

Comorbidities of Coronary Heart Disease and the Impact on Healthcare Usage and Productivity Loss in a Nationally-Based Study

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Abstract

Introduction: The combination of coronary heart disease (CHD) and comorbidities may complicate the clinical management resulting in an increased usage of healthcare and higher productivity loss. The aim of this study is to estimate the association between CHD and other chronic diseases and, to evaluate the impact of CHD with comorbidities on healthcare usage.

Methods: Data from the German Health Interview and Examination Survey (DEGS1), a national survey including a total of 8,152 adults aged 18-79 years, were analysed. Participants with and without a diagnosis of CHD were compared with respect to the ten most frequent chronic medical conditions of the DEGS1 survey. Regression models were applied to analyse the association between CHD and these comorbidities and to assess the effect of patients with at least one of these comorbidities in addition to CHD on healthcare usage.

Results: Overall, 9.32% of the study population reported having CHD. CHD was significantly associated with four of the ten examined chronic conditions: hypertension [80.7%; Odd ratio (OR)=3.18, 95% confidence interval (95% CI) 2.21-4.58], dyslipidaemia (68.3%; OR=2.27; 95% CI 1.69-3.05), diabetes mellitus (27.0%; OR=1.77; 95% CI 1.25-2.49) and thyroid disease (31.9%; OR=1.36; 95% CI 1.01-1.84). The number of days spent in hospital was significantly higher in CHD patients with comorbidity than those who had no chronic condition (OR=4.62; 95% CI 2.24-6.99).

Conclusion: The results of this nationally-based study demonstrate that some comorbidities are significantly associated with CHD and that those patients are prone to use more healthcare services, in particular inpatient care.

Keywords: Chronic conditions; Coronary heart disease; Comorbidity; Multimorbidity; Healthcare utilization

Abbreviation

BGS98: National health interview and examination survey 1998 (Bundes- Gesundheits survey 1998); BMI: Body Mass Index; CAD: Coronary Artery Disease; CHD: Coronary Heart Disease; CVD: Cardiovascular Disease; DEGS1: German health interview and examination survey (Studie zur Gesundheit der Erwachsenen in Deutschland); DPB: Diastolic Blood Pressure; SBP: Systolic Blood Pressure

Introduction

In the past years, awareness about the increasing prevalence of chronic health conditions and the impact of these conditions on healthcare utilization has grown [1]. One of the most important chronic conditions is coronary heart disease (CHD), since it remains the single largest cause of death worldwide and it tends to be among the most common conditions present in patients with multiple chronic conditions [2,3]. While there has been a decline in mortality, hospitalization for CHD has increased in the majority of European countries [4,5]. This is likely to reflect, at least in part, better treatment

leading to improved survival from heart attacks while at the same time resulting in sicker patients with, for instance, heart failure. However, other chronic conditions associated with CHD might also play an important role in the increase of healthcare utilization.

Cardiovascular disease (CVD), including CHD and blood vessel diseases, is usually present with more than one comorbid condition and different patterns have been discovered in various studies. For instance, Garcias-Olmos et al. demonstrated that CVD most often occurs in conjunction with diabetes and hyperlipidaemia [6]. Another study determined that CVD typically occurs in combination with hypertension, hyperlipidaemia, diabetes, and arthritis [7]. Only recently, Forman et al. reported on CVD and its relationship to other chronic diseases in American Medicare patients aged 65 and older [8]. Adults with CVD had a high prevalence of comorbidity and their 30-day readmission rates amplified progressively as their number of chronic diseases increased. Furthermore, Dharmarajan et al. demonstrated that half of readmissions within 30 days after hospitalization for myocardial infarction or heart failure are due to non-cardiovascular diagnosis, revealing the importance of understanding the relationships between diseases [9]. However, previous studies evaluating comorbidities in addition to heart disease have been based mostly on healthcare administrative data or medical record databases. Since these data were not collected for research

purposes, some important variables may be missing, selectively recorded, or inaccurate. Furthermore, the ability to adjust for potential confounders such as health-related factors and socio-demographic factors is limited in those data sets [10].

The aim of this study was to assess the relationship between CHD and the most common chronic diseases using data from a national survey of adults residing in Germany. We also sought to examine the association between these comorbidities and a number of key outcomes, such as the use of inpatient care, outpatient care and productivity loss among participants with CHD.

Method

Data

This study used data from the German Health Interview and Examination Survey for Adults (DEGS1), a national survey carried out by the Robert-Koch Institute. The survey sample included a total of 8,152 adults aged 18-79 years with permanent residence in Germany recruited from November 2008 to December 2011. Of these, 4,193 persons were newly enlisted for the DEGS1 survey and 3,959 persons had already participated in the National Health Interview and Examination Survey 1998 (BGS98). Sampling was performed using a two-stage stratified cluster. In the first stage, sample points were selected from a list of German communities and in the second stage men and women were randomly drawn from local population registries of the sample points. Details of the sampling strategy and protocol have been previously published [11]. Information on health status, medical history, health-related behaviour, socio-demographics and anthropometry were collected using detailed physician-administered computer-assisted interviews, self-administered questionnaires, physical examinations, as well as blood and urine sampling tests.

The implementation of DEGS1 conforms to the principles outlined in the Declaration of Helsinki and to the German Federal Data Protection Act. The DEGS1 study protocol was consented with the Federal and State Commissioners for Data Protection and approved by the Charite-Universitaetmedizin Berlin ethnic committee in September 2008 (No. EA2/047/08). Participants provided written informed consent prior to the interview and examination [11].

Study population and study variables

This study focused on participants with and without known CHD. We defined participants as having CHD who answered 'Yes' to the questions (1) "Have you ever been diagnosed with a circulatory disorder of the heart, a constriction of the coronary arteries or angina pectoris by a doctor?" or "Have you ever had a heart attack diagnosed by a doctor?". Overall, we identified 547 participants with physician-diagnosed CHD in the DEGS1 survey, all above 40 years of age. Consequently, we included all men and women aged 40-79 years in our analyses and our final study population comprised in total 5,782 adults, including 547 individuals with CHD and 5,235 without CHD.

A detailed assessment, which included questions and answers for each of the variables that we used in our analysis. We identified all chronic conditions of patients with CHD that were questioned in the DEGS1 survey, and selected the ten most prevalent chronic conditions for our analyses: hypertension, joint pain, hyperlipidaemia, osteoarthritis, adiposity, thyroid disease, gout, diabetes mellitus, depression, and cancer. Then we compared persons with and without

physician-diagnosed CHD with regards to those ten chronic diseases and analysed if there were any associations.

Participants of the DEGS1 survey were also asked about their healthcare utilization and productivity loss. Healthcare usage was differentiated into outpatient visits, inpatient visits and rehabilitation. Outpatient visits included visits to general practitioners, internal specialists, outpatient clinics and neurologists/ psychiatrists in the last 12 months prior to the survey. Inpatient visits comprised hospital admissions, number of days spent in hospital in the last 12 months, and rehabilitation in the last 36 months. To evaluate productivity loss, we obtained data on the number of sick days in the last 12 months prior to the survey and participants' retirement statuses. These outcome variables were used to estimate the impact of CHD and chronic diseases on healthcare usage and productivity loss.

Statistical analysis

Descriptive statistics were used to examine characteristics of the study population. All cross-sectional analyses were performed using multivariable logistic regression models and DEGS1 sample weights. The weights were adjusted for sampling and dropout possibilities, as well as deviations between the design-weighted net sample and German population statistics in 2010 in regards to age, gender, region, nationality, municipality, and education, to represent the German population aged 18-79 [11].

In accordance with previous studies, several factors were adjusted for, including age, gender, social status, educational status, employment status, smoking status, and body mass index (BMI) [12,13]. The data analysis was completed using STATA Statistical Software 14.1 and results are presented in odds ratios with 95% confidence intervals. Regressions were performed with and without sample weights to test the robustness of results.

Results

Sample characteristics

The characteristics of the study sample are summarized in Table 1. Of the 5,782 participants, a diagnosis of CHD was reported for 9.32% (n=547). Within the CHD subpopulation, 34.8% were female, 50% were 70-79 years old, and 43.6% were obese. After testing the significance of the adjusting variables, we observed that participants with CHD were more likely to be male, current smokers, and obese than those without CHD. CHD was further associated with higher age and unemployment status. We did not find any significant association between CHD, social and educational status. Nevertheless, the variables were included in the regression models in line with previous publications [13-15].

	CHD population (N=547) %(n)	Population without CHD (N=5235) %(n)
Gender		
men	65.2* (362)	47.73 (2383)
women	34.8 (185)	52.27 (2852)
Age groups		
40-49 years	8.06 (25)	35.01 (1497)

50-59 years	12.89 (60)	29.11 (1507)
60-69 years	34.07* (209)	19.73 (1293)
70-79 years	44.99* (253)	16.16 (938)
BMI status		
<18.5 kg/m ²	0.07 (1)	0.87 (35)
18.5 ≤ 25 kg/m ²	15.92 (76)	30.75 (1430)
25 ≤ 30 kg/m ²	40.47 (211)	41.65 (1908)
≥ 30 kg/m ²	43.55 (202)	26.74 (1207)
Physical inactivity (>2.5 h/w)		
No	80.54 (423)	82.08 (4108)
Yes	19.46 (95)	17.92 (901)
Smoking status		
Smoker	19.67 (85)	24.79 (1171)
Ex-smoker	46.13 (260)	33.11 (1751)
Never smoker	34.2 (196)	42.1 (2248)
Social status		
low	29.36 (114)	18.61 (756)
middle	56.36 (314)	60.32 (3105)
high	14.28 (111)	21.06 (1312)
Educational status		
low	27.28 (90)	19.07 (614)
middle	52.49 (263)	54.56 (2736)
high	20.24 (186)	26.37 (1823)
Employment status		
never	3.62 (12)	1.44 (52)
previous	70.31* (394)	36.55 (2058)
current	26.07 (114)	62 (2943)
(n) denotes the number of observations per variable. The prevalence rates are adjusted with weights to reflect the German population (2010). Physical activity (>2.5 h/w): physical activity (>2.5 hours per week) * indicates significance at the 0.05 level after adjustment for chronic conditions		

Table 1: Main characteristics of the study population.

Table 2 lists all chronic diseases according to their prevalence. For our analyses, we focused on the ten most frequent chronic diseases in the CHD sample population. After adjusting for these ten chronic conditions, men were 2.86 times (95% CI 2.04-4.00) more likely to have CHD than women. Additionally, the likelihood of having CHD increased with age. For instance, individuals in the age group 60-69 were 4.13 (95% CI 2.06-8.28) times more likely to have CHD than 40-49 years old and those aged 70-79 were 5.77 (95% CI 2.72-12.19) times more likely to have CHD than 40-49 years old. People aged

50-59 did not appear to be significantly more likely to have CHD than 40-49 years olds. Patients with previous employment were 1.55 (95% CI 1.01-2.38) times more likely to have CHD than those who were currently working.

	CHD population (N=547) % (n)	Population without CHD (N=5235) % (n)
Hypertension	80.7 (438)	40.61 (2282)
Joint pain in the last 12 months	70.99 (372)	62.19 (3211)
Dyslipidemia	68.27 (346)	35.16 (1834)
Adipositas (BMI ≥ 30)	43.55 (202)	26.74 (1207)
Osteoarthritis	40.91 (218)	27.24 (1435)
Thyroid disease	31.87 (180)	27.66 (1510)
Gout or high uric acid	30.25 (150)	11.51 (594)
Diabetes mellitus	27.02 (154)	7.96 (450)
Depression	17.58 (84)	13.04 (674)
Cancer	12.84 (75)	8.37 (480)
Osteoporosis	13.53 (69)	7.71 (284)
Migraine	11.6 (63)	12.38 (6450)
	10.35 (56)	7.41 (383)
Injuries/intoxications (past 12 months)	9.77 (53)	8.87 (450)
Stroke	9.48 (51)	2.54 (133)
Asthma	8.87 (48)	7.37 (384)
Anxiety disorder	8.29 (45)	5.24 (273)
Chronic kidney disease	8.09 (44)	1.65 (86)
Rheumatic arthritis	5.07 (27)	3.19 (165)
Burn Out syndrome	3.69 (20)	5.01 (261)
Chronic inflammatory bowel disease	1.85 (10)	1.46 (76)
Epilepsia	1.28 (7)	1.44 (75)
	0.55 (3)	0.5 (26)
(n) denotes the number of observations per variable. The prevalence rates of chronic conditions refer to participants providing information and are adjusted with weights to reflect the German population (2010).		

Table 2: Distribution of chronic diseases in the health population.

The number of chronic diseases in addition to CHD and the percentage of patients with comorbidities in the CHD population are presented in Table 3. Notably, 91.5% of individuals with CHD had at least one of the ten chronic diseases and approximately 50% had at least three of the conditions.

Number of chronic conditions	CHD population (N=547) % (n)	Population without CHD (N=5235) % (n)
0	1.89 (9)	13.06 (589)
01-02	18.8 (111)	45.79 (2350)
03-04	50.29 (263)	32.12 (1766)
≥ 5	29.02 (164)	9.03 (530)
with comorbidity (a)	91.42 (496)	65.59 (3550)

(n) denotes the number of observations per variable. The prevalence rates are adjusted with weights to reflect the German population (2010).
(a) Comorbidity defined as CHD with one or more of the top 10 chronic conditions.

Table 3: Distribution of the number of the ten chronic diseases and comorbidity.

CHD and the association with other chronic diseases

After controlling for possible confounders in multivariable analyses, a significant association between the ten chronic conditions and CHD was found for four chronic diseases (Table 4). Individuals with hypertension were 3.18 (95% CI 2.21-4.58) times more likely to also have CHD than those without hypertension. Furthermore, patients with hyperlipidaemia had a 2.26 (95% CI 1.69-3.05) higher likelihood, patients with thyroid disease had a 1.36 (95% CI 1.01-1.84) higher likelihood, and diabetic patients had a 1.77 (95% CI 1.25-2.49) higher likelihood to have CHD compared to patients without those chronic conditions.

Participants with CHD		
	OR (95 % CI)	STE
Hypertension	3.18* (2.21 to 4.58)	0.59
Joint pain in the last 12 months	1.18 (0.8 to 1.74)	0.23
Dyslipidemia	2.27* (1.69 to 3.05)	0.34
Adipositas (BMI >=30)	1.41 (0.91 to 2.19)	0.31
Osteoarthritis	1.04 (0.77 to 1.41)	0.16
Thyroid disease	1.36* (1.01 to 1.84)	0.21
Gout or high uric acid	1.39 (0.93 to 2.07)	0.28
Diabetes mellitus	1.77* (1.25 to 2.49)	0.31
Depression	1.89 (0.69 to 1.73)	0.26
Cancer	1.26 (0.84 to 1.87)	0.24
Having Comorbidity (1)	4.43 (1.70 to 11.62)	2.17

OR: Odds ratio. STE: Standard Error.
*denotes significance at the 0.05 level
(1) Comorbidity defined as CHD with one or more of the top 10 chronic conditions or adjusted to age, gender, social status, educational status, employment status, smoking status, and body mass index (BMI).

Table 4: Association between CHD and the ten frequent chronic conditions in the DEGS1 survey.

The impact of comorbid CHD on healthcare usage and productivity loss

The prevalence of outpatient visits, inpatient visits, and productivity loss among participants with CHD is shown in the Table 5. Sixty-one percent of individuals with CHD consulted an internal specialist and 28% went to outpatient clinics in the past 12 months prior to the survey. In addition, 31% of participants with CHD indicated that they were sick eight or more days in the past 12 months and 21% of CHD patients retired due to illness.

	CHD population (N=547) % (n)	Population without CHD (N=5235) % (n)
Outpatient care visits (in the past 12 months)		
General practitioner	86.87 (454)	79.91 (4088)
Internal specialist	61.29 (320)	21.93 (1175)
Outpatient clinics	28.7 (141)	17.2 (841)
Neurologist or psychiatrist	15.05 (73)	9.31 (482)
Inpatient care visit (in the past 12 months)		
Hospital admissions	31.63 (1720)	12.63 (694)
Number of days spent in hospital (mean, SE)	3.54 (0.49)	1.29 (0.29)
Rehabilitation (in the past 36 months)	25.44 (125)	11.7 (621)
Productivity loss		
Number of sick days (in the past 12 months)		
0 days	58.79 (257)	51.39 (2418)
1-7 days	10.25 (60)	21.68 (905)
8 or more days	30.96 (146)	26.93 (1137)
50 or more days		
Retirement		
no	64.74 (104)	90.49 (3127)
due to age	5.01 (9)	2.03 (91)
early	9.34 (16)	3.43 (32)
due to illness	20.91 (28)	4.04 (160)

(n) denotes the number of observations per variable. The prevalence rates are adjusted with weights to reflect the German population (2010)

Table 5: Distribution of healthcare usage and productivity loss.

The effects of CHD with comorbidity on the frequency of healthcare use and sick days are summarized in Table 6. Although patients with CHD and at least one of the ten concomitant chronic diseases were not more likely to seek a hospital in the last 12 months than those without one of those conditions, the former spent on average 4.62 more days in hospital in the last 12 months (95% CI 2.24-6.99). No significant

impact on the use of general practitioners, internal specialists, and neurologists/ psychiatrists was observed for individuals with both CHD and at least one of the ten chronic conditions compared to individuals with only CHD.

Participants with CHD and comorbidity		
	OR (95 % CI)	STE
Outpatient care visits (in the past 12 months)		
General practitioner	0.74 (0.48 to 11.29)	1.02
Internal specialist	0.39 (0.05 to 3.00)	0.4
Outpatient clinics	0.69 (0.11 to 4.31)	0.64
Neurologist or psychiatrist	0.58 (0.05 to 7.10)	0.74
Inpatient care visit (in the past 12 months)		
Hospital admissions	1.64 (0.70 to 3.88)	3.88
Number of days spent in hospital (1)	4.62* (2.24 to 6.99)	1.2
Rehabilitation (in the past 36 months)	2.51 (0.19 to 32.17)	3.25
Productivity loss		
Number of sick days (in the past 12 months)	5.13 (0.60 to 43.74)	5.57
50 or more sick days	2.36 (0.37 to 14.91)	2.26
OR: Odds ratio. STE: Standard Error. * denotes significance at the 0.05 level. (1) This result is a coefficient value, derived from a linear regression. OR adjusted to age, gender, social status, educational status, employment status, smoking status, and body mass index (BMI).		

Table 6: Effect of CHD patients with comorbidities compared to CHD patients without comorbidities on healthcare usage and productivity loss.

A potential association with early retirement could not be evaluated due to the low number of observations. The detailed information about the multivariate regression models is listed. No significant differences were found between the analyses with and without DEGS1 weights, supporting the robustness of results.

Discussion

The objective of the present study was to describe the frequency and association of important comorbidities of CHD patients in a national-wide population and to analyse the healthcare usage. Our observation that approximately 50% of adults with CHD reported at least three concurrent disorders is in line with previous findings by Arnett et al. [16]. In the present study, we found that patients with one of the four comorbidities (hypertension, dyslipidaemia, diabetes mellitus, or thyroid disease) were more likely to have CHD. CHD was particularly related to hypertension and dyslipidaemia, with odds ratios increased more than twofold. Similarly, some previous published studies have reported that CHD is often present together with an increased prevalence of hyperlipidaemia and hypertension, especially in the older population [17,18]. Our study supports the fact that three of the four comorbidities (hypertension, dyslipidaemia and diabetes mellitus) are known major risk factors of CHD [19]. However, the association

between thyroid disease and CHD remains still unclear, even if there is some evidence in the literature suggesting a relationship between abnormal thyroid function and CHD [20,21]. Both hypo- and hyperthyroidism have been related to an increased risk of CHD [12,22]. This connection may be explained by the direct effects of thyroid hormones on the cardiovascular system or by the indirect changes in lipid profile and blood pressure [23,24].

Although CHD patients with comorbidities were not more likely to report admittance to a hospital in the last 12 months prior to the survey than those without one of these conditions, the average number of days spent in hospital in the last 12 months increased significantly with the presence of one or more comorbidities. We have not found any comparable literature evaluating comorbid CHD-related readmission in the last 12 months, but Broemeling et al. demonstrated that the likelihood of an overnight stay increased with the number of chronic conditions and that people with at least three chronic diseases are more than four times as likely to be admitted to the hospital than those with none [25]. Moreover, Dunlay et al. demonstrated that 30-day readmission rates increased significantly in patients with comorbidities following acute myocardial infarction [26].

One strength of our study is the large data source of a national survey with 8,152 participants. Our analyses were based on data that consisted of detailed information on individual characteristics. These included socio-demographic factors and behavioural factors, as well as a range of chronic conditions. Furthermore, all results were weighted to adjust for sampling probabilities and selective participation in order to ensure representativeness at the population level and to enhance generalizability of the present findings to the adult population in Germany [27]. Lastly, by assessing the association of major chronic disease comorbidities with healthcare utilization and productivity loss in German CHD patients, our findings extend previous research addressing the effect of chronic conditions on the use of health services in Canada and Europe [13,25].

We evaluated self-reported medical diagnosis and healthcare services cross-sectionally in a retrospective study. Although this is considered an established method for assessing morbidity in epidemiological studies [28], the retrospective nature of this study is its biggest limitation. First, confounders may influence the analytic results and it is necessary to adjust the results for potential confounding effects. We adjusted the odds ratios for several factors, including age, gender, social status, educational status, employment status, smoking status, and body mass index (BMI) in our multivariable analysis. Although these variables have been used in previous studies, we may have missed some important confounding variables [12,13]. Furthermore, due to the retrospective design of the study some important clinical characteristics may have not been sufficiently recorded.

Second, the retrospective aspect of the study may introduce misclassification, recall and selection bias and therefore limit the validity of the results. The diagnosis for CHD was obtained by a physician-administered questionnaire that showed in a study by Eliassen et al. a very high positive predictive value (93.1%) [29]. Nevertheless, misclassification in the context of underreporting CHD cannot be excluded, particularly among women. Wenger et al. stated that a disproportional number of women do not highlight CHD as their major health concern and that CHD screening tests are performed less frequently in women than in men [30]. Moreover, participants' responses to the questions were depending on the ability to recall diagnosis and past events. This study included self-reported

measures of behavioural factors, such as smoking status, chronic diseases, healthcare utilization, and productivity loss. Similar to a study by Raina et al., underestimation of their prevalence may have influenced our results [31]. The older population, especially, tends to under-report estimates of healthcare utilization in questionnaires. In particular, recall bias in healthcare utilization was reported for physician visits (-70%) and for in-hospital days (-21%) [32]. Selection bias may also be an important limitation in this study. To avoid selection bias and to have a representative German population aged 18-79, a two-stage sampling procedure was developed [11]. However, the response rate of the DEGS1 survey was 64% among the former BGS98 participants and 42% among the new sampled participant. Although these rates are similar to other European studies, we cannot rule out selection bias [33]. Furthermore, the survey was restricted to the population in private households and to those who sufficiently speak German. Elderly living in nursing care facilities and people, who were too sick to answer the survey invitation letter, were not included in the study population.

We did not include pharmacological history of the participants in our regression model, since we did not have all necessary detailed information on their medication. Moreover, not all components of productivity loss associated with comorbidities in addition to CHD could be assessed. The observations for retirement, in particular due to illness, were very low in both CHD and non-CHD participants, thus a regression analysis could not be performed. We also did not include the deceased in our analysis of productivity loss because we lacked relevant data.

The DEGS1 survey covered a selection of prevalent chronic conditions which might have influenced our results. We selected the ten most frequent chronic conditions for our analysis, which reduced comparability to other studies and might have resulted in missing associations. It is noteworthy that the main reason for this limitation is the lack of internationally accepted standards for evaluating multi- or comorbidity [34]. There is limited consensus on the number and type of conditions to be considered and some studies are based on patient-reported data, while others are based on administrative databases or medical records.

The findings of this study contribute to a better understanding of the complexity of different comorbidities in combination with CHD by characterizing their associations and by analysing the impact on healthcare utilization and productivity loss. Knowledge about the association between comorbidities and CHD may be important for individual patient care, because a large amount of health gain may be attained by prevention, timely recognition and appropriate treatment of comorbidities. Special programmes addressing certain comorbidities of CHD patients may lead to a reduction in healthcare usage and costs. One approach may be the introduction of a care manager, who acts as a middleman between physicians and patients. A previously published study by Ciccone et al. demonstrated that incorporating care managers in the management of patients with CVD, diabetes, heart failure and CVD risk improves self-management skills and achieves better compliance with care recommendations [35]. This program resulted in a significant improvement in the clinical parameters and better control of patients' disease. However, the project was implemented only for an 18-month period. Further research should investigate if similar programs such as this disease and care management model are feasible and effective in the long term.

Conclusion

In summary, the results of this nationally-based survey support the importance and implications of comorbidity burden and risk factors in CHD patients. In particular participants with hypertension, dyslipidaemia, diabetes mellitus and thyroid disease are significantly more likely to also have CHD. Moreover, patients with CHD and at least one other high-frequent comorbidity are prone to use more healthcare services.

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