Annex 1. Impact of NCDs on macroeconomic productivity

Noncommunicable diseases (NCDs) affect all countries, but the burden of premature death, disease and disability is heavily concentrated in low- and middle-income countries (1, 2). Studies summarized in Table A1.1 have been systematically reviewed to investigate the macroeconomic impact of NCDs and to identify research gaps, particularly in low- and middle-income countries (3).

Impact of cardiovascular disease on productivity

There is strong evidence of the macroeconomic impact of cardiovascular disease (heart disease and stroke). Of all disability-adjusted life-years (DALYs) at population level in Spain, 4.2% were attributable to coronary heart disease (4), with an estimated age-standardized rate of 4.7 per 1000 persons per year. In China, DALYs attributable to coronary heart disease were estimated to more than double from 2000 to 2030 (5). A study from Kenya estimated the DALY to be 68 per 100 000 person-years of observation (6). Coronary heart disease-related productivity loss in the United States of America was US$ 8539 per person per year, US$ 10 175 per person per year for absenteeism (7) and US$ 2698 per person per year for indirect work-related loss (8). An estimated 4.7 working days per person per year were lost in the United States owing to coronary heart disease (9). Also in the United States, the odds of experiencing a limited amount of paid work due to illness were significantly higher for those with coronary heart disease compared to the control group (10). Total absenteeism-related costs in Australia were estimated at US$ 5.69 billion, mortality-related costs at US$ 23 million and costs related to lower employment at US$ 7.5 billion (11). In Denmark, workforce participation increased with increasing time from 37% after 30 days to 65% after five years following diagnosis (12).

Studies in Spain found that stroke accounted for 3.5% of all DALYs (4) and the loss of 418 052 DALYs (13). A study from Kenya reported a rate of 166 DALYs per 100 000 person-years observed (6). Among indigenous Western Australians, the average annual stroke-attributable DALY count is an estimated 26 315 for men and 30 918 for women (14). In Spain, costs after diagnosis increased over time for caregivers of stroke victims (15). Productivity losses in the Republic of Korea were higher for a severe stroke among men (US$ 537 724) than women (US$ 171 157) (16). A prospective surveillance study from the United Republic of Tanzania reported a mean cost of productivity loss of US$ 213 (17).

Impact of stroke on return to work has been investigated (18–20). In Nigeria, 55% returned to work at a mean of 19.5 months after stroke. A report from the United Kingdom found that 47% were unemployed one year after stroke (20).
Impact of cancer on productivity

The DALY and US dollar costs of cancer were large. With regard to cervical cancer, there were considerable regional differences in the percentage of DALYs attributable to cervical cancer, ranging from 1.6% in New Zealand to 13.4% in Brazil (21, 22). Cervical cancer patients in Argentina reported negative outcomes after one year; 45% of patients reported reduced labour market participation, 28% experienced work interruption and 5% changed work (23). Compared to the general population, cervical cancer survivors had a lower chance of labour force participation after diagnosis in Finland (24), and in another study five-year cancer survivors were found to have a negative change in employment status (25).

Of all the DALYs attributable to cancers among women, 27.3% in New Zealand and 13.4% in Brazil were attributable to breast cancer (21, 22). Total mortality-related lifetime productivity loss costs in the United States were estimated to be US$ 5.5 billion (26). Differential return to work and sick absence rates were observed comparing black and white women in the United States; the percentage of white women returning to work three months after diagnosis was 74.2% compared to 59.6% of black women (27). One year after primary surgery in Germany, nearly 3 times as many cancer survivors had left their job as compared to women in the control group (28). Various studies suggested higher unemployment among breast cancer survivors, reported by around half after one year, 72% after two years (29), 43% after six years and 18% after nine years (27, 28, 30–32). In a study assessing unemployment among the spouses of breast cancer patients, no differences were found (33). Differences were found between countries in average time to return to work, from 11.4 months in the Netherlands (34) and 7.4 months in Canada (35) to only 3 months in Sweden (36). Percentage of return to work after one year ranged from 54.3% in France to 82% in the United States (37, 38).

Of all the DALYs attributable to cancers, 12.9% among women and 13.5% among men were attributable to colon cancer in New Zealand (22) and 9.3% among women and 7.5% among men in Brazil (21). In Spain, 2.1% of DALYs overall were attributable to colon cancer (4). In the Islamic Republic of Iran the total burden of colorectal cancer in 2008 was 52 534 DALYs (39). In the United States, annual productivity losses were calculated to be US$ 20.9 billion (40), while the cost due to absenteeism after one year of diagnosis was US$ 4245 per patient compared to the general population (41).

In New Zealand, of all cancer-attributable DALYs, 14.4% among women and 15.9% among men were attributable to lung cancer (22). In Brazil, lung cancer accounted for 9.8% of all cancer-related DALYs among women and 24.5% among men (21). In Spain, 3.4% of all DALYs were attributable to lung cancer (4). Most of the first year of disease (275 days) was spent in sickness absence in Sweden (36) and between 33% and 79% of lung cancer patients in the United States were unemployed 15 months after diagnosis (43, 46). Average time to re-enter the labour market was 484 days for full-time work and 377 for part-time work in the Netherlands (50). The odds of re-entry into the labour market were significantly lower for lung cancer patients than for the general population (24, 25, 51).
Impact of chronic obstructive pulmonary disease (COPD) on productivity

COPD patients had a higher chance of working fewer hours, of absenteeism and of poorer work performance (presenteeism) (11, 52, 53). COPD patients lost around 8.5 workdays per year due to disease (10, 54). Between 39% and 50% of people stopped working due to the onset of COPD in the Netherlands (55, 56). COPD-related productivity losses cost the United States economy around US$ 88 million or around 482 966 working days per year (57). Modelled annual costs of COPD, estimated at US$ 1.47 billion (58), were higher in Japan than the United States. The productivity loss costs per person per year were somewhat comparable between Germany, Sweden and the Netherlands (US$ 566, 749 and 938 respectively) (57, 59, 60), but differed fourfold from estimated costs in Denmark (61, 62) and more than tenfold from what was estimated in the United States (63). In the United States, 8.5 work days were lost per person per year on average (10), while COPD patients took an estimated 8.6 days of sickness absence in the Netherlands during a two-year follow-up period (54). Also in the Netherlands, 39% of COPD patients left the labour force due to disease onset (55).

Impact of chronic kidney disease on productivity

Renal dysfunction was independently associated with labour force non-participation (64). Evaluation of labour market participation in chronic kidney disease patients, specifically after dialysis or transplantation, found that 35% of these patients were unemployed (65).

Impact of diabetes mellitus on productivity

In Spain, nearly 2% of all mortality-related DALYs were attributable to diabetes mellitus (4). In South Africa, 162 877 DALYs annually were attributable to diabetes mellitus (66). A study from Kenya reported a rate of 364 DALYs per 100 000 observed person-years (6). An estimated 7.2 days were lost per person per year due to diabetes mellitus in the United States (10), and diabetes mellitus patients had an increased risk of absenteeism, poor performance at work and inability to work (4, 10, 11, 52, 64, 67–69). Productivity days lost per year due to diabetes ranged from 3.6 to 7.3 (10, 70). In the United States, the proportion of productivity loss was large due to premature mortality (49%) and poor performance at work (44%), and total productivity-related costs were estimated to be US$ 1 962 314 (71).

Diversity in the macroeconomic measures and outcomes

There were considerable global differences in the NCD-attributable DALY burden, especially the differential impact of each NCD comparing high-income countries and low- and middle-income countries. Lung and colon cancer accounted for nearly 30% of all cancer-attributable DALYs in men in New Zealand, whereas in Brazil lung cancer alone accounted for nearly 25%. Among women in high-income countries, breast cancer imposed a large productivity burden, whereas cervical cancer impacted more dramatically in low- and middle-income countries (4, 21, 22).
In Australia, absenteeism and lower employment due to coronary heart disease cost US$ 13.2 billion annually, as well as an additional US$ 23 million in mortality-related costs \(^{(11)}\). Evidence suggested that COPD costed around US$ 88 million or nearly 500 000 working days per year in the United States, compared to US$ 1.47 billion in Japan. While annual COPD-related productivity costs were comparable in Germany, Sweden and the Netherlands, costs differed fourfold in Denmark and tenfold in the United States \(^{(57, 59–63)}\). In the United States, nearly half of the annual US$ 1.96 million productivity losses due to diabetes mellitus were attributable to mortality, with 44% attributable to poor performance of work and just 4% to absenteeism. In the Republic of Korea, productivity losses for a stroke were 68% higher among men compared to women \(^{(16)}\). Around half of all stroke survivors in a United Kingdom study were unemployed after one year \(^{(20)}\). In the United Republic of Tanzania, productivity losses after six months following stroke were US$ 213 on average, though these losses were most acutely experienced by those in higher-skilled roles \(^{(17)}\). COPD patients experienced reduced working hours, unemployment, absenteeism and poor performance at work \(^{(10, 11, 52–56)}\). Diabetes mellitus patients also had an increased risk of reduced labour market participation \(^{(10, 11, 52, 64)}\).

Total mortality-related lifetime productivity losses due to breast cancer were an estimated US$ 5.5 billion in the United States \(^{(26)}\) and annual productivity losses due to colon cancer costed the United States economy US$ 20.9 billion \(^{(40)}\). The evidence for breast cancer-related labour market dropout showed higher unemployment among survivors one, two, six and nine years after diagnosis \(^{(29–32)}\).

**Table A1.1 Overview of studies (1984–2014) investigating the impact of major NCDs on productivity**

<table>
<thead>
<tr>
<th>Study reference</th>
<th>Type of outcome</th>
<th>Outcomes specified include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>11, 25, 28, 30–32, 42–46, 48, 51, 55, 56, 61, 62, 64, 65, 69, 72, 74, 85, 96, 98, 101, 102, 121, 124, 127, 131, 135</td>
<td>Unemployment</td>
<td>Non-participation in the labour force Limited amount of paid work possible due to illness</td>
</tr>
<tr>
<td>10, 27, 34–36, 38, 54, 72, 93, 94, 112, 117, 137</td>
<td>Sick leave</td>
<td>Duration of sick leave Percentage taking sick leave</td>
</tr>
<tr>
<td>4–6, 13, 14, 21, 22, 39, 66, 73, 95</td>
<td>DALYs</td>
<td>Rate per 10 000 people, age standardized</td>
</tr>
<tr>
<td>7–9, 15, 16, 18, 26, 32, 33, 40, 52, 53, 57–63, 67, 68, 70, 71, 79, 81, 84, 90, 92, 97, 98, 105, 107–109, 113, 125, 128, 135</td>
<td>Productivity loss</td>
<td>Days lost per patient of working age per year Mortality-related total lifetime productivity loss Cost of productivity time lost</td>
</tr>
<tr>
<td>12, 21, 24, 25, 31, 33, 48, 51, 86–88, 104, 118, 120, 132, 137</td>
<td>Labour market participation</td>
<td>Age-standardized prevalence of employment Age-standardized prevalence of sick leave</td>
</tr>
<tr>
<td>17, 19, 20, 23, 27, 29, 37, 38, 47–49, 50, 75–78, 80, 82, 83, 103, 106, 110–112, 114–116, 119, 122–124, 126, 130, 133, 136</td>
<td>Return to work</td>
<td>Return to work at a given point in time after diagnosis Time to return to full-time work after diagnosis</td>
</tr>
</tbody>
</table>
Absenteeism
Absenteeism, days total
Costs of reduced time at work

Presenteeism
Presenteeism, days total

References:


11. Zheng H, Ehrlich F, Amin J. Productivity loss resulting from coronary heart disease in


70. Kessler RC, Greenberg PE, Mickelson KD, Meneades LM, Wang PS. The effects of


84. Boles M, Pelletier B, Lynch W. The relationship between health risks and work


97. Fu AZ, Qiu Y, Radican L, Wells BJ. Health care and productivity costs associated with diabetic patients with macrovascular comorbid conditions. Diabetes Care.


Annex 2. Economic consequences of NCDs on households and impoverishment

The burden exerted by NCDs extends beyond morbidity and mortality to economic consequences for households (1–5). This annex summarizes the results of studies (Table A2.1) that have been systematically reviewed to investigate the microeconomic impact of major NCDs (6).

Microeconomic impact of cardiovascular disease (heart disease and stroke)

Household income losses after cardiovascular disease (CVD) diagnosis were 67.5%, 14.3%, 26.3% and 63.5% in high-income families in Argentina, China, India and the United Republic of Tanzania respectively, and were even higher in the lower-income groups (37).

In the United States, 10.4% of coronary heart disease patients reported that out-of-pocket spending was more than 20% of the family income (59). CVD patients in India spent 30% of their annual family income on direct CVD health care (20, 49). In CVD-affected households in India, 30% borrowed or sold assets to pay for inpatient treatment, compared to 12% in matched control households (68). Also in India, the risk of impoverishment due to CVD was 37% greater than for communicable diseases (49).

With regard to stroke, the average out-of-pocket burden as a percentage of income in Japan ranged between 5.1% and 17.2% (23). In China, out-of-pocket costs in the first three months after diagnosis of stroke were 158% greater than the annual income. Catastrophic spending (out-of-pocket spending greater than 30% of annual income) was experienced by 71%, pushing an estimated 23% of insured and 62% of uninsured stroke patients below the US$ 1 per day poverty line (39). In the United States, 27.8% of stroke patients reported out-of-pocket spending at greater than 20% of the family income (59). Among Australian stroke survivors, an estimated US$ 473 were spent in the first year after diagnosis, and 61% perceived financial hardship after 12 months (47, 51).

Microeconomic impact of cancer

In the United States, out-of-pocket spending as a percentage of annual income was estimated by two different studies at 9.7% and 44% for breast cancer (22, 62). In Canada, the percentage was 2.3% (31). In these countries, perceived financial hardship (worries about, or change for the worse in, financial situation) for breast cancer was reported by 1–92% of women (30, 31, 42). This perception of financial burden was experienced by 70% of breast cancer patients in a study from Pakistan (8). When comparing early to late expenditures for health care in up to 80% of breast cancer patients, 10% increased credit card debt, 7% borrowed from friends or family and 5% left some medical bills unpaid (67).

Microeconomic impact of chronic obstructive pulmonary disease (COPD)

In Australia, financial hardship (worries about, or change for the worse in, financial situation) was felt by 36–78% of COPD patients (36, 48). Financial catastrophe, at a 10% income
threshold, was experienced by 46% of COPD patients. In absolute terms, annual out-of-pocket expenditure among COPD sufferers was US$ 2048 (48).

**Microeconomic impact of chronic kidney disease**

Of Australian chronic kidney disease patients, 57% reported financial hardship. Using the same income threshold of 10%, financial catastrophe was experienced by 71% of patients with chronic kidney disease. This was equivalent in absolute terms to annual out-of-pocket expenditure of US$ 3755 (46). In Japan, mean annual out-of-pocket expenditure was US$ 2604 (38). Out-of-pocket expenses due to chronic kidney disease increased by 60% between 2002 and 2005. About one third of patients with chronic kidney disease spent more than 10% of their income out of pocket (57, 59).

**Microeconomic impact of type 2 diabetes mellitus**

Mean out-of-pocket expenditure per inpatient hospital stay for diabetes mellitus increased from US$ 134 to US$ 211 between 1995 and 2004, and direct total out-of-pocket spending per year was estimated at US$ 262–280 (19, 40, 49). The percentage of household consumption spent out of pocket ranged between 7.7% and 17.5% (16, 20). In Japan, the average out-of-pocket burden for diabetes mellitus, as a percentage of household income, ranged from 4.8% to 11.3% (23).

In the United States, the mean annual out-of-pocket diabetes care cost was US$ 1237 and increased by 23% from 2002 to 2005 (18, 57). Nearly 40% of diabetes mellitus cases in the United States experienced catastrophic spending (using the 10% threshold); 13% experienced catastrophic spending even above the 20% threshold (59). A cross-country analysis quantified the impoverishing effects of purchasing medicines for different diseases, including diabetes mellitus. Buying lowest-price generic or originator brand glibenclamide would plunge either 2 million (5%) or 3 million (10%) chronic patients below the US$ 1.25 per day poverty line, respectively. When stratifying across the 16 countries (El Salvador, Indonesia, Jordan, Kyrgyzstan, Mali, Mongolia, Nigeria, Pakistan, Peru, Philippines, Tajikistan, Tunisia, Uganda, United Republic of Tanzania, Uzbekistan and Yemen), these percentages ranged between 0% and 71% (25).

In 16 low- and middle-income countries, 6–11% of the total population would be impoverished at a US$ 1.25 per day poverty line if they would have to purchase lowest-price generic diabetes medication (6).

**Table A2.1 Overview of studies (1999–2014) investigating the economic impact of major NCDs on households and impoverishment**

<table>
<thead>
<tr>
<th>Study reference</th>
<th>Type of outcome</th>
<th>Outcomes specified include:</th>
</tr>
</thead>
</table>
| 10, 11, 13, 15, 24, 34, 38, 41, 42, 44, 48, 51, 55, 60, 63, 66 | Financial burden | > 10% of disposable income  
Per person annual costs  
Total direct costs per patient per year  
Total non-health care costs |
## Table: Outcomes specified include:

<table>
<thead>
<tr>
<th>Study reference</th>
<th>Type of outcome</th>
<th>Outcomes specified include</th>
</tr>
</thead>
</table>
| 7, 9, 10, 14, 16, 18–20, 22, 23, 26, 28, 29, 31–35, 39, 40, 43, 45, 48, 49, 51–53, 56, 57, 62, 64, 65, 69 | Out-of-pocket expenditure | Out-of-pocket expenditure per year
| | | Out-of-pocket expenditure as a proportion of annual individual income, annual family income, monthly non-food expenditure or household capacity to pay |
| 11, 13, 14, 37, 39, 48, 49, 52, 59 | Catastrophic expenditure | Out-of-pocket expenditure exceeds 10–40% of household income |
| 25, 39, 49 | Impoverishment | Patients with income above the poverty line and moved below the poverty line due to out-of-pocket expenditure |
| 12, 16, 17, 21, 27, 30, 37, 50, 53, 61, 70 | Income loss | Reported income loss per patient
| | | Decrease in individual income
| | | Decrease in household income |
| 17, 54, 58, 67, 68 | Coping strategy | Change in value of household assets |
| 8, 28, 30, 31, 36, 42, 46, 47 | Hardship | Time of paid work and leisure time forgone |

## References:


21.


35. Kang HY, Lim SJ, Suh HS, Liew D. Estimating the lifetime economic burden of
stroke according to the age of onset in South Korea: a cost of illness study. BMC Public Health. 2011;11:646.


47. Essue BM, Wong G, Chapman J, Li Q, Jan S. How are patients managing with the costs of care for chronic kidney disease in Australia? A cross-sectional study. BMC


Annex 3. Financial burden of NCDs at the macroeconomic level

Most NCDs are long-term health conditions that require prolonged individual care and specialized health care services (1, 2). Historically, high-income countries experienced the greatest economic consequences of NCDs (3). Yet, as a result of economic growth, epidemiological transition, ageing populations and health care system development, low- and middle-income countries now experience a greater impact of NCDs and their risk factors (1–5).

Literature was systematically reviewed (Table A3.1) to evaluate the financial burden of major NCDs at the macroeconomic level in order to quantify (a) the costs related to NCDs; (b) the per capita health care expenditure on NCDs; (c) national economic loss due to NCDs; and (d) the overall aggregate economic impact of NCDs on national income and health care spending (6).

Direct costs

Reported health care costs associated with NCDs varied across countries and regions, and across the type of NCDs (Table A3.2). Reported annual direct costs of NCDs were the highest in the Americas, followed by the European and Western Pacific Regions. The minimum and maximum mean reported annual total direct costs for CVD were US$ 6668 (7) and US$ 81 096 (8) in the Americas, US$ 1643 (9) and US$ 69 440 (10) in the European Region, and US$ 3862 (11) and US$ 5693 (12) in the Western Pacific Region.

Worldwide, of all the selected NCDs, cancer and CVD had the highest reported mean annual total direct costs. Average CVD-related direct costs ranged from US$ 1643 (9) in Poland to US$ 81 096 (8) in the United States. Among cancers, the estimated mean annual total direct costs varied: from US$ 4595 (14) to US$ 82 794 (15) for breast cancer; US$ 4964 (16) to US$ 161 048 (15) for lung cancer; and US$ 2208 (17) to US$ 197 722 (17) for colorectal cancer. Only one study from Singapore reported annual total direct costs for cervical cancer with an average estimate of US$ 8049 (18). COPD annual direct costs varied substantially, with Norway reporting the lowest direct costs, at US$ 431 (19), and the United States reporting the highest, at US$ 34 101 (20). The lowest direct costs for chronic kidney disease were observed in Germany, with an average estimate of US$ 5439 (21), whereas mean direct costs for chronic kidney disease in the United States were estimated to be up to US$ 71 824 (22).

Diabetes mellitus average annual direct costs varied from US$ 162 (23) in India to US$ 15 611 in the United States (24). Inpatient costs are the main source of direct costs for NCDs. Inpatient costs accounted for 47–58% of total direct costs of COPD (26) and 63% of total direct costs for diabetes mellitus (27). Hospital costs represent the main driver of stroke expenditure, accounting for 90% of total direct costs (28). Hospitalization charges represented the greatest economic burden (55%) for the management of colorectal cancer, followed by medical purchases (24%) and outpatient care (18%) (29).
Indirect costs

Mean annual estimated indirect costs for NCD patients were highest for cancer and diabetes mellitus, with estimates up to US$ 24,740 (30) and US$ 23,418 (31), respectively. Mean annual indirect costs for breast cancer varied extensively, from US$ 2,109 (32) to US$ 24,740 (30). The lowest indirect cost for COPD was reported in Japan, with an average estimate of US$ 326 (33), and highest in the United States, at US$ 3,393 (34). Mean diabetes mellitus indirect annual costs were estimated at US$ 104 in Serbia (35) compared to US$ 7,797 in China (27).

Total costs

Cancer and stroke led the total costs with average estimates up to US$ 105,310 (30) and US$ 44,937 (31) respectively. The mean total cost per patient for breast cancer was estimated at US$ 30,000 in Belgium (36) and the United States (37), although the mean costs for metastatic breast cancer were 3 times higher at US$ 105,310 (30). For lung cancer, mean estimates varied from US$ 4,964 (16) in Australia to US$ 50,495 in the United States (38), whereas colorectal cancer total costs were US$ 52,068 (38). Mean COPD total costs were estimated around US$ 1,700 in the United Kingdom and Japan (33), but exceeded the value of US$ 15,500 in Denmark (39). Diabetes mellitus total costs were estimated at an average of US$ 12,920 in Sweden (40), whereas estimated mean total costs in Serbia were US$ 1,005 (35). No study reported total costs for cervical cancer or chronic kidney disease.

Costs of NCDs over time

There was an increase in health care costs associated with NCDs over time. One study showed that, despite a 19% decline in the hospitalization rate for coronary heart disease (acute myocardial infarction) in the United States, overall health care expenditure per patient increased by 17% from 1998 to 2008, and use of outpatient services increased by 65% (absolute difference, US$ 1,000) (41), and similarly for heart failure (8). The average treatment cost of colorectal cancer patients in the United States increased by 73% from 2005 to 2009 (42), mainly driven by the use of new regimens, higher chances of surgery and radiation. In the United States, COPD-related health care costs increased by 5–6% annually (43). Further, a 29% increase in medical treatment costs for diabetic patients was observed from 1999 to 2001 in Israel (44).

Costs according to disease severity and comorbidity

Overall health care costs due to NCDs increased with the severity of the disease, years lived with the condition and co-morbidity (9, 36, 45–55). Patients with severe stroke had almost a 40% greater increase in costs compared to mild stroke patients (45). Among cancer patients, given the same stage of diagnosis, those with one, two or three co-morbidities experienced increased costs of US$ 3,737, US$ 4,188 and US$ 10,442 respectively (56). Costs for a diabetic patient tripled between the first and seventh year after diagnosis (57). An increase in treatment costs of breast cancer by stage was reported (55). Patients with co-existence of
COPD and CVD had 135% higher annual care costs compared with patients without CVD, whereas COPD-related total costs were 38% higher (54). Some studies reported lifetime health care costs of NCDs (initial, continuing and terminal care), demonstrating that initial and terminal care are the most costly (13, 15, 58–60).

Health care expenditure on NCDs

CVD accounted for 12% of all health care expenditure in the European Union (61). Coronary heart disease health care-related costs accounted for 14.2–16.5% of the annual health care budget in the Region of the Americas. Chronic kidney disease and cancer accounted for 3.2% and 3.4% of health care expenditure respectively (25, 62). In the United States, 1.2% of the health care budget was spent exclusively on the treatment of breast cancer (25). The proportion of national health care-related expenditure for COPD ranged from 0.7% in Norway (19), to 1–3% in the Netherlands (63), up to 3.8% in Canada (62). Again in Canada, 3.8% of health care expenditure was attributable to diabetes mellitus (62), whereas in the European Union, diabetes mellitus-related health care expenditure was an estimated 7.4% (64, 65).

In absolute terms, annual CVD hospital costs in the United States reached an estimated US$ 400 billion in 2008, doubling the US$ 195 billion in 1995 (66, 67). In the United States, coronary heart disease-related hospital costs were estimated at US$ 59.1 million in 1995, whereas the CVD-related hospital costs were US$ 130 billion in 2010 (68). In the European Union, CVD-related hospital costs were estimated at US$ 151 billion in 2003, with coronary heart disease accounting for US$ 32.9 billion (61). In Australia, annual hospital costs due to CVD were estimated at US$ 164 million in 1997 (69). In France and Hungary the annual estimated colorectal cancer health-related costs were US$ 565 million and US$ 43 million respectively (70, 71). In the Islamic Republic of Iran, the minimum annual health care-related cost for colorectal cancer was estimated at US$ 39 million for the period between 2005 and 2010 (72). For cervical cancer, the estimated costs were US$ 1.83 million in Singapore (18), US$ 18.2 million in Spain (73) and US$ 12.98 million in Malaysia (74). The estimated total health care costs in the United States for lung, colorectal, cervical and breast cancer combined were US$ 5.2 billion (75). In the United States, health-related costs for COPD and chronic kidney disease in 2005 were an estimated US$ 9.2 billion (24). COPD costs accounted for US$ 232 million in Iceland (19), whereas both COPD and diabetes mellitus accounted for US$ 162 million in Australia (76). Diabetes mellitus hospital-related costs varied from US$ 9.7 billion in the African Region (77), to US$ 41.1 billion in Europe (65), and to US$ 160 billion in the United States (78).

A data series of hospital expenditure on CVD was only available in the United States. This showed a twofold increase in health care share from 1995 to 2008, with estimated health costs of US$ 195 billion in 1995 to US$ 400 billion in 2008 (66, 67). An increase in health care expenditure was also seen for colorectal cancer in Brazil, from US$ 18.54 million in 1996 to US$ 37.64 million in 2008 (79). There was a sharp increase in health care spending on most chronic diseases between 2000 and 2008 (80).
The estimated cost of CVD in Germany in 1999 was US$108.9 billion, whereas for the entire European Union the estimate was US$244.3 billion for the year 2003 (61, 81). Stroke costs were up to US$1.3 billion in Australia, US$3.47 billion in Canada and US$72.4 billion in the United States (69, 87, 88). Worldwide, colorectal, lung, breast and cervical cancer made up 41% (US$127.8 billion) of the US$310.15 billion aggregate cost of new cancer cases in 2009, with lung cancer posing the highest economic burden (US$57.4 billion) (84). In the United States, colorectal cancer and lung cancer total costs were US$2.5 billion each (38), whereas in France, the total colorectal cancer costs were estimated at US$1.24 billion (70). In Malaysia, the total estimated cervical cancer costs were US$17.1 million (74). Total COPD costs varied from US$133.7 million in the Netherlands to US$1.1 billion in Sweden and US$9.1 billion in Japan (33, 47, 85). Total estimated costs of diabetes mellitus increased from US$142.5 billion in 1997, to US$171 billion in 2002, and to US$195.5 billion in 2007 (78, 86, 89). Diabetes mellitus imposed US$30.4 billion in costs in the African Region and US$46.7 billion in costs in China (27, 77).

Impact on national income

In general, NCDs have a large impact on national income, mainly due to loss of productivity as a result of absenteeism and inability to work. There was a US$463 billion increase in economic loss in the United States due to CVD for the period 1993–2008 (66). In the European Union, estimated economic loss in 2003 was US$92.9 billion for CVD. Estimated loss in national income from coronary heart disease-related productivity loss in 1996 was US$71 billion in Germany (81). Economic loss from stroke in 1997 was US$51.7 million in Australia (82), whereas coronary heart disease-related productivity loss was US$2.2 billion in 2004 (83). Worldwide, economic loss from colorectal, lung, breast and cervical cancer at year 2009 were US$13.7 billion, US$8.2 billion, US$1.7 billion and US$8.4 billion respectively (84). In Malaysia, estimated income losses from cervical cancer-related productivity loss were US$4.1 million (74). In the Netherlands, estimated losses in national income from COPD were US$388 million (85). National income losses from diabetes mellitus were estimated at US$20.8 billion in the African Region in 2000 and at US$65.2 billion in 2007 in the United States (77, 86).

Table A3.1 Overview of studies (1999–2014), investigating the health care costs of major NCDs

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<th>Study reference</th>
<th>Type of outcome</th>
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<td>7, 19, 24–26, 33, 39, 43, 47–52, 54, 63, 76, 80, 85, 102, 107, 114, 115, 117, 131, 132, 136, 151–157,</td>
<td>Direct costs COPD</td>
<td>Patient/year</td>
</tr>
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<td>Capita/year</td>
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### Study reference

<table>
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<th>Type of outcome</th>
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<tr>
<td>166, 167</td>
<td>Direct costs chronic kidney disease</td>
<td>Patient/year Capita/year</td>
</tr>
<tr>
<td>21, 22, 24, 25, 80, 101, 147, 149, 170</td>
<td>Direct costs diabetes mellitus</td>
<td>Patient/year Capita/year</td>
</tr>
<tr>
<td>9, 16, 27, 30, 31, 33, 35–39, 40, 47, 77, 92, 93, 95, 98, 112, 113, 116, 139, 179</td>
<td>Annual total costs NCDs</td>
<td>Per year</td>
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### Table A3.2 Economic impact of NCDs by World Health Organization regions

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<thead>
<tr>
<th>Region of the Americas</th>
<th>Min costs</th>
<th>Max costs</th>
<th>Min costs</th>
<th>Max costs</th>
<th>Min costs</th>
<th>Max costs</th>
<th>Min costs</th>
<th>Max costs</th>
<th>Min costs</th>
<th>Max costs</th>
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</thead>
<tbody>
<tr>
<td><strong>CVD</strong></td>
<td>6668</td>
<td>81096</td>
<td>9899</td>
<td>161048</td>
<td>1777</td>
<td>34101</td>
<td>17681</td>
<td>58871</td>
<td>3373</td>
<td>15611</td>
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<td><strong>Cancer</strong></td>
<td>6752</td>
<td>NA</td>
<td>2109</td>
<td>24740</td>
<td>3393</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>COPD</strong></td>
<td>23065</td>
<td>NA</td>
<td>26492</td>
<td>105310</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td><strong>Health care expenditure</strong></td>
<td>130.6 billion</td>
<td>400 billion</td>
<td>18.5 million</td>
<td>5.2 billion</td>
<td>9.2 billion</td>
<td>NA</td>
<td>NA</td>
<td>230.5 million</td>
<td>160 billion</td>
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<tr>
<td><strong>National income losses</strong></td>
<td>600 billion</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>52 billion</td>
<td>78.3 billion</td>
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<tr>
<td><strong>National income and health care expenditure</strong></td>
<td>3.47 billion</td>
<td>1 trillion</td>
<td>2.5 billion</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>142.5 billion</td>
<td>195.5 billion</td>
<td></td>
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<tr>
<td><strong>European Region</strong></td>
<td>1643</td>
<td>69440</td>
<td>3826</td>
<td>60519</td>
<td>692</td>
<td>13583</td>
<td>5439</td>
<td>71824</td>
<td>901</td>
<td>7570</td>
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<tr>
<td><strong>Direct cost</strong></td>
<td>1780</td>
<td>23418</td>
<td>23692</td>
<td>NA</td>
<td>970</td>
<td>3264</td>
<td>NA</td>
<td>NA</td>
<td>104</td>
<td>5350</td>
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<tr>
<td><strong>Indirect cost</strong></td>
<td>11396</td>
<td>44937</td>
<td>26680</td>
<td>NA</td>
<td>1662</td>
<td>15585</td>
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<td>NA</td>
<td>1005</td>
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<tr>
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<td>4.5 million</td>
<td>564.6 million</td>
<td>NA</td>
<td>232.3 million</td>
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<td>NA</td>
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<td><strong>National income losses</strong></td>
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<td>92.9 billion</td>
<td>679.1 million</td>
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<td>388.6 million</td>
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<td>NA</td>
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<td>NA</td>
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<td><strong>Western Pacific Region</strong></td>
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<td>5693</td>
<td>4964</td>
<td>8049</td>
<td>551</td>
<td>14326</td>
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<td>NA</td>
<td>952</td>
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<tr>
<td><strong>Direct cost</strong></td>
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<td>NA</td>
<td>326</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
<td>7797</td>
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<tr>
<td><strong>Indirect cost</strong></td>
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<td>NA</td>
<td>4964</td>
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<td>Health care expenditure</td>
<td>Min costs</td>
<td>Max costs</td>
<td>Min costs</td>
<td>Max costs</td>
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<td>Max costs</td>
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<td>Max costs</td>
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<tr>
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<td>164 million</td>
<td>13 million</td>
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<td>4.1 million</td>
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<td>National income and health care expenditure</td>
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<td>NA</td>
<td>46.7 million</td>
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</tr>
</tbody>
</table>

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