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Health care utilization and the associated costs attributable to cardiovascular disease in Ireland: a cross-sectional study

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Background

Cardiovascular disease (CVD) is the leading cause of mortality and disability globally. We examined healthcare service utilization and costs attributable to CVD in Ireland in the period before the introduction of a major healthcare reform in 2016.

Methods

Secondary analysis of data from 8113 participants of the first wave of The Irish Longitudinal Study on Ageing. Cardiovascular disease was defined as having a self-reported doctor's diagnosis of myocardial infarction, angina, heart failure, stroke, atrial fibrillation, or transient ischaemic attack. Participants self-reported the utilization of healthcare services in the year preceding the interview. Negative binomial regression with average marginal effects (AMEs) was used to estimate the incremental number of general practitioner (GP) and outpatient department (OPD) visits, accident and emergency department attendances and hospitalizations in population with CVD relative to population without CVD. We calculated the corresponding costs at individual and population levels, by gender and age groups.

Results

The prevalence of CVD was 18.2% (95% CI: 17.3, 19.0). Participants with CVD reported higher utilization of all healthcare services. In adjusted models, having CVD was associated with incremental 1.19 [95% confidence interval (CI): 0.99, 1.39] GP and 0.79 (95% CI: 0.65, 0.93) OPD visits. There were twice as many incremental hospitalizations in males with CVD compared to females with CVD [AME (95% CI): 0.20 (0.16, 0.23) vs. 0.10 (0.07, 0.14)]. The incremental cost of healthcare service use in population with CVD was an estimated €352.2 million (95% CI: €272.8, €431.7), 93% of which was due to use of secondary care services.

Conclusion

We identified substantially increased use of healthcare services attributable to CVD in Ireland. Continued efforts aimed at CVD primary prevention and management are required.

Keywords

Cardiovascular disease • Direct costs • Healthcare use • Ireland

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Ireland were assigned to one of 3155 geographic clusters, stratified by geography and socioeconomic group, and a sample of 640 clusters was selected with a probability that is proportional to the number of individuals aged 50+ years in each cluster. Forty households were then selected from each cluster to allow for 25 600 addresses to achieve a sample size of 8000, and each address was visited by an interviewer to establish eligibility criteria. All the individuals aged 50+ living at the selected addresses at the time of the visit together with their partners (of any age) were invited to take part in the study. Out of 10 128 addresses that were considered eligible for inclusion based on the presence of an individual aged 50+ years, successful interviews were obtained from 6279 addresses (62% response rate), and 8175 participants aged 50+ years were recruited. Ethical approval was obtained from the Trinity College Dublin Research Ethics Committee. Data collection took place between October 2009 and November 2011. All individuals who agreed to participate in the study were visited by a trained interviewer and underwent a computer-assisted personal interview in their home with questions relating to sociodemographic information, general health and well-being as well as self-reported doctor diagnosis of chronic conditions and healthcare utilization.

Participants were given a card with a list of heart conditions and asked whether a doctor had ever told them that they had any of the conditions on the card. We considered a participant as having CVD if they reported a doctor's diagnosis of any of the following conditions: heart attack (myocardial infarction), angina, heart failure (congestive cardiac failure), stroke (cerebrovascular accident), atrial fibrillation (abnormal heart rhythm), or ministroke (transient ischaemic attack). Participants reported the number of visits to the GP and outpatient department (OPD), the number of attendances to accident and emergency department (A&E) and the number of hospital admissions in the 12 months preceding the interview.

Other variables of interest included age, gender, marital status (married or living with partner/never married/separated or divorced/widowed), highest education level attainment (none or primary/secondary/tertiary), household location (Dublin/another town or city/rural), self-reported health status (excellent/very good/good/fair/poor),²⁹ healthcare coverage (Medical or GP visit card/private health insurance only/dual cover/none), and self-reported doctor diagnosis of other chronic conditions deemed not to be associated with CVD. Participants who reported having a medical or GP visit card were considered to have public health insurance. Between 2009 and 2011 (e.g. the period during which data collection took place), eligibility for a medical or GP visit card in Ireland was primarily based on an income means test, with the exception of those aged 70+ years.^{30,31}

Analysis

We examined the healthcare service utilization of participants with and without CVD. The differences in the mean number of GP and OPD visits, attendances at A&E and hospital admissions were compared using the Wilcoxon rank sum test, and the differences in the proportion of people attending each type of healthcare service at least once were compared using Pearson's chi-square test. Ordinary least squares, Poisson, negative binomial, zero-inflated Poisson, and zero-inflated negative binomial regressions were used to model the association between CVD and the frequency of healthcare service use. The choice of the model was based on the comparison of Akaike information criterion (AIC) and the inspection of model predicted vs. observed probabilities. Negative binomial regression was selected for all four studied outcomes based on the lowest AIC values, and the best fit to the data (Additional files 1 and 2) and average marginal effects (AME) were calculated to provide an estimate of the incremental GP and OPD visits, A&E attendance, and hospital admissions that were attributable to CVD.

The marginal effect of CVD is the change in the expected number of outcomes (i.e. number of GP and OPD visits, A&E attendances, and hospital admissions) due to CVD for each individual in the dataset based on his/her observed set of values for variables included in the model. The AME averages the marginal effects over all subjects and represents the average number of events due to CVD.³²

Covariates

The inclusion of appropriate variables in the multivariable regression models was informed by the Anderson framework for the societal and individual determinants of healthcare utilization with the aim of identifying an independent effect of CVD on healthcare service utilization.³³ Accordingly, multivariable models were adjusted for age, gender, marital status (predisposing factors), location, highest education level attainment, health care coverage (enabling factors), and other chronic conditions, including diabetes, asthma, chronic obstructive pulmonary disease, osteoporosis, arthritis, cancer, and ulcers (need factors), while any potential mediators of the association between CVD and healthcare service use were omitted. We included interaction terms between CVD and age and between CVD and gender to allow the effect of CVD on healthcare service utilization to vary by age and gender. Sampling weights were applied to all estimates to adjust for differential non-response and to reduce the potential for selection or participation bias.²⁷

Cost data

A societal perspective was adopted applying average unit costs of €50 for a GP visit, €160 for an OPD visit, €5 030 for hospital inpatient admission, and €183 for A&E attendance in Ireland obtained from the Office of the Revenue Commissioner and The Health Service Executive (HSE) for a previous study.^{34,35} The HSE adopts the case-mix and diagnosis-related group costing methodology to obtain unit cost estimates. These costs were inflated to represent the costs in euros for April 2023 using the Consumer Price Index Inflation Calculator for Ireland.³⁶ The corresponding inflated unit costs were €58.3, €191, €5 991, and €225 for a GP visit, OPD visit, hospital admission, and A&E attendance, respectively.

We estimated direct healthcare costs of CVD in Ireland in a two-step approach. First, we applied AME to the corresponding inflated average unit costs for each studied healthcare service to calculate the average cost per person of the incremental healthcare service use attributable to CVD. We also estimated AME and average costs per person separately for males, females, and age groups (50–59, 60–69, and 70+ years old) in the sample. Second, we estimated the prevalence of CVD in the sample (e.g. age- and gender-specific, where necessary) and applied it to the most recent Irish census data (2022) to obtain an estimate of the total number of people with CVD in the Irish population. This was multiplied by the average cost per person from the first step to extrapolate the costs of the incremental healthcare service use attributable to CVD to the population level.

All analyses were carried out in R version 4.1.2.³⁷ We carried out the complete case analysis, as complete data were available from 8113 participants (99.2%) (Figure 1).

Results

The mean age of the participants was 63.5 years, and 54.2% were female. The prevalence of CVD was 18.2% (95% CI: 17.3, 19.0), and 5.6% (95% CI: 5.1, 6.1) had more than one cardiovascular condition. The characteristics of the participants by their CVD status are shown in Table 1. Compared to the participants without CVD, those with CVD were on average older and were more likely to be male, widowed, less educated, have another chronic condition, and reside in urban areas. They were less likely to report good health and have private health insurance only.

A greater proportion of individuals with CVD reported seeking healthcare services than those without CVD (Table 2). Specifically, a greater percentage of participants with CVD reported visiting a GP [95% (95% CI: 94%, 96%) vs. 86% (95% CI: 85%, 87%)] and OPD [60% (95% CI: 58%, 63%) vs. 37% (95% CI: 36%, 38%)], attending A&E [24% (95% CI: 22%, 26%) vs. 13% (95% CI: 12%, 14%)], or having a hospital admission [25% (95% CI: 23%, 27%) vs. 10% (95% CI: 9.6%, 11%)] over the 12 months preceding the interview.

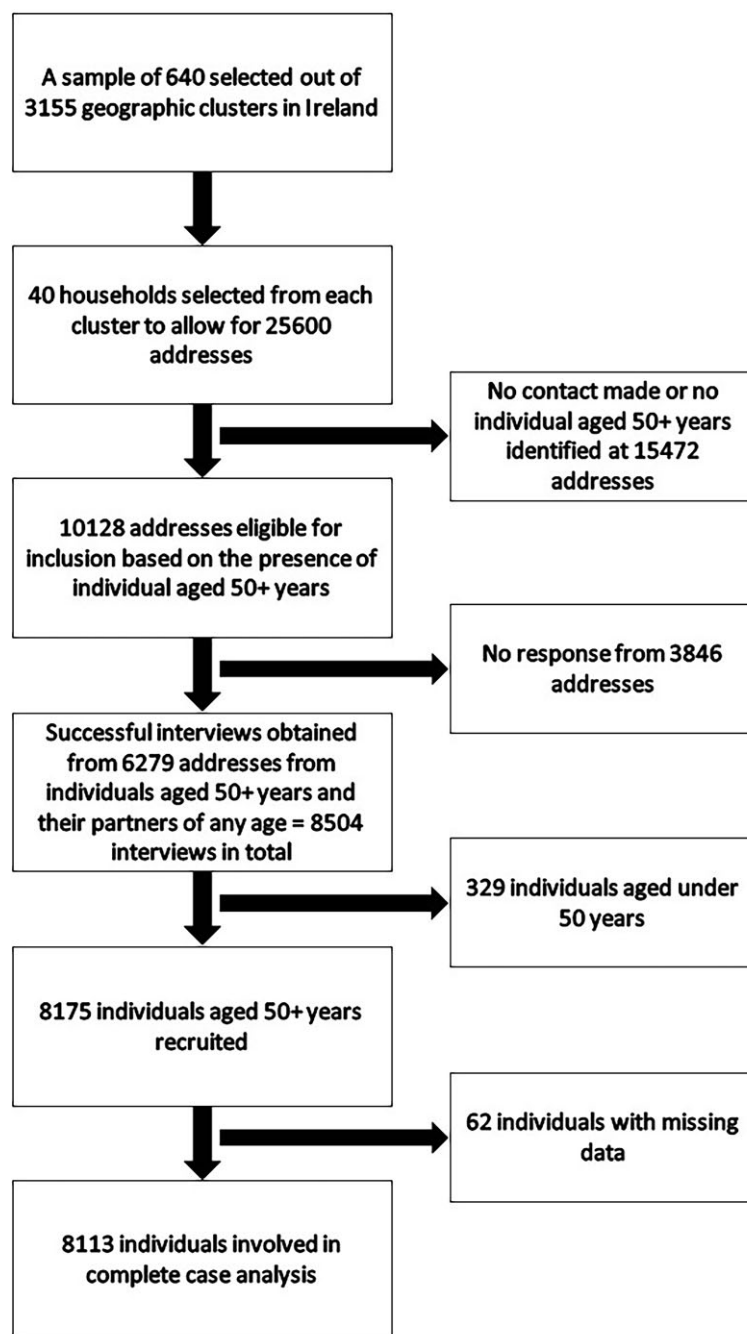


Figure 1 A flow diagram of participant inclusion in the TILDA study.

Average marginal effect from unadjusted and adjusted negative binomial regression models are presented in [Table 3](#). Having CVD was associated with higher incremental healthcare service use across all studied services. In the adjusted model, having CVD was associated with an average of 1.19 (95% CI: 0.99, 1.39) incremental GP visits and 0.79 (95% CI: 0.65, 0.93) incremental OPD visits over the past 12 months. Having CVD was also associated with 0.14 (95% CI: 0.10, 0.18) incremental A&E attendances and 0.15 (95% CI: 0.11, 0.18) incremental hospital admissions over the past year.

[Table 3](#) also provides estimates of the mean per capita costs and population-level costs attributable to incremental healthcare services

use associated with CVD in Ireland. These costs are also presented according to healthcare service type. There was an estimated average cost of €1135 (95% CI: €879, €1391) per person associated with the incremental healthcare service use attributable to CVD. Applying the prevalence of CVD in the sample to the total Irish population aged 50+ (CSO estimate for 2022: 1 696 153), it was estimated that 310 305 adults aged 50+ in Ireland live with CVD. The cost of the corresponding incremental healthcare service use associated with CVD in this population was €352 million (95% CI: €273 million, €432 million) per annum. Hospital admissions accounted for nearly 80% of this cost (estimate: €274 million; 95% CI: €209 million, €339 million),

Table 1 Characteristics of the study population by CVD diagnosis

Variable	No CVD, N = 6655	CVD, N = 1458	Overall, N = 8113
Gender			
Female	3761 (57%)	635 (44%)	4396 (54%)
Male	2894 (43%)	823 (56%)	3717 (46%)
Mean age (SD)	62.4 (8.9)	68.4 (8.8)	63.5 (9.2)
Age category			
50 to 59	2960 (44%)	295 (20%)	3255 (40%)
60 to 69	2125 (32%)	450 (31%)	2575 (32%)
70+	1570 (24%)	713 (49%)	2283 (28%)
Household location			
Dublin	1537 (23%)	389 (27%)	1926 (24%)
Another town or city	1870 (28%)	428 (29%)	2298 (28%)
Rural	3248 (49%)	641 (44%)	3889 (48%)
Marital status			
Married/living with a partner	4660 (70%)	938 (64%)	5598 (69%)
Never married	664 (10.0%)	124 (8.5%)	788 (9.7%)
Separated/divorced	456 (6.9%)	90 (6.2%)	546 (6.7%)
Widowed	875 (13%)	306 (21%)	1181 (15%)
Education			
None or primary	1899 (29%)	579 (40%)	2478 (31%)
Secondary	2722 (41%)	522 (36%)	3244 (40%)
Tertiary	2034 (31%)	357 (24%)	2391 (29%)
Healthcare cover			
Medical or GP visit card only	1972 (30%)	624 (43%)	2596 (32%)
Private health insurance only	2887 (43%)	382 (26%)	3269 (40%)
Dual cover	1039 (16%)	372 (26%)	1411 (17%)
No cover	757 (11%)	80 (5.5%)	837 (10%)
Self-reported health			
Excellent	1197 (18%)	73 (5.0%)	1270 (16%)
Very good	2068 (31%)	254 (17%)	2322 (29%)
Good	2153 (32%)	489 (34%)	2642 (33%)
Fair	1009 (15%)	458 (31%)	1467 (18%)
Poor	228 (3.4%)	184 (13%)	412 (5.1%)
Other chronic conditions			
Diabetes	432 (6.5%)	192 (13%)	624 (7.7%)
COPD	237 (3.6%)	90 (6.2%)	327 (4.0%)
Asthma	570 (8.6%)	175 (12%)	745 (9.2%)
Arthritis	1684 (25%)	552 (38%)	2236 (28%)
Osteoporosis	624 (9.4%)	159 (11%)	783 (9.7%)
Cancer	398 (6.0%)	113 (7.8%)	511 (6.3%)
Ulcers	414 (6.2%)	153 (10%)	567 (7.0%)

Results presented as n (%) unless indicated otherwise; CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease.

with OPD visits accounting for an additional 13% (estimate: €46.8 million; 95% CI: €38.5 million, €55.1 million).

Figure 2 displays the incremental healthcare service use associated with CVD and the corresponding costs separately for males and females. While there was no difference between males and females in the incremental GP visits, OPD visits, and A&E attendances associated with CVD, males had higher incremental hospital admissions attributable to CVD than females [AME: 0.20 (95% CI: 0.16, 0.23) in males vs. AME: 0.10 (95% CI: 0.07, 0.14) in females]. The total per capita cost of the incremental healthcare service use attributable

to CVD was 72% higher in males than in females [€1470 (95% CI: €1214, €1726) vs. €852 (95% CI: €596, €1108)], and the difference was mainly driven by the higher cost of incremental hospitalizations in males with CVD compared with females with CVD [€1183 (95% CI: €974, €1392) in males vs. €627 (95% CI: €418, €826) in females]. When calculated at the population level, taking into account the gender-specific prevalence of CVD in the sample [estimate: 21.0% (95% CI: 19.7%, 22.4%) in males and 15.6% (95% CI: 14.4%, 16.7%) in females], the costs associated with the incremental healthcare service use attributable to CVD were 119% higher in males than in females

Table 2 Use of healthcare services over the past year by CVD diagnosis

Healthcare service	No CVD, N = 6655	CVD, N = 1458	Overall, N = 8113
<u>GP visits</u>			
Mean (SD) number	3.4 (3.8)	5.7 (5.0)	3.9 (4.1)***
Attended	5703 (86%)	1391 (95%)	7094 (87%)***
<u>A&E attendance</u>			
Mean (SD) number	0.2 (0.6)	0.4 (0.9)	0.2 (0.7)***
Attended	871 (13%)	348 (24%)	1219 (15%)***
<u>OPD visits:</u>			
Mean (SD) number	1.0 (2.0)	2.1 (2.8)	1.2 (2.2)***
Attended	2446 (37%)	880 (60%)	3326 (41%)***
<u>Hospital admissions:</u>			
Mean (SD) number	0.2 (0.6)	0.4 (0.9)	0.2 (0.6)***
Admitted	686 (10%)	362 (25%)	1048 (13%)***

Results presented as *n* (%) unless indicated otherwise; CVD, cardiovascular disease; GP, general practitioner; A&E, accident and emergency department; and OPD, outpatient department; *** indicate significance at level $P < 0.001$.

Table 3 Incremental healthcare service use and costs attributable to CVD

Health service	Average marginal effect (95% CI)		Direct costs, 2023 (95% CI)		
	Univariate	Multivariable	Costs per person (€)	Costs overall (million €)	% total
GP visits	1.98 (1.76, 2.2)	1.19 (0.99, 1.39)	€71.6 (€59.7, €83.6)	€22.2 (€18.5, €25.9)	6.3%
OPD visits	0.85 (0.72, 0.98)	0.79 (0.65, 0.93)	€150.8 (€124.1, €177.6)	€46.8 (€38.5, €55.1)	13.3%
A&E attendances	0.17 (0.13, 0.2)	0.14 (0.10, 0.18)	€31.2 (€23.0, €39.4)	€9.7 (€7.1, €12.2)	2.7%
Hospital admissions	0.18 (0.14, 0.21)	0.15 (0.11, 0.18)	€881.5 (€672.3, €1090.7)	€273.5 (€208.6, €338.5)	77.7%
Total			€1135.2 (€879, €1391.3)	€352.2 (€272.8, €431.7)	100.0%

Outputs from univariate and multivariable analyses. Legend: CI, confidence interval; GP, general practitioner; A&E, accident and emergency department; and OPD, outpatient department. Multivariable model adjusted for participant gender and age, household location, education level, marital status, healthcare cover, other chronic conditions, and the interaction terms of age and gender with CVD. Cost estimates based on average marginal effects from multivariable models.

[€254 million (95% CI: €210 million, €298 million) vs. €116 million (95% CI: €81, €151 million)].

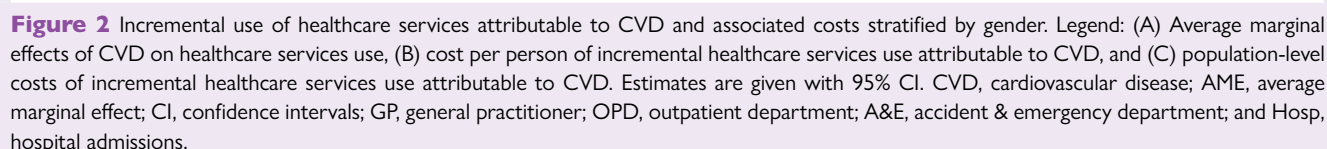
There were no differences observed in the incremental healthcare service use attributable to CVD between those aged 50–59, 60–69, and 70+ years (Figure 3). However, an increasing trend in cost at the population level was observed when moving from the youngest to the oldest group both in total costs [€62.3 million (95% CI: €44.2 million, €80.4 million) vs. €103 million (95% CI: €79.1 million, €127 million) vs. €208 million (95% CI: €132 million, €283 million) for age groups 50–59, 60–69, and 70+ years] and across each studied healthcare service separately (Figure 3). This was, however, mainly driven by a higher prevalence of CVD in older age groups [9.3% (95% CI: 8.3%, 10.4%) vs. 17.6% (95% CI: 16.1%, 19.1%) vs. 31.3% (95% CI: 29.3%, 33.3%) for age groups 50–59, 60–69, and 70+ years].

Discussion

In this large nationally representative sample of older adults in Ireland from 2009 to 2011, having CVD was associated with higher incremental healthcare service utilization across all services examined, incurring an estimated total marginal cost of €352 million at the population level and an estimated marginal cost of €1135 per person per annum at the individual level. The main contributor to costs were hospital

admissions, which accounted for more than three-quarters of the costs. While there is a paucity of studies on the cost of CVD in Ireland, this finding is in line with the research on healthcare expenditure due to CVD reported internationally, whereby hospital inpatient costs are the main contributor to total healthcare costs.^{38–41} In addition, we observed increased hospital admissions associated with CVD in males compared to females, and individual and population-level costs attributable to CVD were higher in males due to greater healthcare service utilization and a higher prevalence of CVD in this population. An increasing trend was also observed in the costs of the healthcare services associated with CVD at the population level when moving from the youngest to the oldest age group, but this was driven by the increase in the prevalence of CVD in older ages.

To the best of our knowledge, this study represents the first examination of the incremental healthcare service use attributable to CVD in Ireland, as well as the associated costs. Our analysis considers both primary and secondary healthcare costs, thus providing a comprehensive understanding of the financial implications of CVD on the Irish healthcare system. Direct comparisons with previous studies in Ireland are challenging due to differences in methodologies. Previous studies examined selected CVD endpoints^{14,15,42} or wider chronic disease burden,^{16,17} focusing on specific aspects of secondary care only^{15,16} or not calculating the incremental health service use



costs compared to our study.⁴ This can be due to the different methodologies used in the two studies.⁴ Our findings further build on the previous studies by providing estimates of the incremental healthcare service use attributable to CVD with the associated costs overall as well as by gender and age groups.

The number of hospital admissions attributable to CVD was twice as high in males than in females, with the cost per person associated with the incremental healthcare services use being 72% higher in males than in females. Significant gender disparities have been reported with respect to the presentation, prevention, and management of CVD internationally, although with conflicting results.^{43–46} An Australian study that reviewed the records of >50 000 patients from 60 primary healthcare services for the treatment of CVD risk found that, after adjustment for demographic and clinical characteristics and relative to males, females had lower odds of having sufficient risk factors measured for CVD risk assessment (OR: 0.88; 95% CI: 0.81, 0.96), with heterogeneity in the gender-specific prescription of guideline-recommended medications across different age groups.⁴³ Another study that involved 503 cardiologists in simulated decision-making for suspected coronary artery disease revealed that cardiologists have varying degrees of implicit gender bias for the characteristics of strengths and risk taking in patients with an immediate likelihood of CHD.⁴⁴ In a large retrospective cohort of US adults, females were less likely to fill a guideline-recommended prescription for high-intensity statins following hospitalization for myocardial infarction compared to males.⁴⁵ In another US study with over 20 000

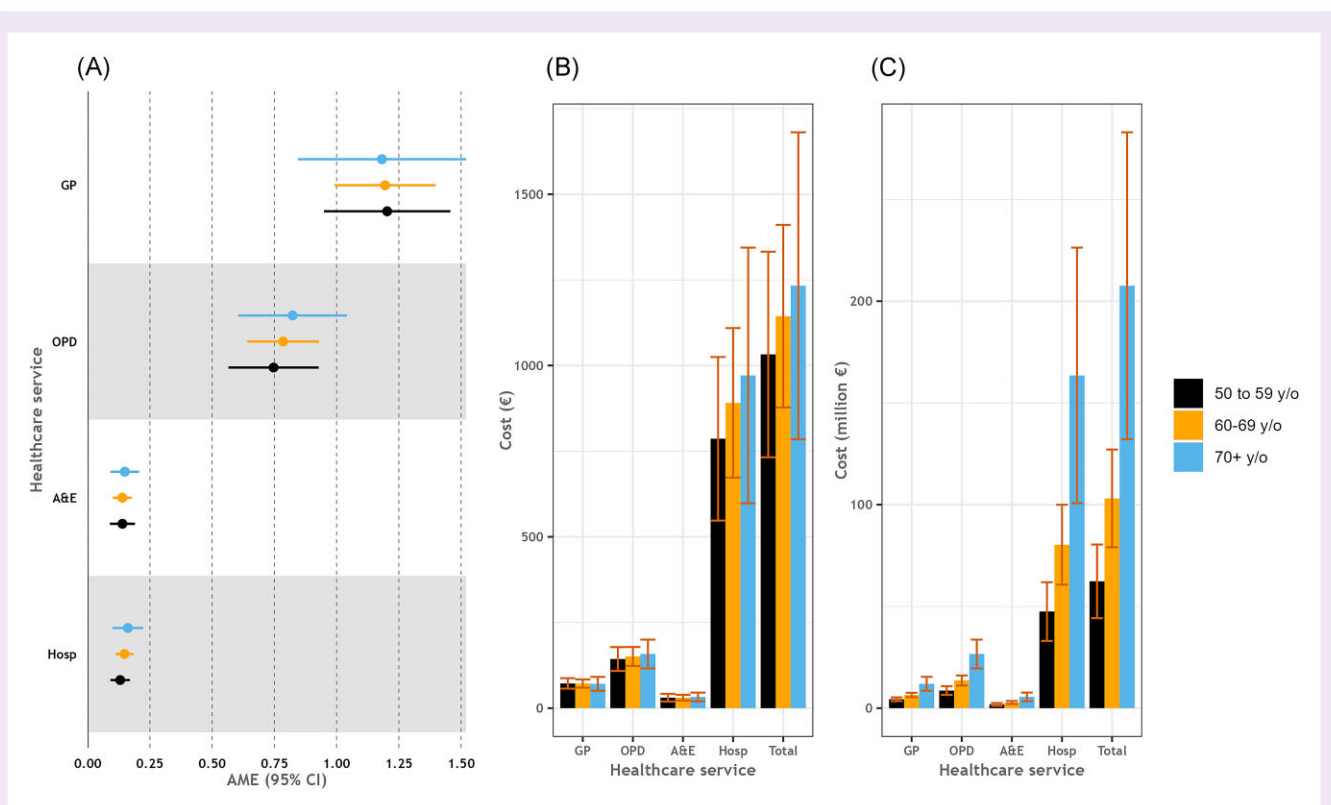


Figure 3 Incremental use of healthcare services attributable to CVD and associated costs stratified by age group. Legend: (A) Average marginal effects of CVD on healthcare services use, (B) cost per person of incremental healthcare services use attributable to CVD, and (C) population-level costs of incremental healthcare services use attributable to CVD. Estimates are given with 95% CI. CVD, cardiovascular disease; AME, average marginal effect; CI, confidence intervals; GP, general practitioner; OPD, outpatient department; A&E, accident & emergency department; and Hosp, hospital admissions.

participants of the Medical Expenditure Panel Survey, compared to their male counterparts, female adults with atherosclerotic CVD were less likely to report aspirin or statin use and more likely to utilize the emergency department two or more times per survey year.⁴⁶ They were also more likely to experience lower healthcare satisfaction, poor perception of health status, poor patient-provider communication, and lower health-related quality of life.⁴⁶ To the best of our knowledge, the findings of our study are among the first to suggest a gender disparity in the use of healthcare services attributable to CVD in Ireland. Further research is required to confirm these findings.

The higher use of GP services among individuals with CVD observed in our study suggests that a significant proportion of the burden of CVD is managed through primary healthcare services. This is in line with the chronic nature of CVD, whereby the majority of its burden is expected to be managed in primary care, with exacerbations often requiring acute care.¹¹ It is, however, interesting to note that just over 93% of costs associated with incremental healthcare service use attributable to CVD at the population level relate to secondary healthcare services. The population-level cost of the incremental healthcare service use attributable to CVD was estimated to €352 million in the current study, representing approximately 1.2% of total Irish healthcare expenditure for 2021.⁴⁷ For comparison, the cost of incremental healthcare service use attributable to diabetes in Ireland was almost four times lower (~€89 million) when estimated from the same data and applying the same methodology as used in our study.²⁰ Sláintecare, a 10-year programme, is a proposed reform of the Irish

healthcare system introduced in 2016. The aim of Sláintecare is to establish a universal single-tier healthcare service that ensures equitable access based on need rather than on the ability to pay and to move from the current hospital-centred system of healthcare provision to a primary and social care-focused system.¹³ In terms of management of CVD, this translates to managing all uncomplicated cases of already established disease in the primary healthcare setting where GPs act as gatekeepers to the secondary system, thus reducing the number of unnecessary hospitalizations. While this shift is currently ongoing, continued efforts aimed at CVD primary prevention are required for conditions that cannot be managed in primary care (e.g. heart attack) coupled with health promotion to further tackle the CVD burden on the Irish healthcare system.⁴⁸ Preliminary results from the Structured CDMP in Ireland are indicative of some improving trends over time in both self-reported and non-self-reported risk factors for CVD in this context.⁴⁹ The national implementation of the Integrated Model of Care for the Prevention and Management of Chronic Disease also emphasizes secondary prevention, self-management support, and the management of more complex CVD and multimorbidity in the community as important factors in reducing the burden of CVD in Ireland.¹¹ The implementation of Sláintecare together with the reorganization of the Irish healthcare system should be evidence-informed, and its performance should be assessed relative to the period prior to its introduction. As a period of considerable reform of the Irish health system is ongoing, our findings are of direct relevance in that they provide information on healthcare utilization among older adults with CVD in a period before the introduction of

Sláintecare and particularly the ICPCD and can serve as a baseline for future evaluations of healthcare services use for this cohort. Further analyses should establish the health service use attributable to CVD in more recent years and contrast these findings to our findings from 2009 to 2011.

It is important to consider the potential limitations of the current study when interpreting the findings. We cannot exclude the possibility of reverse causality due to the cross-sectional nature of the study; that is, the participants who attended the GP were more likely to be diagnosed with CVD. Nevertheless, 87% of the cohort reported visiting their GP at least once over the year preceding the interview, thus, reducing the potential for reverse causality. We also acknowledge that misclassification bias may have been introduced by individuals reporting their doctor's diagnosis of CVD. It has, however, been shown that self-report is a suitable measure for estimating the prevalence of CVD compared to electronic medical records, with substantial agreement between the two measures for stroke and myocardial infarction and moderate agreement for heart failure.⁵⁰ In addition, healthcare service utilization was also self-reported in the current study, introducing the potential for measurement bias. Self-report is, however, often used in health services research, and while evidence suggests a good validity of self-reporting for GP and OPD visits,^{51,52} the number of emergency department visits was found to be slightly overreported in one of the studies using data from TILDA.⁵¹ We anticipate that this would have unlikely impacted our main findings, as there were on average only 0.14 incremental A&E visits associated with CVD, accounting for less than 3% of the total costs attributable to CVD at a population level. Furthermore, while we aimed to explore the cost of the incremental healthcare service utilization attributable to CVD, we acknowledge that the total cost of CVD in Ireland is likely much higher. Other categories of healthcare costs relating to CVD, such as medication, have been found to contribute to this. For instance, medication expenditure was shown to account for between 11% and 52% of direct healthcare costs attributable to CVD across Europe, which came mainly secondary to hospital inpatient costs but was greater than the costs of GP, OPD, and emergency department visits.⁴¹ Moreover, data collection for the first wave of TILDA used in our study took place between 2009 and 2011. However, the results on the incremental healthcare service utilization attributable to CVD are still of relevance, as they refer to the period before the introduction of the CDMP in Ireland and can serve as a baseline assessment for the programme. Last, we were unable to distinguish between different types of hospitalizations in the current study and we thus applied the same costs across all hospital admissions. We acknowledge that the cost of hospital inpatient admissions may vary considerably depending on the type of CVD with which each patient presents (e.g. stroke vs. CHD), and this should be kept in mind when interpreting the results.⁴ Our study also has several strengths, including the comparison of CVD to no CVD to assess the incremental use of healthcare services attributable to CVD and the inclusion of both primary and secondary healthcare services in the analyses. Our results are also representative of the Irish general population over 50 years, and using census 2022 data, we have provided the total incremental costs attributable to CVD at the population level. Another strength of our study is reporting on AME. These are easily understandable and straightforward to interpret, contrary to incidence rate ratios that are the traditionally reported effect size from count data models and that only provide a relative measure of the relationship between exposure and outcome, without giving the true sense of the magnitude of effect.⁵³ Finally, to adjust for differential non-response, minimize the potential for selection bias and improve the representativeness of our findings, survey weights were applied to all the estimates.

Conclusions

Our findings suggest that while most CVD burden in Ireland is managed through primary care, more than 93% of the incremental costs attributable to CVD are generated through the use of secondary care services. While a shift towards the management of uncomplicated CVD cases in primary care is currently being implemented in Ireland, continued efforts aimed at CVD primary prevention and management are required to reduce health service costs attributable to CVD. Further research with regard to gender disparities in the use of healthcare services due to CVD is needed.

Supplementary material

Supplementary material is available at *European Heart Journal—Quality of Care and Clinical Outcomes* online.

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Data availability

The data that support the findings of this study are available from: <https://www.ucd.ie/issda/data/tilda/>.

Author contributions

D.S. had a primary responsibility for performing the analyses and drafting the manuscript. All authors made a substantial contribution to the conception or design of the work and interpretation of data and analyses. All authors contributed to the final manuscript, provided its critical revision and gave their approval for the final version to be published.

Authors' information

Not applicable.

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