.6 95%UI), and 6.2% from neurological disorders (391.8 YLLs per 100,000; 362.2 to 423.6 95%UI). The leading Level 3 causes of NCD YLLs were IHD (20.7%; 1,314 YLLs per 100,000; 1,187 to 1,475 95%UI), lung cancer (7.3%, 461.2 YLLs per 100,000; 412.4 to 515.5 95%UI) and stroke (6.4%; 406.6 YLLs per 100,000; 368.1 to 456.6 95%UI).

YLDs were responsible for 58% of the overall NCD DALYs (8,785 YLDs per 100,000; 6,592 to 11,303 95%UI). The leading Level 2 causes of NCD YLDs were musculoskeletal disorders (26.6%; 2,337 YLDs per 100,000; 1,692 to 3,152 95%UI), mental disorders (19.7%; 1,732 YLDs per 100,000; 1,283 to 2,239 95%UI) and neurological disorders (12.6%; 1,111 YLDs per 100,000; 748 to 1,543 95%UI). Meanwhile, the leading Level 3 causes of NCD YLDs were low back pain (1,405 YLDs per 100,000; 1,001 to 1,902 95%UI) and headache disorders (909 YLDs per 100,000; 600.4 to 1,294 95%UI), contributing 16.0% and 10.3% to the

total NCD YLDs, respectively. Other NCD-groups that contributed a notable amount to the non-fatal NCD burden were depressive disorders (5.5%; 482.2 YLDs per 100,000; 342.6 to 658.9 95%UI) and anxiety disorders (5.4%; 472.3 YLDs per 100,000; 335.9 to 628.4 95%UI). Table 1 shows the rankings for the top five Level 2 and Level 3 NCDs that contributed most to the NCD YLLs, YLDs, and DALYs in Cyprus in 2017.

Table 1
The contribution of the top five Level 2 and Level 3 causes of NCD to NCD YLL, YLD and DALY in Cyprus in 2017

Rank	Level 2 NCD	DALY NCD (%)	Level 2 NCD	YLL NCD (%)	Level 2 NCD	YLD NCD (%)
1	CVDs	16.5%	Neoplasms	36.7%	Musculoskeletal disorders	26.6%
2	Neoplasms	16.3%	CVDs	34.2%	Mental disorders	19.7%
3	Musculoskeletal disorders	15.6%	Diabetes and CKD	7.6%	Neurological disorders	12.6%
4	Mental disorders	11.4%	Neurological disorders	6.2%	Skin diseases	7.2%
5	Neurological disorders	9.9%	Chronic respiratory diseases	4.9%	Other NCDs	6.8%
Rank	Level 3 NCD	DALY NCD (%)	Level 3 NCD	YLL NCD (%)	Level 3 NCD	YLD NCD (%)
1	Low back pain	9.3%	IHD	20.7%	Low-back pain	16.0%
2	IHD	9.0%	Lung cancer	7.3%	Headache disorders	10.3%
3	Headache disorders	6.0%	Stroke	6.4%	Depressive disorders	5.5%
4	Diabetes	5.0%	Diabetes	4.5%	Neck pain	5.5%
5	Stroke	3.5%	Alzheimer's disease	3.9%	Anxiety disorders	5.4%

CKD: chronic kidney disease; CVDs: cardiovascular diseases; DALY: disability-adjusted life years; IHD: ischemic heart disease; NCD: non-communicable disease; YLL: years of life lost; YLD: years lived with disability

Changes in NCD DALY rates in Cyprus, 1990–2017

Table 2 shows the age-standardized YLL, YLD, DALY rates and percentage change for Level 2 NCD-group, in Cyprus between 1990 and 2017. In the period 1990 to 2017 NCD DALY rates in Cyprus decreased from 19,608 DALYs per 100,000 (17,362 to 22,248 95%UI) in 1990 to 15,129 DALYs per 100,000 (12,809 to 17,707 95%UI) in 2017, representing a 23% decrease over the 28-year study period. Time trends by cause of NCD varied considerably. Overall, CVDs and neoplasms had the highest DALY rates over the 28-year study period. However, between 1999 and 2017 the CVDs DALY rate decreased steeply, whereas more gradual decreases in DALY rates were observed for neoplasms, neurological disorders, diabetes and kidney diseases, other non-communicable diseases and chronic respiratory diseases were observed. Figure 1 represents how NCDs DALY rates has changed over the period from 1990 to 2017 in Cyprus; the figure is given as age-standardized DALYs per 100,000.

Age-standardized DALY rates of Level 2 NCDs per 100,000 in Cyprus from 1990 to 2017

Age-standardized NCD DALY rates for males decreased significantly, from 21,012 DALYs (18,937 to 23,505 95%UI) in 1990 to 16,627 DALYs per 100,000 (14,358 to 19,159 95%UI) in 2017, a decrease of 20.9% (-4,385 DALYs per 100,000). Largest decreases in NCD DALY rates were observed for CVDs (-2,814 DALYs per 100,000), of which IHD (-1,944 DALYs per 100,000) and stroke (-615 DALYs per 100,000) ranked among the most significant causes of decreases in DALY rates. Congenital birth defects (-580 DALYs per 100,000), chronic obstructive pulmonary disease (COPD; -192 DALYs per 100,000) and diabetes (-124 DALYs of 100,000) also showed large decreases in DALY rates over the period from 1990 to 2017. On the other hand, DALYs associated with pancreatic cancer (+ 55 DALYs per 100,000), drug use disorders (+ 53 DALYs per 100,000), acne vulgaris (+ 31 DALYs per 100,000), and kidney cancer (+ 26 DALYs per 100,000) increased from 1990 to 2017.

For Cypriot females age-standardized NCD DALY rates declined from 18,527 DALYs (16,049 to 21,367 95%UI) in 1990 to 13,923 DALYs per 100,000 (11,453 to 16,802 95%UI) in 2017, reflecting a decline of 24.8% (-4,604 DALYs per 100,000). The leading causes of the decrease in NCD DALY rates in females, were IHD (-1,150 DALYs per 100,000), stroke (-657 DALYs per 100,000), and diabetes mellitus (-342 DALYs per 100,000). An increase in age-standardized DALY rates were observed for acne vulgaris (+ 42 DALYs per 100,000), psoriasis (+ 28 DALYs per 100,000), and eating disorders (+ 25 DALYs per 100,000) increased over the period of 1990–2017.

Changes in NCD YLL rates in Cyprus, 1990–2017

In 1990, YLLs due to NCDs constituted 55% (10,793 YLLs per 100,000; 10,484 to 11,096 95%UI) of the overall NCD DALYs (19,608 DALYs per 100,000; 17,362 to 22,248 95%UI), whereas in 2017 they accounted for 42% (6,345 YLLs per 100,000; 10,793 to 11,096 95%UI) of the overall NCD burden (15,129 DALYs per 100,000; 12,809 to 17,707 95%UI) (Table 2).

For males age-standardized NCD YLL rates declined from 13,088 YLLs (12,629 to 15,539 95%UI) in 1990 to 8,610 YLLs per 100,000 (7,747 to 9,546 95%UI) in 2017 (-34.2%; -4,478 NCD YLLs per 100,000). Key contributors that led to the NCD YLLs reductions were IHD (-1,913 YLLs), stroke (-606 YLLs per 100,000),

congenital birth defects (-578 YLLs per 100,000), and diabetes (-217 YLLs per 100,000). On the other hand, YLL rates associated with pancreatic cancer, drug use disorders, kidney cancer, and liver cancer increased by 55, 40, 25, and 19 YLLs per 100,000 between 1990 and 2017.

For females NCD YLL rates decreased by 50.4%, from 8,812 YLLs (8,520 to 9,104 95%UI) in 1990 to 4,372 YLLs per 100,000 (3,961 to 4,859 95%UI) in 2017. The main contributors to this decrease were IHD (-1,125 YLLs per 100,000), stroke (-646 YLLs per 100,000), congenital birth defects (-472 YLLs per 100,000), and diabetes mellitus (-361 YLLs per 100,000). Over the same period, the DALY rates of lung cancer (+ 19 YLLs per 100,000) and pancreatic cancer (+ 18 YLLs per 100,000) increased.

Changes in NCD YLD rates in Cyprus, 1990–2017

Between 1990 and 2017, the share of NCD YLDs of the total NCD burden increased by 13%. Specifically, in 1990, NCD YLDs were responsible for 45% (8,815 YLDs per 100,000; 6,608 to 11,395 95%UI) of the overall NCD DALYs (19,608 DALYs per 100,000; 17,362 to 22,248 95%UI), while in 2017 NCD YLDs were responsible for 58% (8,785 YLDs per 100,000; 6,592 to 11,303 95%UI) of the overall NCD burden (15,129 DALYs per 100,000; 12,809 to 17,707 95%UI), (Table 2).

Between 1990 and 2017 the NCD YLD rates for Cypriot males increased by 92 YLDs per 100,000. Major contributors to this increase were observed for diabetes (+ 93 YLDs per 100,000) and neoplasms (+ 79 YLDs per 100,000). Notably, within the neoplasms category, the YLD rates of prostate cancer (+ 34 YLDs per 100,000) and colorectal cancer (+ 11 YLDs per 100,000) showed the largest increase. Age-standardized YLD rates of oral disorders (-35 YLDs per 100,000), IHD (-31 YLDs per 100,000), and asthma (-23 YLDs per 100,000) showed the largest decreases in YLD rates.

For females, between 1990 and 2017 the NCD YLD rates decreased by 166 YLDs per 100,000. The largest decreases were observed for oral disorders (-43 YLDs per 100,000), hemoglobinopathies and haemolytic anemias (-33 YLDs per 100,000), gynecological diseases (-28 YLDs per 100,000), and COPD (-25 YLDs per 100,000). The largest increases were seen in the YLD rates of neoplasms (+ 44 YLDs per 100,000), acne vulgaris (+ 42 YLDs per 100,000), psoriasis (+ 27 YLDs per 100,000), eating disorders (+ 25 YLDs per 100,000) and diabetes mellitus (+ 19 YLDs per 100,000), between 1990 and 2017.

Table 2
Age-standardized YLL, YLD, DALY rates and percentage change for Level 2 NCD-group, in Cyprus from 1990 to 2017

	YLLs			YLDs			DALYs		
	1990 age-standardized rates per 100,000	2017 age-standardized rates per 100,000	Percentage change in age-standardized rates per 100,000	1990 age-standardized rates per 100,000	2017 age-standardized rates per 100,000	Percentage change in age-standardized rates per 100,000	1990 age-standardized rates per 100,000	2017 age-standardized rates per 100,000	Percentage change in age-standardized rates per 100,000
All causes	14,614 (14,339 – 14,887)	7,904 (7,332 – 8,540)	-45.9%	1,0597 (7,972 – 13,641)	10,383 (7,841 – 13,374)	-2.0%	25,211 (22,605 – 28,229)	18,287 (15,607 – 21,322)	-27.5%
Group II: Non-communicable diseases	10,793 (10,484 – 11,096)	6,345 (5,892 – 6,856)	-41.2%	8,815 (6,608 – 11,395)	8,785 (6,592 – 11,303)	-0.3%	19,608 (17,362 – 22,248)	15,129 (12,809 – 17,707)	-22.8%
Cardiovascular diseases	4,583 (4,428 – 4,752)	2,171 (1,981 – 2,389)	-52.6%	397.1 (291.5 – 516.6)	326.2 (241 – 420.6)	-17.9%	4,980 (4,787 – 5,183)	2,497 (2,276 – 2,729)	-49.9%
Neoplasms	2,718 (2,592 – 2,828)	2,327 (2,150 – 2,523)	-14.4%	81.7 (59.8 – 105.7)	142.2 (103.3 – 189.4)	74.1%	2,800 (2,673 – 2,916)	2,469 (2,277 – 2,681)	-11.8%
Musculoskeletal disorders	41.9 (30.3 – 51.3)	27 (20 – 32)	-34.7%	2,337 (1,700 – 3,151)	2,337 (1,692 – 3,152)	0.0%	2,379 (1,740 – 3,187)	2,365 (1,719 – 3,177)	-0.6%
Mental disorders	0.02 (0.01 – 0.02)	0.04 (0.02 – 0.05)	100.0%	1,734 (1,290 – 2,246)	1,732 (1,283 – 2,239)	-0.1%	1,734 (1,290 – 2,246)	1,732 (1,284 – 2,239)	-0.1%
Neurological disorders	543.2 (500.6 – 578.8)	391.8 (362.2 – 423.6)	-27.9%	1,117 (761 – 1,526)	1,111 (748 – 1,543)	-0.5%	1,660 (1,310 – 2,072)	1,503 (1,136 – 1,932)	-9.4%
Diabetes and kidney diseases	825.7 (758.4 – 901.3)	460.2 (417.4 – 505.6)	-44.3%	494.9 (348.6 – 680)	539.8 (373 – 734.9)	9.1%	1,321 (1,156 – 1,512)	1,000 (832 – 1,206)	-24.3%
Other non-communicable diseases	1,020 (725 – 1,272)	298.5 (262.1 – 333.6)	-70.7%	679.6 (466.5 – 959.7)	595.6 (408.8 – 836.7)	-12.4%	1,699 (1,314 – 2,095)	894 (706.4 – 1,133)	-47.4%
Chronic respiratory diseases	519.2 (460.3 – 576.9)	311.2 (276.1 – 344.2)	-40.0%	484.5 (374.5 – 605.4)	449.1 (352.8 – 556.9)	-7.3%	1,004 (880 – 1,138)	760.7 (659.9 – 870.2)	-24.2%
Skin and subcutaneous diseases	19.7 (8.9 – 27.5)	17.1 (8.8 – 21.7)	-13.2%	564.9 (383.1 – 809.4)	632.3 (433.7 – 902.8)	11.9%	584.7 (403.1 – 825.9)	649.4 (449.4 – 916.9)	11.1%
Sense organ diseases	0	0	N/A	531.5 (359.3 – 752.3)	501.8 (339.8 – 715.5)	-5.6%	531.5 (359.3 – 752.3)	501.8 (339.8 – 715.5)	-5.6%
Digestive diseases	474.1 (380.6 – 570.6)	270.6 (241.7 – 302.6)	-42.9%	204.5 (142.3 – 279.5)	217.4 (152 – 298)	6.3%	678.7 (557.4 – 799.7)	488 (419.4 – 576.7)	-28.1%
Substance use disorders	48 (37.9 – 61.2)	69.3 (59 – 84)	44.1%	188.1 (131.1 – 252.3)	199.7 (138.3 – 266.2)	6.2%	236.2 (178 – 298.7)	268.9 (208.8 – 333.9)	13.9%

YLLs	YLDs	DALYs
Data in parentheses are 95% uncertainty intervals (UIs)		
A positive percentage change indicates an increase and a negative change a decrease between 1990 and 2017		
DALYs: disability-adjusted life years; YLLs: years of life lost; YLDs: years lived with disability		
N/A: not applicable		

Changes in NCD DALY rates in the elderly (70 + years) in Cyprus, 1990–2017

Over the period from 1990 to 2017, the NCD DALY rates in the elderly (70 + years) were higher compared to the age-standardized NCD-related DALYs per 100,000 of other age groups. Major contributors to the NCD DALYs in elderly in 2017 were CVDs, neoplasms, and diabetes and CKD. CVDs accounted for 27.5% (20,890 DALYs per 100,000; 19,253 to 22,783 95%UI), neoplasms for 18% (13,950 DALYs per 100,000; 12,687 to 15,184 95%UI), and diabetes and CKD for 10% (7,761 DALYs per 100,000; 6,808 to 8,847 95%UI) of the total NCD burden. Leading Level 3 causes of NCDs in the elderly in terms of DALYs were IHD (13.5%; 10,296 DALYs per 100,000; 9,384 to 11,649 95%UI) and diabetes (7%; 5,506 DALYs per 100,000; 4,663 to 6,434 95%UI). Stroke was also a major cause in the elderly contributing 7% (5,299 DALYs per 100,000; 4,749 to 5,959 95%UI) to the overall NCD burden.

Between 1990 and 2017 NCD DALY rates in the elderly decreased from 98,331 DALYs per 100,000 (92,636 to 104,594 95%UI) in 1990 to 70,432 DALYs per 100,000 (63,850 to 77,228 95%UI) in 2017, representing a 28% decline. CVDs and neoplasms DALYs showed the largest decline over the 1990–2017 period. The CVD DALY rates decreased sharply (-47.8%) from 40,014 DALYs per 100,000 (38,152 to 42,251 95%UI) in 1990 to 20,890 DALYs per 100,000 (19,253 to 22,783 95%UI) in 2017. A similar pattern was also seen in DALYs due to diabetes; from 11,285 DALYs per 100,000 (9,976 to 12,614 95%UI) in 1990 to 7,761 DALYs per 100,000 (6,808 to 8,847 95%UI) in 2017, representing a decrease of 31%. More gradual decreases in NCD DALY rates among the elderly population were observed for neoplasms, digestive diseases, mental and neurological disorders, chronic respiratory diseases, and other non-communicable diseases. Figure 2 shows the NCD DALY rates in the elderly population over the period from 1990 to 2017.

Discussion

Summary of findings

The findings of this study showed that in Cyprus in 2017 83% of the total burden of disease was attributable to NCDs, and that CVDs, neoplasms and musculoskeletal disorders were the top contributors to the burden of NCDs. Between 1990 and 2017, age-standardized NCD DALY rates decreased by 23%. For both males and females, the largest decreases in DALY rates were observed in IHD and stroke. However, over this 28-year period, CVDs, neoplasms, and musculoskeletal disorders were consistently major contributors to NCD DALYs for both males and females. In particular, neoplasms and CVDs were mostly driven by YLLs, whereas musculoskeletal disorders were driven by YLDs. From 1990–2017, NCD DALY rates were highest among the elderly (70 + years).

Although the NCD burden of IHD and stroke, as quantified by age-standardized DALY rates, declined for both Cypriot males and females over the period from 1990 to 2017, they remained the main CVD DALY contributors. A possible explanation for this may be that around 30% of Cypriots have untreated hypertension [18]. Since hypertension is a major risk factor for IHD and stroke, the high prevalence of hypertension may therefore be a main contributor to the burden of IHD and stroke. Also, smoking is a well-established risk factor for IHD and stroke. Notably, the prevalence of tobacco use over time is consistently high in Cyprus compared with other European countries [19] and high IHD and stroke DALY rates may reflect the legacy of high cigarette smoking rates in Cyprus. To achieve further decreases in the prevalence and mortality of IHD and stroke in Cyprus it is therefore important to target these risk factors. For instance, by setting up early detection screening programmes for hypertension, and scaling up of smoking cessation interventions to prevent the disease burden possibly attributable to the tobacco use among the Cypriot population.

Remarkably, the proportion of DALY for diabetes in Cyprus was higher than in the WHO European Region [21]. Our findings showed that YLDs caused by diabetes increased for Cypriot males as well as females, during the period of 1990–2017. Environmental, lifestyle and genetic factors might have a significant effect on the pathogenesis of diabetes in the Cypriot population [21, 22]. Thus, the large proportion of diabetes-related DALY in the total NCD burden, as found in this study, calls for efforts to investigate leading risk factors for diabetes and kidney disease in Cyprus as well as improvements in diabetes management.

Cypriot males had substantially more YLLs and DALYs due to pancreatic cancer than females. Alcohol consumption and tobacco use have been identified as major risk factors for pancreatic cancer [23, 24]. In Cyprus, the smoking prevalence is high; similarly, the prevalence of heavy episodic drinking is estimated to be 28%, which is close to that of WHO EU countries (30%) [25]. However, a high proportion of alcohol-related and smoking-related disease burden increase the risk of other health conditions, such as CVDs and neoplasms. Smoking cessation and alcohol abuse interventions have been shown to be effective with a potential effect on public health [26, 27]. Thus, alcohol and tobacco control policies should also be considered in the Cypriot primary health care. Also, during the period from 1990 to 2017, the burden of SUDs increased for Cypriot males. This burden is mainly driven by alcohol and drug use disorders. Previous studies have yielded evidence of an association between alcohol consumption and/or drug use and unemployment status among males [28, 29]. In Cyprus in 2017, the unemployment rate of the labor force in males was 10.4% whereas in females was 9.8% [30]. This highlights the importance of both strengthening the social welfare policies as well as incorporating such policies in population mental health promotion strategies.

Age-standardized YLD and DALY rates due to eating disorders, such as anorexia nervosa and bulimia nervosa, have been identified as being higher in Cypriot females than males. The burden of eating disorders has traditionally been linked to body-image dissatisfaction and the role of social media [31, 32]. More research is needed in order to explore specific determinants for eating disorders in the Cypriot community. Nonetheless, the development and use of validated screening tests in primary healthcare setting may help to determine future health strategies regarding the burden of eating disorders in Cyprus.

Between 1990 and 2017, the leading cause of DALYs in elderly (70+ years) shifted to CVDs. A possible explanation for this is that most of the metabolic risk factors namely high fasting plasma glucose and/or high blood pressure are highly prevalent in the aged. The interaction of multiple health conditions and risk factors prove a challenge for the prevention of NCDs in elderly. However, CVD risk assessment in elderly emerges an essential priority for health policy authorities.

Strengths and limitations of the study

This study has several strengths and limitations. The present study has introduced the use of GBD 1990–2017 results to provide a comprehensive, up-to-date and in-depth overview of the burden of NCDs in terms of YLL, YLD, and DALY in Cyprus. A major strength of the GBD estimates that we have used in our study is the internal consistency and comparability of the age-standardized YLL, YLD, and DALY estimates, which allow comparison across world countries and regions across multiple time points. Therefore, our findings are indispensable in helping Cypriot policy-makers to develop evidence-based prevention and intervention strategies for NCDs.

This study shares the limitations of the GBD 2017 study, which have been discussed in detail elsewhere [11, 33]. First and foremost, the GBD methodology produces sub-regional estimates for a number of countries; however, sub-regional estimates are not available for Cyprus. For Cyprus this means that the estimates presented here are based on both the northern and the southern part of Cyprus. However, since the northern part is under Turkish occupation and the southern part is controlled by the government of Cyprus, there may be differences in health policy and prevention measures in the northern and southern part. These differences may result in difference in NCD DALYs, but because of the lack of estimates for Cyprus' sub-regions it is not possible to study differences. Similarly, the GBD does not produce estimates for sub-groups of the population according to socio-economic status or ethnic background. Second, co-morbidity adjustment in the GBD 2017 study assumes independent distributions of having any NCD state; thus, in the presented findings, co-morbidity distributions by NCD cause, age, and sex could vary over time. Since any possible interactions between co-existing NCDs are not taken into account, the burden of disease of NCDs in Cyprus may be underestimated. Third, we did not report burden of NCDs by age groups, which would be necessary for the implementation of age-specific intervention strategies and/or activities in primary healthcare in Cyprus. Fourth, the data on NCD prevalence data in Cyprus is lacking; the DALY estimates, in the GBD study, were based on the limited health survey, scientific literature report, and/or epidemiological data that was available, which possibly led to large UIs.

Implications for health policy in Cyprus

Our findings have important implications for evidence-based decision-making on the NCD intervention strategies in Cyprus. The majority of the NCDs share modifiable risk factors, namely tobacco use, hypertension, unhealthy diets, and alcohol abuse. Policymakers in Cyprus should consider targeting these NCD risk factors in targeted health prevention policies. Cyprus has a similar NCD risk profile compared with other Mediterranean countries (Greece, Italy, France, Spain, etc.) and the effect of preventive policies mainly for tobacco control has been effective [34, 35]. From this perspective, planning and developing patient-centered interventions of the NCD risk factors and/or early detection and disease screening can reduce the incidence of NCDs and exacerbation of prevalent NCDs. More importantly, the Cypriot health authorities should formulate and enact on prevention and health promotion strategies for NCDs in order to reduce population exposure in NCD risk factors. Furthermore, there is need to strengthen the epidemiological base for NCD prevalence in Cyprus.

Conclusions

Despite a decrease in the burden of NCDs over the period from 1990 to 2017, NCDs are still a major public health challenge with CVDs, neoplasms, and musculoskeletal disorders to be major contributors to the burden of NCDs for both males and females. Implementation of early detection screening programmes of modifiable NCD risk factors and population-level health promotion programmes are needed to reduce the incidence and exacerbation of leading causes of NCDs in the Cypriot population.

List Of Abbreviations

CKD: Chronic Kidney Disease

COPD: Chronic Obstructive Pulmonary Disease

CVD: Cardiovascular Disease

DALY: Disability Adjusted Life Year

DW: Disability Weight

EU: European Union

GBD: Global Burden of Disease

IHD: Ischemic Heart Disease

IHME: Institute for Health Metrics and Evaluation

NCD: Non-Communicable Disease

SMPH: Summary Measures of Population Health

SUDs: Substance Use Disorders

UI: Uncertainty Interval

WHO: World Health Organization

YLD: Years Lived with Disability

YLL: Years of Life Lost

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The dataset used in this study is publically available at: <http://ghdx.healthdata.org/gbd-results-tool>.

Competing interests

All authors declare no competing interests.

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Authors' contributions

PC, JH, BD generated the initial idea for the study; PC analyzed the data; PC drafted the manuscript with assistance from JH; PC revised the manuscript; JH supervised the study. All authors provided critical input into the interpretation of the results, revisions to the manuscript, and approved the final draft.

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Figures

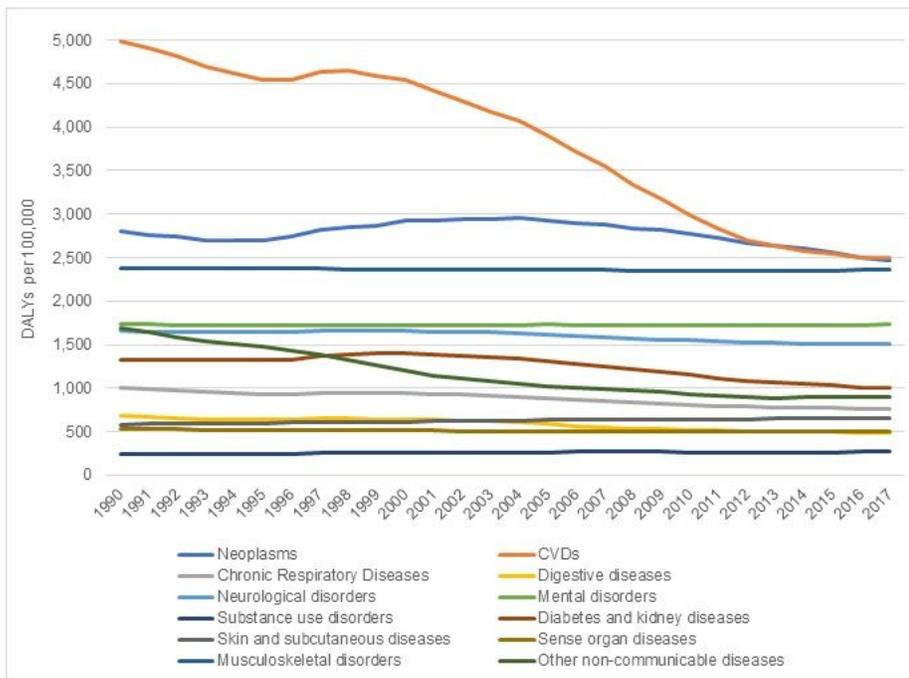


Figure 1
Age-standardized DALY rates of Level 2 NCDs per 100,000 in Cyprus from 1990 to 2017

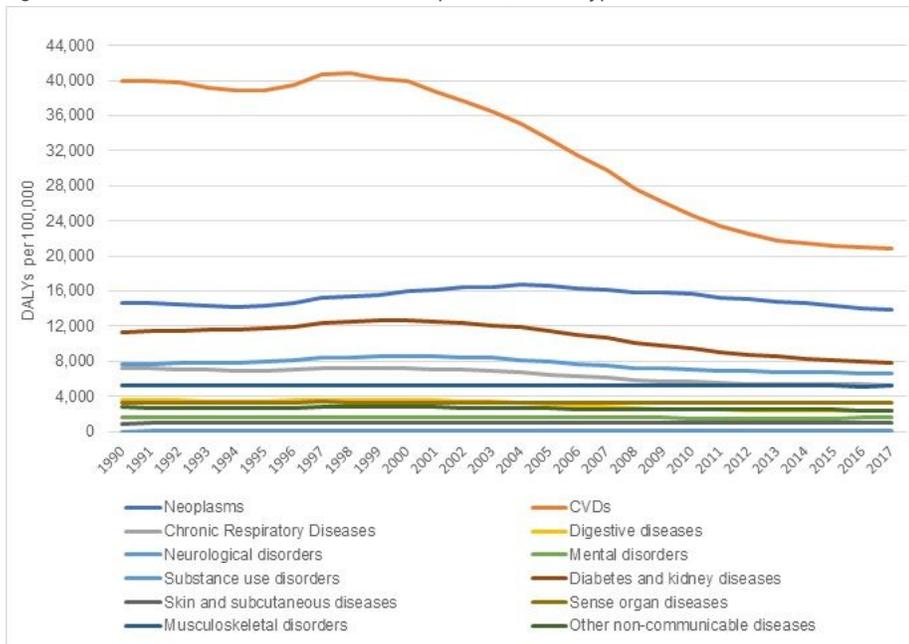


Figure 2
NCD DALY rates in elderly (70+ years) in Cyprus from 1990 to 2017