



Gender bias in the diagnosis of cardiovascular disorders in Catalonia

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ABSTRACT

In this study, we examine patient gender bias on the probabilities of both visiting the cardiologist and of being diagnosed with a heart disease. Using data from the Catalan Health Survey, we are able to conclude that there is gender bias both in access and diagnosis for patients with high likelihood of suffering heart issues. Our findings suggest that women have lower probabilities of visiting the cardiologist and of being diagnosed with a heart disease after controlling for risk factor and demographics characteristics.

1. Introduction

The World Health Organization (WHO) states that cardiovascular diseases (CVD) are a leading cause of death globally [1]. CVD are the primary cause of death among women, and they have a lower survival rate following an acute cardiovascular event compared to men [2]. In 2019, CVD accounted for 35% of total global deaths among women, making their relative risk of CVD morbidity and mortality even higher [3].

CVD have traditionally been referred to as a "male" disease due to its higher incidence among men, and medical research has often been conducted on male patients. This has resulted in a lack of recognition of symptoms that are more common among women, such as cold sweats, nausea, vomiting, and unusual tiredness (Erlinger et al. 2020). The typical symptoms of myocardial infarction, such as chest discomfort, pain in one or both arms, and difficulty breathing, are not representative of these common symptoms experienced by women. These findings highlight the need for increased awareness and understanding of the different symptoms of CVD in women to improve their diagnosis and treatment.

The Lancet Commission [4] highlights that the higher relative risk of mortality among women due to CVD is largely due to under-studied, under-recognized, under-diagnosed, and under-treated conditions globally. Women have historically been excluded from cardiovascular

clinical trials, hindering the ability to measure the effectiveness of treatments for them or to identify gender-based differences in health outcomes. These factors can impact the strategies and policies implemented to address these disparities [4].

Gender bias is not a novel phenomenon and is also evident in other settings such as the labor market and education. However, the examination of gender differences in diagnostics and the broader healthcare sector is still in its early stages. This study aims to contribute to the growing body of evidence on gender bias in access to specialized healthcare, specifically cardiologist visits by women compared to men.

The scarcity of data in this area may be due to a lack of studies, including the difficulty in including individuals who remain undiagnosed but are suffering from CVD. Utilizing cross-sectional health survey data from Catalonia (Enquesta de Salut de Catalunya, ESCA) from 2016 to 2017, we estimate the probabilities of visiting a cardiologist and being diagnosed with a heart condition. Our findings indicate that women with high-risk factors for heart diseases, such as hypertension, high Body Mass Index (BMI), and diabetes, have a lower probability than men of being referred to a cardiologist and receiving a diagnosis for cardiovascular disease.

In this study, we aim to contribute to the current understanding of discrimination by investigating the role of gender in accessing specialized healthcare, specifically in the cardiology field. Our focus is to determine whether there is evidence of gender-based discrimination in

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the probability of visiting a cardiologist or receiving a diagnosis for a heart condition. This research represents a crucial step in understanding the underlying factors that contribute to disparities in healthcare access and outcomes and sheds light on the importance of addressing any biases that may exist within the medical system. By providing insight into this under-explored area, we hope to inform policies and practices that promote equal access to healthcare for all individuals, regardless of gender.

The existing literature on gender bias in cardiovascular diseases is limited. However, according to a study by Møller-Leimkuhler [5], women with acute myocardial infarction tend to present with atypical symptoms such as abdominal pain, dyspnea, and unexpected fatigue, which may be less recognized by physicians compared to the typical male complaint of chest pain. This leads to misconceptions about the risks and symptoms of CVD, resulting in inadequate screening and lower probabilities of seeing a cardiologist for women. The main risk factors for CVD were previously assumed to be the same for both genders, however, physiological and pathological differences between men and women have been observed, including narrower arteries, distinct electrical properties, and different plaque composition and development in women [5]. According to Legato [6], these differences could result in distinct CVD patterns between men and women.

Multiple studies have shown that if a woman experiences a myocardial infarction (MI), she is more likely to have a worse prognosis and poorer health outcomes compared to men [7]. A recent VIRGO (Variation in Recovery: Role of Gender on Outcomes of Young Acute Myocardial Infarction Patients) analysis has shed even more light on this issue, revealing that women are 11% less likely to be at risk of experiencing an MI than men [8]. These findings highlight the importance of better understanding the unique challenges that women face when it comes to heart health, and the need for improved awareness and support to help mitigate these disparities.

The rest of the study is structured as follows: Section 2 presents the data and methods used in our study, while Section 3 presents the results. In Section 4, we discuss the finding and finally, in Section 5 we draw conclusions.

2. Materials and methods

In Spain, particularly in Catalonia, the public health system operates such that patients can only receive specialized medical services, such as seeing a cardiologist, after being referred by either a general practitioner or through an emergency room visit. This system creates two points of potential gender bias in the medical treatment process.

Firstly, the initial screening by a general practitioner may exhibit gender bias, potentially leading to unequal or incorrect diagnosis or referral. Secondly, the specialized clinician may also exhibit gender bias in their assessment and treatment of the patient.

It is important to note that these potential biases can have serious consequences for patients and their health outcomes. Therefore, it is crucial to address and eliminate any sources of gender bias in the healthcare system to ensure equal and effective medical treatment for all patients.

To answer whether there exists a gender bias in the Catalan Healthcare System with regard to CVD, we have used the microdata from the 2016 and 2017 rounds of the Catalan Health Interview Survey (*Enquesta de Salut de Catalunya, ESCA*). This is a cross-sectional survey that interviews more than 5000 people every year since 2010 in Catalonia. The survey collects information from individuals of all ages living in Catalonia, on their health status, lifestyle habits, and socio-economic conditions, among many other variables. We use the most recent years 2016 and 2017 where the variables of interest are presented in both surveys, where the survey collects information on specialist visits for cardiologists.

As cardiovascular diseases are uncommon among the younger age cohorts, we dropped individuals under 40 years old. This process leaves

a sample of 5122 individuals. Table A0 presents the descriptive statistics of the outcome variables for both men and women, including whether they visited a cardiologist in the past 12 months and whether they were diagnosed with heart pathology. The table also includes statistics for the set of control variables, such as age, province, smoking status, body mass index, and others, which are included in our model.

We noticed that a higher proportion of men compared to women had visited a cardiologist in the past year. Men typically have a higher Body Mass Index (BMI) and smoke more frequently, while women are slightly more educated and typically have twice the amount of caregiving responsibilities compared to men. There are hardly any differences in regards to the "make ends meet" variable, which was included as a control for household income as data for household income was not available in the dataset, as well as in regards to the variable indicating whether the interviewee has private insurance or not (as can be seen in the table in the online appendix).

We observe differences in the relative importance of specific causes of mortality among men and women. CVD are the leading cause of death for women (see Figure A1), and they also have a higher relative importance than for men. In line with the results stressed by the [3] report, we find that in Catalonia women have a higher relative risk of dying due to cardiovascular diseases than men.

Figure A2 shows how each dependent variable is distributed differently among the various age cohorts. Both outcome variables feature the same trend for both genders, with increases by age. Moreover, for every age group, it is the case that more males have visited the cardiologist and also that more men are diagnosed with heart issues than women.

We attempt to measure the respondents' exposure to risk factors by including variables that tell whether people are taking medication for High Blood Pressure, Cholesterol, Diabetes, or Other Heart Diseases, or if they are not. We use drug intake rather than self-reportedly diagnosed variables as we believed that this measure would control better for the fact that someone was really experiencing these conditions or was preventing them with such medication. Figure A3 shows that medication intake increases with age for each condition included, and that usage patterns are similar for men and women. The National Health Interview Survey (US, 2009) reports that 25% of men did not have any medical office visits recorded in the past 12 months, compared to 12% of women [9], indicating that women in the US are more likely to visit primary care services than men. The same trend can be seen in Catalonia, where 24.4% of women visited any type of clinician in the previous two weeks, compared to only 18.9% of men during the same period, regardless of the time of year the survey was conducted, social class, or age. Similar findings have been reported by Fernandez et al. [10].

To evaluate the impact of gender on the likelihood of visiting a cardiologist, we conduct an analysis using a linear probability model. The dependent variable in this model is a binary indicator, indicating whether an individual has seen a cardiologist in the past 12 months.

In order to estimate the potential causal relationship, we control for various factors in our model. These include a binary indicator for female individuals, age, attendance at a general practitioner in the previous 12 months, number of emergency room visits in the previous year, body mass index, and a set of explanatory variables for heart diseases or risk factors (see Table A0 for the variables included).

Additionally, we take into account various lifestyle habits, such as drinking and smoking, and socio-economic factors such as difficulty making ends meet, nationality, education, and others. By controlling for these factors, we aim to isolate the effect of gender on the likelihood of visiting a cardiologist. Finally, we have year and health regions (Basic Healthcare Areas) fixed effects. The Healthcare Area is the most basic geographic health delimitation that serves as a reference for the planning and organization of the work of the "Primary Care Teams", the area reflects also the urban and rural indicators of the patients associated with that area. The standard errors are clustered in the Basic Healthcare Areas to control for the variance between these 43 health administrative divisions in Catalonia.

Using the same model we estimate also the probability of being diagnosed with a Myocardial Infarction (MI) or any Other Heart Disease (OHD), where the dependent variable is a dummy that takes the value of 1 for those individuals who had been diagnosed with a Myocardial Infarction and/or any Other Heart Disease during their life. We have omitted from the model variables relating to drugs for CVD with a group of self-reported diagnosis dummy variables indicating whether individuals were previously suffering from heart risk factors to avoid possible reverse causality. We have also included a variable to indicate whether the individual has visited a cardiologist in the last 12 months, as this could be directly related to a higher chance of a diagnosis of a heart condition.

Three different specifications of the model are run, adding further control variables and using the specific sample of individuals prone to suffer from serious heart conditions, as described in the previous section.

3. Results

In order to assess the effectiveness of the risk factor variables as predictors for a diagnosis of cardiovascular disease (CVD), we estimated the probability of reporting a myocardial infarction in our sample. The results, presented in Table 1, indicate that all variables, with the exception of overweight, are strong predictors.

To examine the relationship between these variables and the probability of visiting a cardiologist, we estimated three models with varying controls, the results of which are displayed in Table 2. The key coefficients of interest in our study are those associated with the "Female" variable.

Our findings demonstrate that the "Female" variable has a significant coefficient in all three models, suggesting that there are gender-based differences in the probability of visiting a cardiologist. The negative coefficients indicate that, even after controlling for health status and risk factors, women have a lower probability of visiting a cardiologist than men.

The results show that the probability of female individuals visiting a cardiologist is lower compared to males, especially when lifestyle habits and socioeconomic factors are considered in the regression analysis (column 2). Furthermore, the coefficients for individuals taking medication for risk factors (column 3) are larger in absolute terms, indicating that the gap between the genders is wider among this sub-sample. Older individuals, and those taking medication for cholesterol (CHO), other heart diseases (OHD), and diabetes (DIA), have a higher likelihood of

Table 1
Effects of the potential explanatory variables on having a myocardial infarction.

(1) VARIABLES	Probit
High Blood Pressure (0.0842)	0.179**
Cholesterol	0.275*** (0.0701)
Diabetes (0.0839)	0.405***
Overweight (0.0745)	-0.0287
Tobacco Consumption (0.0836)	0.278***
Observations	4703

Notes: This Table provides the Probit estimates for the effect of these variables on having a Myocardial Infarction. Using the sample of individuals over 40 years old and controlling for individual's age, Catalan Health Regions, visits to the general practitioner and to the emergency room, alcohol consumption, physical activity, education, making ends meet, hours of care work, and nationality. Year-fixed effects are also included. Standard errors clustered at the Healthcare Management Area level are in parentheses. Significant levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Own elaboration with 2016 and 2017 Catalan Health Interview Survey data.

Table 2
Effect of biological sex and control variables on the probability of visiting the cardiologist.

VARIABLES	(1)	(2)	(3)
Female	-0.128** (0.0586)	-0.189*** (0.0699)	-0.367*** (0.0755)
Age 56–70	0.185** (0.0831)	0.236*** (0.0859)	0.238** (0.0948)
Age over 70	0.332*** (0.0863)	0.465*** (0.150)	0.514*** (0.158)
Medication for HBP	0.0881 (0.0679)	0.0811 (0.0716)	
Medication for CHO	0.189*** (0.0573)	0.189*** (0.0550)	
Medication for OHD	1.565*** (0.0806)	1.588*** (0.0813)	
Medication for DIA	0.149** (0.0694)	0.164** (0.0723)	
Visited General Practitioner last 12 months	0.427*** (0.113)	0.466*** (0.115)	0.695*** (0.187)
Emergency Room visits last 12 months	0.0595*** (0.0163)	0.0584*** (0.0182)	0.102*** (0.0242)
Private Insurance		0.282*** (0.0670)	0.316*** (0.0918)
Observations	5118	5107	2147
lifestyle habits	NO	YES	YES
SE controls	NO	YES	YES

Notes: This Table provides the Probit estimates for the effect of these variables on the probability of having visited the cardiologist. Columns (1) and (2) use the sample of individuals over 40 years old, and column (3) uses the sample of individuals over 40 years old that take medication for risk factors of heart diseases. Year-fixed effects included. Besides from the control variables shown in the table, we have also controlled for the Catalan Health Regions, Body Mass Index, tobacco consumption, alcohol consumption, physical activity, education, making ends meet, hours of care work and nationality. Standard errors clustered at the Healthcare Management Area level are in parentheses. Significant levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Own elaboration with 2016 and 2017 Catalan Health Interview Survey data.

visiting a cardiologist. However, taking medication for high blood pressure (HBD) does not significantly impact the probability of a cardiologist visit.

The study also found that visiting a general practitioner or emergency room in the last 12 months and having private insurance increase the probability of a cardiologist visit.

Table 3 shows the estimated likelihood of a diagnosis for Myocardial Infarction or another heart disease. Women have a lower probability of being diagnosed compared to men, as evident in all three columns of the table. The effect is more pronounced in the sub-sample of patients taking medication for risk-related conditions. Differences in the coefficients of the variables can be seen between the two specifications with/without lifestyle habits and socioeconomic controls, but the most significant changes occur in the third column when considering only those with at least one risk factor.

The likelihood of being diagnosed with myocardial infarction (MI) or other heart diseases (OHD) increases with age, particularly for those over 70 years old who also have one or more risk factors. Analysis of the data shows that high blood pressure (HBP) has the largest impact on the probability of a MI or OHD diagnosis, with those suffering from HBP having the greatest chances of being diagnosed with heart disease. Although taking medication for HBP does not significantly affect the probability of visiting a cardiologist, it is a significant factor once the individual has made a visit.

Suffering from high cholesterol, diabetes, and varicose veins (VSC) also has a positive impact on the probability of being diagnosed, although their effects are not statistically significant at any level of significance.

Table 3

Effect of biological sex and control variables on the probability of being diagnosed with a myocardial infarction or another heart disease.

VARIABLES	(1)	(2)	(3)
Female	−0.261*** (0.0571)	−0.288*** (0.0682)	−0.315*** (0.0697)
Age 56–70	0.265*** (0.0935)	0.244*** (0.0913)	0.480*** (0.107)
Age over 70	0.737*** (0.0840)	0.650*** (0.156)	0.830*** (0.178)
Suffer from HBP	0.296*** (0.0579)	0.296*** (0.0594)	
Suffer from CHO	0.145** (0.0735)	0.156** (0.0731)	
Suffer from DIA	0.147** (0.0701)	0.119* (0.0716)	
Suffer from VSC	0.146* (0.0770)	0.136* (0.0796)	
Visited the Cardiologist last 12 months	1.700*** (0.0557)	1.713*** (0.0632)	1.670*** (0.0792)
Visited General Practitioner last 12 months	0.546*** (0.144)	0.511*** (0.146)	0.520*** (0.175)
Emergency Room Visits last 12 months	0.0545*** (0.0137)	0.0394*** (0.0150)	0.0415** (0.0183)
Private Insurance		−0.116 (0.0709)	−0.0251 (0.0849)
Observations	5112	5101	2947
lifestyle habits	NO	YES	YES
SE controls	NO	YES	YES

Notes: This Table provides the Probit estimates for the effect of these variables on the probability of being diagnosed a Myocardial Infarction or another Heart Disease. Columns (1) and (2) use the sample of individuals over 40 years old, and column (3) uses the sample of individuals over 40 years old that suffer from high blood pressure and/or cholesterol and/or diabetes and/or varicose veins. Year fixed effects included. Besides from the control variables shown in the table, we have also controlled for the Catalan Health Regions, Body Mass Index, tobacco consumption, alcohol consumption, physical activity, education, making ends meet, hours of care work and nationality. Standard errors clustered at the Healthcare Management.

Area level are in parentheses. Significant levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Own elaboration with 2016 and 2017 Catalan Health Interview Survey data.

As cardiologists are responsible for diagnosing MI or OHD, visiting them should increase the probability of being diagnosed with cardiovascular disease (CVD), which is evident in Table 3. Having private insurance has been shown to be a determining factor in explaining the probability of visiting a cardiologist, but it does not affect the likelihood of being diagnosed with heart disease.

4. Discussions

The finding that otherwise similar individuals have significantly different outcomes solely based on their gender is a crucial observation for society and policymakers, as it confirms persistent trends in gender discrimination.

Given the importance of gender inequalities in today's society, policymakers should take action to close the existing gaps in various areas between men and women. In the context of our study, it is critical to start by addressing the gender bias present in the healthcare sector, specifically in cardiology and the lower levels of treatment received by women compared to men.

We acknowledge that our dataset may not be representative of the entire population, and this may limit the external validity of our findings. Despite these limitations, we believe that our study provides valuable insights into the issue at hand and highlights the need for further research to address these limitations.

To address these inequalities in the short term, informational campaigns aimed at raising awareness about the differences in the causes,

symptoms, and treatment of cardiovascular disease (CVD) among genders would be a good first step. Additionally, healthcare professionals, including both cardiologists and general practitioners, should participate in training sessions to improve their diagnosis and treatment tools and overcome gender bias in their services.

5. Conclusions

The presence of gender discrimination is a complex issue that is not limited to healthcare or any other specific field. There are many factors that contribute to gender inequality, including gender-specific characteristics and deeply ingrained societal stereotypes that persist even today. Our study reveals that women have a lower probability of visiting a cardiologist and of being diagnosed with a heart condition compared to men, even when controlling for various risk factors, healthcare utilization, lifestyle habits, and socioeconomic characteristics.

While the association between only having secondary education and a higher likelihood of visiting a cardiologist is noteworthy, economic difficulties have a negative impact on both the probability of visiting a cardiologist and being diagnosed with a heart condition. These results are indicative of a gender bias in the healthcare sector.

We believe that this disparity in doctor turnout for men and women can be traced back to societal norms that continue to place women at a disadvantage in both work and family contexts, as well as to a lack of gender-adapted standards in medical diagnosis. Addressing these biases requires a multi-faceted approach, including awareness-raising campaigns for both the general public and healthcare professionals and training programs for medical professionals to ensure that they are equipped with the tools and knowledge necessary to provide gender-sensitive diagnoses and treatments.

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All the authors declare that they do not have any conflict of interest. They disclose any paid or unpaid positions as officer, director, or board member of relevant non-profit organizations or profit-making entities.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.healthpol.2023.104823.

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